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Private Sector Investment to Build Climate Resilience in Niger's Agricultural Sector: Introducing Improved Irrigation Systems and Climate Resilient Seeds

Final Report

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Submitted by

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For public release

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Preface

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

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

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

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

IFC is responsible for sub-components of the above projects that focus on engaging the private sector in the PPCR and catalyzing investment in climate change adaptation activities. For Niger, increased climate resilience and improved food security are closely interlinked. Unless adaptation measures are put in place, climate change is likely to increase the risk of famine and social collapse. Investigations in the three under mentioned areas were taken up with a view to build climate resilience in Niger's agricultural sector by mobilizing the private sector.

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

The present study pertains to point one above and focuses on assessing the prospects of using improved irrigation and climate resilient seeds to adapt to climate change impact in Niger.

This study analyzes suitable improved irrigation systems for agriculture in the country, their economic viability, and the necessary steps to be taken towards introducing these improved irrigation systems in the country. A suitable business model for financing the sector has also been explored as the final step in the study.

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

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

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

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Acronyms

APPSN	Association Des Producteurs Prives de Semence du Niger
CCFAN	Consultative committee on the groundnut industry in Niger
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Centre)
DFI	Decentralized Finance Institutions
ECOWAS	Economic Community of West African States
ERR	Economic Rate of Return
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
IFC	International Finance Corporation
IITA	International Institute of Tropical Agriculture
INRAN	National Agricultural Research Institute of Niger
INS	Institut National de la Statistique
IRR	Internal Rate of Return
NAPA	National Action Programmes for Adaptation
NAPA	National Action Programmes for Adaptation [IFC notes that this is a duplicate listing.]
O&M	Operation and Maintenance
ONAHA	Office National des Amenagements Hydro-Agricole
PACRC	Community Action Project for Climate Resilience
PDIPC	Climate Information Development and Forecasting Project
PPP	Public-Private Partnership
PROMOVARE	Project for the Mobilization and Development of Water Resources
SCF	Strategic Climate Fund
SDR	Strategy for Rural Development
SPCR	Strategic Program for Climate Resilience
UEMOA	West African Economic and Monetary Union
WASA	West Africa Seed Alliance

1 Executive Summary

Niger is a Sahelian country with three quarters of its territory being desert. About 80% of the population depends on agriculture and subsistence farming and stock rearing contribute approximately 40% to the GDP (second only to services, which provide 42%). Nearly three-quarters of the labor force is employed in this sector. Agricultural activity in Niger is mainly rainfed and, therefore, is highly vulnerable to climate induced hazards particularly drought. Considering this, it is important to invest in improved irrigation and the use of climate resilient seeds for agriculture in Niger. The IFC Advisory Services of Africa, under the Niger Pilot Program for Climate Resilience (PPCR), through this study wants to assess the market potential for improved irrigation and climate resilient seeds in Niger to improve agriculture and climate resilience through private sector investment.

The study explores suitable improved irrigation systems and climate resilient seeds suitable for Niger and assesses their markets, economic viability, and recommends suitable investment models for developing these. The study focuses on in-depth examination and assessment in the following areas:

- Assessment of Niger's agricultural production with a focus on selected priority crops, including fodder, cash, and food crops
- Impact of observed climate variability and projected climate change over the next two decades on water demand and crop performance in Niger's agricultural sector
- Assessment of the market for improved irrigation systems suitable for Niger
- Assessment of the market for climate resilient seeds
- Based on the assessments, the study analyzed the economic and revenue models for investments under Public Private Partnership investment model and Private investments model

The methodology adopted for the study includes extensive consultation with various stakeholders, a questionnaire survey among the farming community, in-country data collection, analyses of crop statistics, market assessment and economic analysis for improved irrigation and climate resilient seeds, stakeholder consultations, assessment of existing institutional mechanism, and identifying suitable investment models for implementing improved irrigation and climate resilient seeds in Niger. The key agriculture, social and economic data, collected through primary and secondary sources were used for the analysis and are provided in the subsequent sections.

The country has an average population density of 12.25 persons/sq.km as on 2010 (World Bank Statistics). The annual average percentage population growth (2010 - 2015 as per UN estimate) of the country is 3.7% with urban population growth slightly higher at 4.7%. The dependent population (age <15 and age above 65) comprises more than 51% (2011) of the total population. Group farming is widely practiced and farmer's cooperatives help Niger farmers to access funds, technical support, and other resources. The cooperatives are coordinated at national level through Federations. The Operation and Maintenance (O&M) of some of the irrigation projects are managed by cooperatives under the supervision of Office National des Amenagements Hydro-Agricole (ONAHA). Often, development agencies and NGOs provide financial aid and technical support to the farming community through cooperatives and federations.

The key crops, in terms of area under cultivation and production, are millet, cowpea, sorghum, peanut, and onion. In terms of acreage, millet contributes the highest share (44%) followed by cowpea (31%) and sorghum (19%). In terms of production too, these crops contribute the major share of total agriculture production in Niger (millet 60% and cowpea

and sorghum 18% each). Other crops such as maize, vegetables (tomato and red chili), and sesame are cultivated in small quantities. Rice is grown in the western part of the Niger River valley under assured irrigation conditions. Onion is considered as a cash crop and is cultivated under irrigation.

The fluctuations in crop production in the country are mainly due to fluctuations in rainfall. Drought years like 2004 and 2009 show a substantial dip in the national production trends of millet and sorghum. However, the production trend of the key crops over the past 15 years shows a substantial increase in production. The low versus high points of production shows ample headroom for enhancing the production of key crops, particularly millet, sorghum, cowpea, peanut, and rice.

Only 11.6% of the land area of Niger is under agriculture of which 0.73% is under irrigation (107,000 hectares) [IFC notes that this statement requires further verifications.]. The potential land that can be brought under irrigation is estimated around 270,000 ha. The western and southern districts, especially the banks of the Niger River, the Komadougou River valley, and the Lake Chad area, are the main irrigated areas in Niger. Traditional irrigation practices are dominant in these areas. Approximately 200,000 households of farmers, representing more than one million people are involved in the production of irrigated crops.

Niger has rich aquifers and there is a high prospect of utilizing ground water for irrigation. The country's renewable water sources include about 31 billion cubic meters of surface water, 2.5 billion cubic meters of groundwater, and 2,000 billion cubic meters of non-renewable water. Almost none of the non-renewable sources and only 20% of renewable water resources are being tapped.

The large-scale traditional irrigation systems are maintained either by public institutions or by farmer's cooperatives. An irrigation service fee is charged from users, which is high compared to international standards due mainly to the high cost of energy for pumping and the inclusion of capital charges. The irrigation value is estimated to range from 12-25% of the crop value. In addition to traditional irrigation practices, a few number of small landholding farmers in the country are successfully using manual and mechanized means of irrigation mainly to cultivate vegetable crops. Compared to large-scale irrigation projects, installations for the use of ground water resources in a decentralized manner through construction of wells and bore wells that are operated and maintained by farmers or farmer's groups would be cost effective (with a lower investment in infrastructure development) and sustainable.

Taking into consideration the water availability, soil type and terrain conditions, improved irrigation systems like surface drip and sub-surface drip irrigation system are suitable for Niger to cultivate some of the high value crops and cereals. The economics of investment analysis shows the investment cost of improved irrigation can be recovered in 2.2 to 2.6 years [IFC notes that this statement requires further verificaitons]. The IRR for surface drip and sub-surface drip irrigation system 22 and 18% respectively which show both the systems are economically viable in Niger.

There are several HYV and early maturing seeds in use in Niger. INRAN has developed seeds for several crops to adapt to the climatic conditions of Niger. The present seed demand in the country is estimated at 100,000 tons against which the available supply is only 5,000 tons. The supply of seeds can be increased through increased local production as well as by encouraging international seed suppliers to bring in crop specific seeds that are suitable for Niger.

Interventions in various segments are required to promote the use of improved irrigation systems and climate resilient seeds. The sector interventions required include improving the

financial capacity of farmers, providing technical support for development of water sources, providing affordable and sustainable energy sources, development of skills and knowledge of farmers for using improved irrigation and climate resilient seeds, development of rural infrastructure (markets, roads, etc.), fixing base prices for farm produce, and strengthening bilateral relationships for increasing export of farm produce.

Taking into consideration the economic conditions of the farming community and the present network of financial institutions, and agribusiness firms and farmer's cooperatives, a private investment model with active support of public organizations is suggested. The study suggests that private banks and DFIs could play a key role in channelizing finance to the key actors in the sector – farmers (through farmer's federation), seed producers (through seed producer's federation), and agribusiness and seed firms. Farmers' federations can bridge the gap between DFIs and individual farmers for accessing credit and the pay back can be on a quarterly basis at the end of the harvest. Financial support is required to improve seed production and can be routed through seed companies and seed producers' associations. It is further recommended to synergize the investments in improved irrigation systems and climate resilient seeds to provide a cost-effective yet doubly beneficial boost to the agriculture sector in Niger.

2 Objectives and Study Area

Niger is a Sahelian country with three quarters of its area categorized as desert. Recurrent droughts and soil erosion have caused a loss of vegetative cover and resulted in a loss of fertility of agricultural land. An increasing population has further added pressure on land available for cultivation. A large portion of Niger's population depends on rainfed agriculture for food and livelihood. Water resource utilization is not adequate and there are competing demands for the available supply. In view of the above, Niger's vision on irrigation development is to increase the contribution of irrigation to agricultural GDP to 28% by 2015 and thus contribute to the country's food security agenda.

Improved irrigation methods and use of climate resilient seeds can help Niger in adapting to climate change and can help improve food security of the country. However, a major impediment in introducing these changes is the low investment levels and the lack of access to credit for agricultural producers. In order to bridge these gaps, the Government of Niger is seeking to improve irrigation technologies and methodologies. Such an objective calls for the expansion of the irrigation infrastructure (especially systems that survive silting and flooding), introduction of climate resilient seeds, and introduction of public-private partnerships, which will help increase access to credit for farmers.

The objective of this study is to suggest ways to build climate resilience in Niger's agricultural sector by facilitating private sector investment. It focuses on establishing financial mechanisms to catalyze private sector investments to determine whether the adoption of improved irrigation systems are commercially viable; and whether the potential markets for improved irrigation systems and climate-resilient seeds are large enough to generate the interest of equipment suppliers, seed growers, and financial institutions. The selected investments will help enhance the agriculture sector's adaptive capacity and contribute to food security in Niger, which is faced with an increasing frequency and intensity of climate change-induced hazards.

To achieve the objectives of the study, the following tasks have been carried out:

1. Assessment of Niger's agricultural production in terms of number of farming households, production areas, productivity trends, price and profit margins, input costs, water consumption, irrigation costs, and financing resources. Selecting priority crops, including fodder, cash, and food crops based on this assessment
2. Assessment of the market for improved irrigation systems suitable for Niger. The assessment is based on soil condition, terrain, water availability, and crop suitability. The existing supply and distribution network and potential market of improved irrigation systems is assessed along with economic and revenue models of investment. In addition to this, the study also assesses the awareness, and the technical and financial capacities of farmers, the capacity of financing institutions, and the possible incentives for supporting these irrigation systems.
3. Assessment of climate resilient seed markets in Niger, including the performance of current seeds for the priority crops and the applicability of climate resilient seeds for these crops in specific areas. The task also includes assessment of production/distribution networks and economics of climate resilient seeds for understanding their suitability for investment and financing options. The awareness, and the technical and financial capacity of the farmers and financing institutions for the adoption of climate resilient seeds has also been assessed along with identifying financial incentives for both farmers and financing institutions for increasing the adoption of climate resilient seeds.

The study area for the present study is the entire country. However, considering the intensity of agriculture activity and prospects of improving agriculture through improved irrigation and climate resilient seeds, the study focused on seven regions of Niger, namely – Niamey (C.U.N), Talibery, Dosso, Tohoua, Maradi, Zinder, and Diffa.

3 Methodology

3.1 Identification of Data Elements

As the first step in data collection, the team identified the secondary data sources (key government departments and other organizations) for collecting various data required. In addition to this, primary data was also collected through questionnaire surveys among the farming communities.

Economic variables of agriculture were considered for assessing Niger's agriculture production. Area and productivity were the key indicators considered for identifying major crops. Regional level crop statistics were analyzed to identify the major crops for each region. Two staple crops, two cereals, and two cash crops were identified along with fodder crops in each region. Historical and spatial distribution of these identified crops, both in terms of acreage and productivity, were then analyzed to assess the trend and yield over time and across the region. Data on availability of water resources (surface/ground water), soil types, and terrain types were collected, which are variables to determine the suitability of various irrigation systems.

Information collected for assessing the climate resilient seeds market included the extent of agricultural land, potential land for agriculture, and present seed types used by farmers and their availability. The findings of the assessment of agriculture production were also fed in as key information for the assessment of the seed market. Taking stock of existing seed available in Niger is challenging since there is a substantial informal seed trade that takes place across the borders of Niger with Nigeria. This challenge is further compounded by the lack of information on farmers' seed stocks from the previous year's harvest. However, analysis of indicators like present land under cultivation and potential land for cultivation, sales statistics of private companies, customs records of import of seeds, etc., were considered to estimate the seed market in Niger.

For understanding farming communities, farming practices, and farmers' associations, RMSI collected information from the Directorate of Cooperative and from some of the national federations of farmer's cooperatives. Key information collected from these federations included the number of farming communities, area under cultivation, crops, average yields, organizational set up, access to credit and subsidies, access to technology including irrigation and climate resilient seeds, issues faced, if any, etc. Information related to credits and subsidies and information on access to risk sharing facilities were collected from the Departments of Agriculture and Finance, and from banks and micro financing organizations.

Information on crops, production yield, use of modern technologies, access to credit and insurance, risk experience, etc. were collected at farm level through a questionnaire survey (see Section 10.2 Annexure 1 for sample questionnaire) information on awareness on technology, access to training, perceptions on modern irrigation practices, climate resilient seeds, and insurance were also collected. This primary field level information was used to complement the analysis of secondary data.

The information related to existing agriculture, livestock and seed policy, and information on other key initiatives in this sector were also collected as learning from such development projects is important to synergize present efforts with past projects.

3.2 Information Collection and Compilation

Both primary and secondary data were collected from various sources and is elaborated in the sections below.

3.2.1 Literature Review and Data Collection

Literature was collected from the public domain on various aspects of agriculture in Niger at country and regional levels. This exercise provided first level information on agricultural activities in Niger, key issues and initiatives in the region, and the key stakeholders. The team carried out a country visit (see Section **Error! Reference source not found. Error! Reference source not found.**) to meet the key stakeholders for discussions and further information gathering. The country focal point facilitated the meetings with key stakeholders. Meetings were conducted with key government departments supporting agricultural operations, farmers' cooperatives and federations, and NGOs and major private agribusinesses in the country. These interactions yielded quantitative and qualitative data related to agriculture and socio economic and financial aspects.

The key data collected and their sources are summarized in Table 3-1.

Table 3-1 Particulars of Data collected

Variables	Main source	Other source	Remarks
Crop data – area, production	Department of Agriculture, Agricultural Statistics	Supplemented with data collected from INS, FAO publications	Agricultural data for the period 1995-2011 (17 years)
Weather data	Meteorological Department	None	Weather data (monthly level, temperature, rainfall, solar radiation, wind speed and relative humidity) were available for 29 years from 15 weather stations and rainfall data for 29 years from 154 rain gauge stations
Ground water and availability of surface water	Department of Hydraulics	None	-Ground water map of Niger
Soil and terrain	GeoWRSI tool developed by FEWS NET (Famine Early Warning Systems Network)	None	Soil water holding capacity across Niger was extracted from GeoWRSI tool
Irrigation statistics	ONAHA and FAO	None	Data on location and characteristics of pumping stations and economic data
Basic demographic data	Institut National de la Statistique (INS) publication, National Institute of Statistics, Niger	Annual Statistical Reports, 2006 – 2010 from INS	Regional data on number of males and females, rural males, rural females, urban males, and urban females
Insurance statistics	Directorate of Insurance Control – Ministry of Finance	Insurers' Committee Insurance companies	CIMA status was available from 2008 to 2010 Annual report was available for 2010
Farming communities	Federation of Cooperatives (RECA,	-	Information related to organizational profiles, strategies

Variables	Main source	Other source	Remarks
and farmers associations	FCMN, MOORIBEN, AINOMA, FUCOPRI) and Department of Agriculture		and plans
Private players in agri business	Chamber of Commerce	-	Many private entities are registered with the Chamber of Commerce. Information on size of the organizations, product wise sales statistics, etc., were collected for some of the key players
Financial organizations	Ministry of Finance Directorate of Credit	Sonibank, Bank of Africa, ASUSU, KOKARI SICR ARSM, ECOWAS website	ARSM report on micro-finance was available for 2012 but final compilation is still in progress Banks and DFIs data were available from 2008 to 2010
Policy documents	3N High Commission	-	Information on 3N, and PROMOVARE. As the seed policy is not approved by the parliament, it is not yet available
Livestock statistics	Directorate of Statistics - Livestock	-	Good quality region wise data on livestock was collected and compiled for period 1970-2007

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

3.2.2 Primary Data Collection among Farming Communities

A questionnaire survey was conducted among 180 farmers. The farmers were randomly selected in the Sahelian agro climatic zone of Niger where 80% of the agricultural activity in the country is concentrated. RMSI focused on the four livelihood zones (livelihood zones 3, 4, 5, and 6[1]) for the survey. The districts considered for the survey in these zones were Niamey, Dosso, Tohoua, Maradi, Zinder, and Diffa regions. As livelihood zones are geographic areas in which households share, on average, similar livelihood patterns, or generally have access to the same set of food and cash income sources and markets, these zones can be considered as homogenous regions. Furthermore, in every Nigerien livelihood zone, a combination of cereals, and roots and tubers are grown. In each region, 30 samples were administered at three different locations with a total of 180 questionnaires.

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

- Presence of irrigation and livestock farming to complement the deficits of rainfed agriculture in a changing climate
- Presence of private investment and insurance services to support irrigation

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

- Priority sites of Niger Government and funding agencies.

The uniqueness within districts is:

1. Diffa: near the Lake Chad. Area where both climate change challenges and irrigation opportunities (fertile land, ground water) can be observed
2. Zinder: Area facing water scarcity issues
3. Maradi: Area facing food insecurity challenge and relatively densely populated
4. Dosso: Area where Niger Government is promoting irrigation. Several investments have been made
5. Niamey: Cases on irrigation and group farming
6. Tahoua: Region has relatively better water resources. Niger Government encourages the Tahoua population to undertake irrigation agriculture and invest in it. Many funding agencies are also intervening in Tahoua to promote irrigation

Three sites in each region were selected. A combination of household farmers (20%), group farmers (40%), women groups (10%), and commercial farming (30%) were selected. After data entry, 10% of the questionnaires were picked and quality checked to ensure data quality.

3.3 Data Validation and Analysis

The secondary data collected from various departments and organizations was tabulated for analysis. Before analysis, necessary data validations were made to ensure data integrity and quality. Validations included analyzing anomalous data; for instance, weather data of a month with very high values was compared to other months and years. Before eliminating or fixing this type of data, it was crosschecked with figures from other sources. The crop data was summarized at the regional level and dominant crops were identified based on area and production.

In addition to supervision of data collection during the survey, quality checks were also performed on survey data. Ten per cent of the questionnaires were verified after data entry to ensure data quality.

Analyses were carried out in GIS and the database to derive quantified information on production, yields, and trends. For the assessment of investment in irrigation and climate resilient seeds, econometric analyses and deductive research methods were adopted. Supply chain analysis and economic rate of return (ERR) analyses were carried out for market assessment and for assessing the feasibility of introducing improved irrigation and climate resilient seeds. Analysis of primary data collected from farming communities was used for assessing awareness and perception of communities towards irrigation, climate resilient seeds, and agricultural insurance.

3.4 Stakeholder Workshop

A stakeholder consultation workshop was conducted to present and discuss the findings of the study and to receive feedbacks. The summary of the workshop is provided in Section 10.3 Annexure 3. Discussions were also held with technical experts, private sector representatives, and relevant Government Officials on the key findings to fine-tune feedbacks on the proposed recommendations.

4 Agricultural Profile

Niger is a landlocked country with a total land area of 1.267 million sq. km (126.7 million ha). Of this total area, only about 4% is arable and 9% is permanent pastures[2]. The entire area of the country is categorized under the arid and semi-arid climatic types with a very short rainy season (June-September in case of Niger). Variation in rainfall is high across the country. The southern part (Sahelian region) receives an annual average of 600 mm, while the northern part (a continuation of the Sahara desert) gets less than 150 mm.

Farming is the main source of income for 80% of the population in Niger with millet and sorghum being the major rainfed subsistence food crops. The global average yield of millet and sorghum is 1,100 kg/Ha and 750 kg/Ha[3]. Niger is the world's top millet per capita producer and the second largest producer (16%)[4] in West Africa. Considering the present population, per capita availability of cereal grains (millet and sorghum) in Niger is 200 kg per annum. This definitely needs to be supplemented by external inputs to meet the food demand of the country.

Other crops such as maize, cowpea, peanut, rice, vegetables (onion, tomato, red chili), and sesame are cultivated in a few regions. Among vegetables, onions and peppers are the dominant crops and are cultivated at a commercial scale. Rice is grown in the western part of the Niger River valley under assured irrigation conditions.

Table 4-1 Key land utilization statistics, Niger

S. No.	Land utilization	Area in hectares (2009)
1.	Niger total land area	126.7 million ha
2.	Annual crop land area	15 million ha
3.	Perennial crop land area	12.67 million ha
4.	Irrigated land area	65,600 ha (107,000 ha as per latest Government statistics)

Source: Aquastat, FAO (2012)

Niger's economic growth is highly dependent on rainfall, which causes wide fluctuations in its agricultural outputs. Rice cultivation is concentrated in the south centre and southwest of Niger, which has an annual rainfall between 300 and 600 mm. A small area on the southern tip of the nation, surrounding Gaya, receives 700 to 900 mm of rainfall. Very high temperatures and frequent droughts along with low biomass have depleted the soil fertility in the region. Low rainfall, high temperatures, and frequent droughts being the major maladies of Niger, it is important to invest in augmenting water resources for irrigation and in promoting the use of climate resilient seeds for agriculture.

In 2010, the economy reflected a strong growth (8% growth rate in real GDP, up from -1.2% in the drought year of 2009)[5]. Subsistence farming and stock rearing contribute approximately 40% to the GDP (second only to the services sector, which provides 42%) and nearly three-quarters of the labor force is employed in this sector[6].

[2] FAO 2006, Country Pasture/Forage Resource Profiles, Niger

[3] FAO 1996, The world sorghum and millet economics, Facts and trends and outlooks, FAO.

[4] Obilana A B, 2003, Overview: importance of millets in Africa, ICRISAT, Kenya

[5] Bureau of African Affairs, 2012, http://www.state.gov/r/pa/ei/bgn/5474.htm

[6] FAO 2006, Country Pasture/Forage Resource Profiles, Niger

The Niger Government recognizes rural development to be a significant path to poverty reduction and has thus formulated the Strategy for Rural Development (SDR). The objective of SDR is to reduce poverty in various regions from 66% to 52% by the year 2015 through promoting sustainable natural resource management, food safety and security, and socio-economic development. SDR aims at integrated rural development through the "expansion of products", "maintenance of self-sufficiency in food production", "risk reduction", "improvement in the organizational efficiency of producers", and "the supply of public materials", etc[7].

4.1 Key Agricultural Areas

The agricultural areas of Niger can be distinctly demarcated based on the climate zones they are located in. Niger, one of the hottest countries in the world, has three basic climatic zones: the Saharan desert in the north, the Sahel to the south of the desert, and the Sudan in the southwest corner[8]. The intense heat of the Saharan zone often causes the scant rainfall to evaporate before it hits the ground. At Bilma, in the east, annual rainfall is only 20 mm. On an average, rainfall in the Aïr Massif is limited to a maximum of 250 mm annually, and most of it arrives during a single two-month period. At Agadez, in the northern Sahel, annual rainfall averages 165 mm, but yearly totals often vary greatly. In the south, rainfall is higher. It averages 560 mm at Niamey in the southern Sahel, and 870 mm at Gaya in the Sudanese zone. The rainy season is from June through September, with most of the rain in July and August. At Niamey, the average maximum daily temperature fluctuates from 31°C in August to 41°C in April. Nights are cool (below 20°C) from November to February[9].

4.1.1 Agro-Ecological Zones

Based on soil, landform and climatic characteristics of the region, Niger has four distinct types of agro-ecological zones[10]. These are: (1) Desert Sahara zone, (2) Sahel Sahara zone, (3) Sahel Sudan zone and (4) Sahel zone (Figure 4-1).

[7] JAICAF, 2009, Minor cereals in Niger – Focusing on Pearl millet and Sorghum, http://www.jaicaf.or.jp/publications/niger_e.pdf

[8] http://www.nationsencyclopedia.com/Africa/Niger-CLIMATE.html

[9] http://www.nationsencyclopedia.com/Africa/Niger-CLIMATE.html

[10] BEST Analysis – Niger. USAID Office of food for peace Niger, Bellmon Estimation, October 2011. Prepared by Fintrac Inc., Washington D. C., USA and reviewed by U. S. Agency for International Development (USAID), Washington D. C

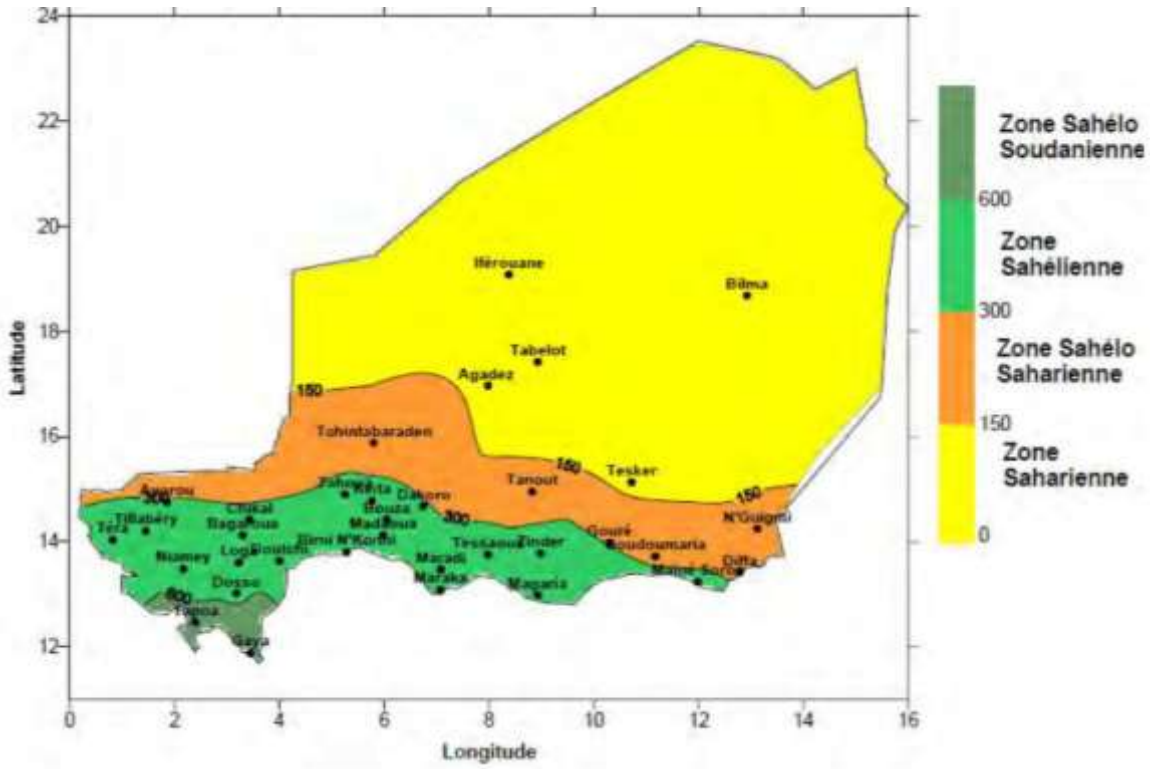

Figure 4-1: Map showing agro-ecological zones of Niger

(Source: Department of National Meteorology, Niger)

Agriculture is limited in the north by the 350 mm isohyet beyond which millet production practically ceases. The Nigerien Sahelo-Sudanian and Sudanian zones are considered as potentially sedentary areas (in contrast to the northern zones where primarily nomadic activities are found). Here, mainly millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) - traditional extensive crops covering most of the cultivated soil - cowpea (*Vigna unguiculata*), and peanut (*Arachis hypogaea*) are also found. Some cotton (*Gossypium spp.*) appears further south, in the Sudanian zone. The depressions of recent and ancient rivers are used for growing vegetables (tomatoes, onions, etc.) or some fruit trees. Rice is cultivated around the Niger and Komadougou rivers. Other crops of lesser importance are sugarcane, maize, and sweet potato.

4.1.2 Rainfed and Irrigated Agricultural Areas

Almost 80% of Nigerian agriculture is rainfed and is on the subsistence farming scale. The total irrigated land is 107,000 ha, which is 0.07% of the total agriculture area. The western and southern districts, especially the banks of Niger River, the Komadougou river valley and Lake Chad areas are the main irrigated areas in the country. Water intensive crops, and those crops that need water for longer durations of their growth cycle mainly rice, vegetables, cotton, wheat, potato, and sugarcane are cultivated under irrigation. Both surface water and ground water resources are being used for irrigation. Some of the irrigation schemes on the Niger River pump water from the river using electrically powered pumps and distribute it to the fields through canal networks that are usually lined. These are managed by cooperatives with the technical support of ONAHA. Some of the schemes have been operational since 1967 while a few have been rehabilitated at a later stage. In addition to this, farmers also use petrol-run pumps to extract ground water mainly in the southwestern part of the country. The cost of fuel often makes it unviable for raising crops using petrol-run motor pumps. The community also uses open wells for cultivating

vegetables on a very small scale. A few small holding farmers extract water manually or using treadle pumps.

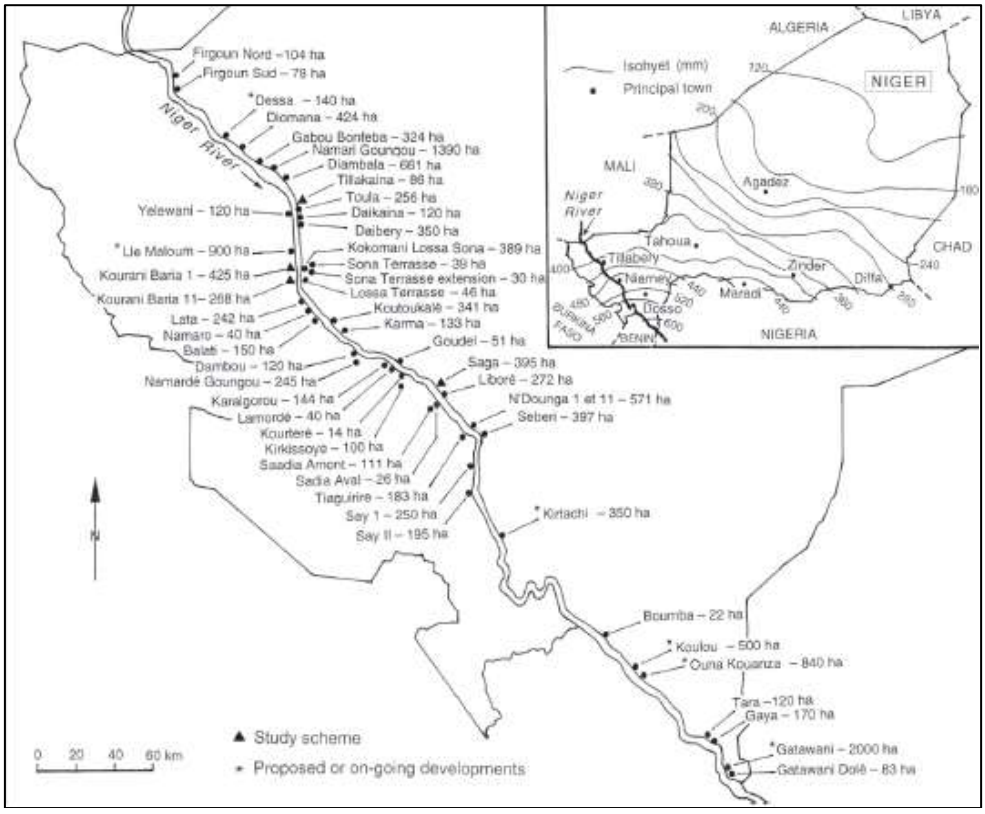

Figure 4-2: Location of irrigation systems in the Niger River Valley (Inset: Isohyets of mean rainfall, 1961–1990)

Source: Charles L. Abernethy, Hilmy Sally, Kurt Lonsway and Chégou Maman 2000, Farmer-Based Financing of Operations in the Niger Valley Irrigation Schemes, International Water Management Institute, Sri Lanka.

4.2 Farming Demography

Niger has a total population of approximately 16 million people of which more than 14 million live in rural areas (2011). The rural population includes crop farmers and herders. The degree to which these communities rely on one or the other activity is determined by the amount of annual rainfall received, and the inter-annual rainfall variability, which increases as one goes further north[11]. The country has an average population density of 12.25 persons/ sq. km as on 2010 (World Bank statistics). The annual average population growth (2010 – 2015 as per UN estimate) of the country would be 3.7% with urban population growth slightly higher at 4.7%. The dependent population (age below 15 and age above 65) is more than 51% (2011) of the total. The average household size is 6.4 and each village has about 1,300 households.

Group farming, helps farmers in Niger to access funds, technical support, and other resources. The farmer's cooperatives are coordinated at regional and national levels through unions and federations. Cooperatives support farmers in accessing credits, relief, subsidies,

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

technical knowledge, and selling of farm products. The operation and maintenance (O&M) of some of the irrigation projects are managed by cooperatives under the supervision of ONAHA. Often, development agencies and NGOs provide financial aid and technical support to the farming community through these cooperatives.

4.3 Key Crops

As already stated, millet, sorghum, and cowpea are main crops across the country, both in terms of acreage and production. The annual production of millet and sorghum staple crops was approximately 2.4 million tons and 0.72 million tons respectively (as per 2011 agricultural statistics). The mean yield for millet and sorghum is around 450 kg/ha and 330 kg/ha respectively. However, the extent of cultivation varies from region to region based on water availability, soil parameters, and geographic constraints.

Other key crops, peanut, pepper (capsicum), and onion, have average yields of 350, 30 and 16,410 kg/ha respectively.

Market demand also sometimes drives farmers to choose crops. For instance, in the last few years, farmers in many districts have started cultivating onion as this fetches good returns in the markets of the nearby countries. As per agricultural statistics, the onion production has increased from 181,000 tons (1997) to 348,000 tons (2010).

The average acreage of crops in Niger is provided in Figure 4-3. In terms of area, millet (pearl millet) occupies 44%, and cowpea and sorghum occupy 31% and 19% respectively.

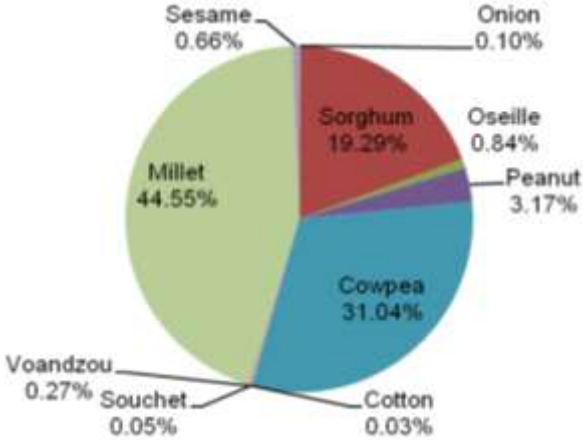

Figure 4-3: Average crop acreage of major crops in Niger (1995-2011)

In terms of production also, millet contributes the major share of about 60% and sorghum and cowpea about 18% each. Wheat production is very marginal and Niger imports wheat flour from neighboring countries. Onion is the key crop that is exported mainly to the West African countries.

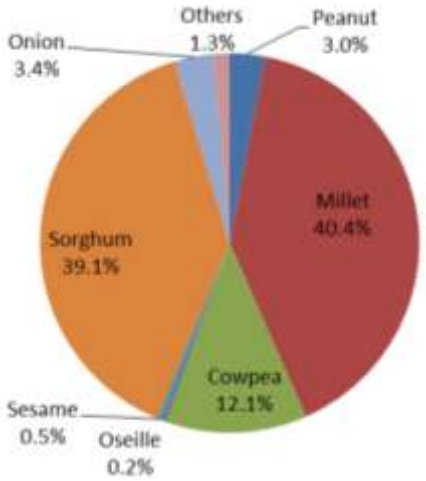

Figure 4-4 Crop production of major crops in Niger (average of 1995-2011)

There is diversity in the area under cultivation and production of various crops across the country. The regional average area under cultivation of major crops is provided in Table 4-2.

Table 4-2 Regional percentage of area under cultivation of major crops in Niger

Regions	Crops								
	Millet	Sorghum	Cowpea	Peanut	Rice	Onion	Maize	Others	Okra
Agadez	22.41	3.94	2.33	-	-	11.8	45.73	13.79	-
Niamey	53.7	5.7	34.7	3.6	1.4	0.2	-	0.7	-
Diffa	72	8.7	16.83	0.83	-	0.2	1.1	0.34	-
Dosso	48.7	4.1	40.5	2.37	0.2	0.02	0.08	4.03	-
Maradi	38.2	25.4	28.8	5.2	-	0.01	0.04	2.35	-
Tahoua	47.3	17.6	31.9	2	-	0.4	0.1	0.6	0.1
Tillabery	58.9	9.72	28.01	0.7	0.15	0.04	0.04	1.87	0.57
Zinder	36.18	29.06	29.43	3.84	-	0.04	-	1.32	0.13
Total	44.4	19.23	30.94	3.16	0.06	0.09	0.06	2.06	-

Figure 4-5 shows the distinct variation in the area under cultivation across the regions. The agricultural activities are concentrated among the southern districts of Niger. Niamey, due to its urban characteristics, has more secondary and tertiary activities and has less land under agriculture.

Maradi region has the highest acreage of millet followed by Tillabery, Tahoua and Zinder, Dosso, Diffa, Niamey, and Agadez. Maradi region has the highest acreage for sorghum also. This is followed by Zinder, Tahoua, Tillabery, Dosso, Diffa, Niamey, and Agadez. Tahoua region has the highest areal acreage of onion crop followed by Zinder, Maradi, Dosso, Diffa, Agadez, Tillabery, and Niamey regions.

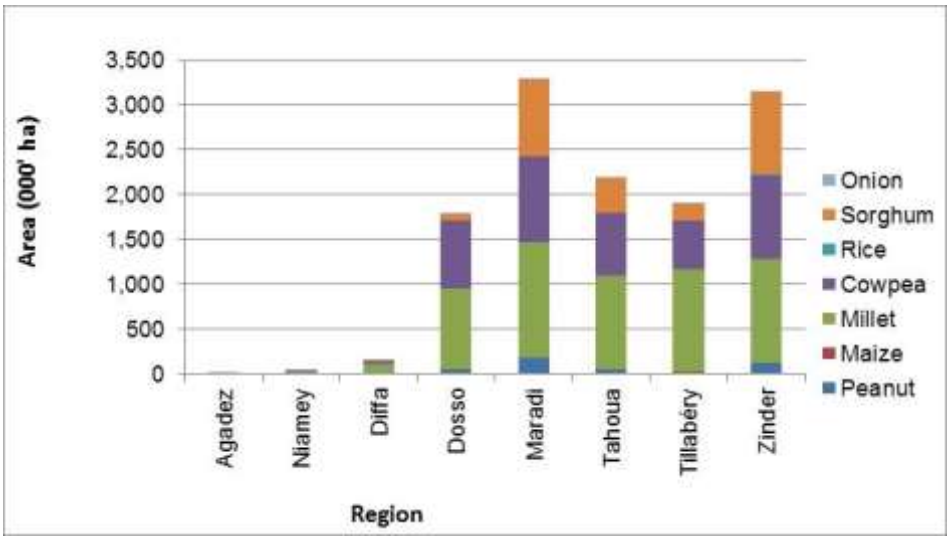

Figure 4-5 Average crop area distribution in different regions, Niger (average of 1995-2011)

4.4 Productivity Trends

The production output trends vary from region to region. In this section, the production trends of key crops across regions have been analyzed using secondary crop data available for the last 15 years.

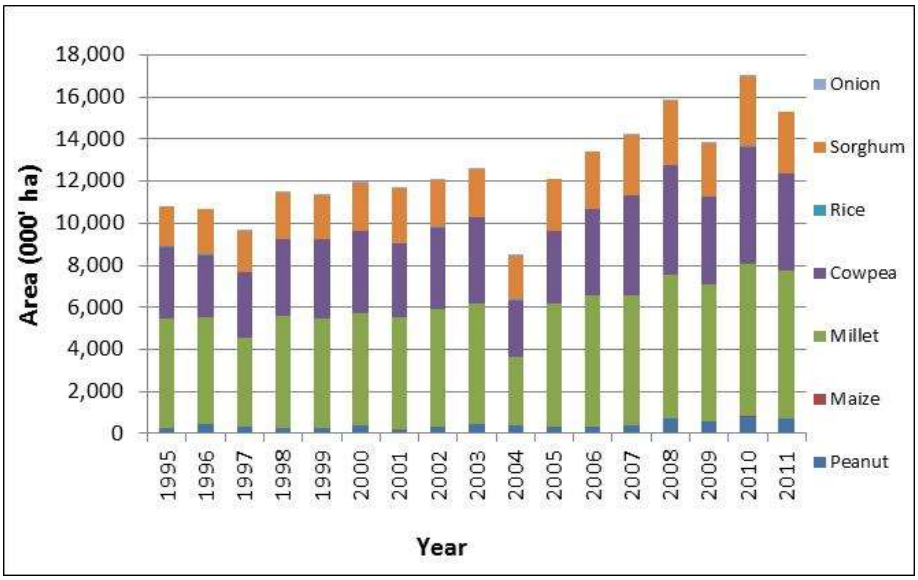

Figure 4-6 Distribution trends of major crop areas in Niger (1995-2011)

Figure 4-7 shows trends in the productivity of key crops during the last 15 years. The fluctuation in production, mainly of rainfed crops, is in line with the rainfall trends in Niger. Drought years like 2004 and 2009 show a substantial dip in the national production trends particularly of millet and sorghum. The trends of irrigated crops do not show much fluctuation.

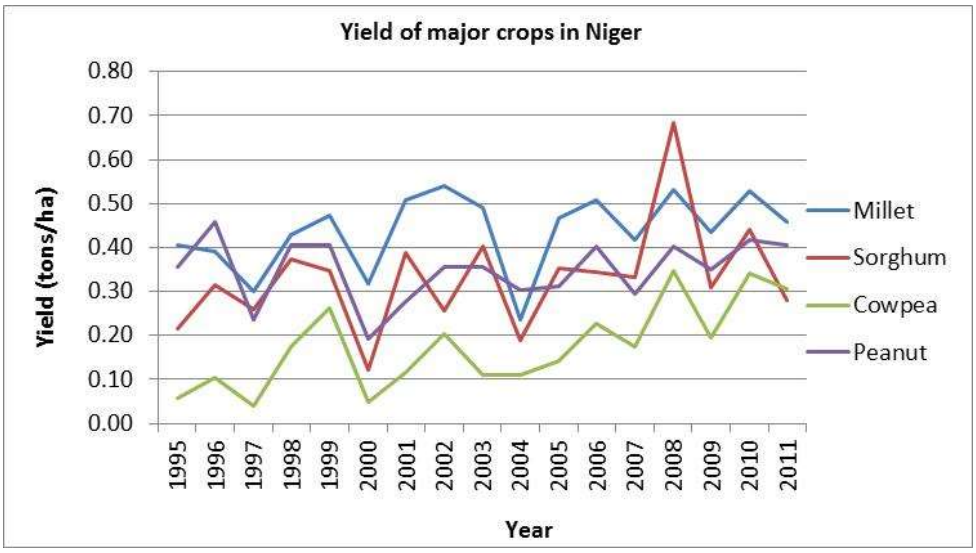

Figure 4-7 Production trends of key crops in Niger (1995-2011)

Since millet and sorghum cover larger areas in terms of acreage, any reduction in their production affects the food security of Niger. The encouraging part of Niger's agriculture sector is that trends over the past 15 years show a steady increase in the production and acreage of almost all the key crops. The low point and high point also show that there is ample scope for increasing national production without increasing the acreage. Therefore, the country has a high potential of increasing agricultural production by further strengthening irrigation and the use of climate resilient seeds and/or early maturing seeds.

Table 4-3: Production low vs. high trends for key crops in Niger

Key crops	Production in metric tons			Remark
	Low point	High point	Average	
Millet	1,256	3,843	2,427	Year 2010 has highest production
Sorghum	206	1,305	717	Year 2010 has highest production
Peanut	94	406	183	Year 2010 has highest production
Maize	1	19	6	Highly fluctuating and 2006&7 having the highest production
Cowpea	161	1,773	726	Year 2010 has highest production
Rice	1	32	11	Highly fluctuating and 2010 having the highest production
Onion	181	489	206	Highest production in the last 5 years

4.5 Water Consumption and Irrigation Cost

Traditional irrigation dates back several centuries in some arid regions south of the Sahara. However, in recent times, development of the irrigation subsector in sub-Saharan Africa has been constrained by the high cost of irrigation schemes constructed until now as well as their management complexity. The large irrigation schemes of Niger are in the Niger River and Lake Chad basins. These large irrigation schemes are mostly to support rice cultivation and use traditional flooding or channel irrigation methods. The investment cost of a full-control irrigation scheme in Niger is USD 10,000 – 25,000/ha[12] (FCFA 5 to 12.5 million). The

[12] http://www.fao.org/docrep/W7314E/W7314E00.htm

investment costs of large schemes are high both in terms for commissioning as well as for operation and maintenance. There are four key components for large schemes:

i. the capital cost of building the irrigation facilities,
ii. the routine annual cost of operating and maintaining the facilities,
iii. the occasional cost of major maintenance and renewals of the facilities, and
iv. the overhead cost of any national or regional organizations that exist to organize and provide technical support services.

In Niger, most of the investment cost is met with donor funds. The initial O&M supports the projects for the initial years. Eventually, these projects will be transferred to the community where two levels of irrigation organizations are active – GMP (Groupement Mutualiste des Producteurs or Mutual Production Group) and cooperatives.

The irrigation service fee is high, compared to international standards due to the high cost of energy for pumping and the inclusion of capital charges. Unlike Asian countries, Niger does not follow a fixed price for water use. This is determined based on the amount of water used and is collected by cooperatives as cash or crop products. The average gross value of production at the four systems studied was USD 1,476 (FCFA 738,000) per year per developed hectare[13]. The irrigation cost is estimated to range from 20-25% of the crop value.

In addition to traditional irrigation practices, substantial small landholder farmers in the country use manual and mechanized power to irrigate. The choice of manual versus mechanized power depends on the depth of groundwater and the size of landholding. Majority of the well constructions and installation of pumps are supported by donor funds.

Table 4-4: Comparisons of alternative water lifting technologies

Water lifting device	Capacity at 4.5 m (l/sec)	Initial cost	Initial cost	Depth range (m)
		USD	CFAF	
Rope and bucket	0.3	10	5,000	0 - 7
Treadle pump	1.7	126	63,000	0 - 7
Motorized pump	2.1	722	361,000	0 - 7

Source: FAO, 1997

Most of the farmers cultivate more than one crop. The average landholding size of rainfed farmers is bigger than those practicing irrigated crops. About 12% of the farmers surveyed have landholding sizes of less than 0.5 ha [IFC notes that this statement requires further verifications.], while 17% have landholding sizes of 2-5 ha. Less than 10% of the sample farmers are earning more than USD 1,000 (FCFA 500,000) and they are mostly farmers of irrigated land.

However, the economics of investment analysis carried out as part of the study and by the World Bank (2008)[14] and Dittoh Saa et al., (2010)[15] show that the investment cost of

[13] Source: Charles L. Abernethy, Hilmy Sally, Kurt Lonsway and Chégou Maman 2000, Farmer-Based Financing of Operations in the Niger Valley Irrigation Schemes, International Water Management Institute, Sri Lanka.

[14] World Bank 2008, Irrigation Development in Niger: Diagnosis and Strategic Options, Journal of Irrigation Sector, Agriculture and Rural Development, AFTAR, Department AFCF2 countries Africa Region

improved irrigation can be recovered in 2-3 years. The details of economics of investment of two preferred improved irrigation system is provided in subsection 5.2.4 and 5.2.5.

Table 4-5: Most profitable drip irrigation systems in some West African countries

Country	Description of the most profitable micro irrigation system in Sahel countries	Computed net annual return per 500 sq. m area of vegetables	
		FCFA	USD
Burkina Faso	AMG permanent well, motorized pump, concrete reservoir system (individual)	227,575.00	494.73
Mali	AMG permanent well, pedal pump, barrel system (individual)	61,860.00	134.48
Niger	AMG permanent well, motorized pump, concrete reservoir system (individual)	110,510.00	240.24
Senegal	AMG permanent well, motorized pump, barrel system (Group)	464,660.00	1,00.13

Analysis was done for several drip and non-drip micro irrigation systems.

Source: Dittoh Saa et al., (2010)*

4.6 Farm Economics

The income from agriculture in Niger is very erratic due to various reasons. Even though the main reason for this is high vulnerability to climatic hazards, other key factors control the farm economics in Niger for small land holding farmers in particular. The vicious cycle of poverty, low economic state, and lack of proper grain storage facilities force farmers to sell their produce during the harvest season when the market price can be as low as 50% compared to the price during the post-harvest season. This adversely affects farmer's returns, particularly those farmers who cultivate grains and cereals that have a longer shelf life. Additionally, the market demand and price in neighboring countries, particularly Nigeria, often influence the crop price. As such the farm gate price depends on when the farmers sell and whether they sell to procurement firms (Federation like SOCOPAP SA) or to intermediaries. SIMA and Agricultural Information System in Niger publish market prices of crops and fruits[16]. However, there is no mechanism to fix the base prices of agricultural produce in Niger to protect smallholder farmers.

4.7 Farm Financing

Niger's agriculture is heavily supported by government subsidies and external aid. External aid often comes on a project mode, specific to certain regions or thematic basis under national programs.

[15] Dittoh Saa, Akuriba Margaret A., Issaka Balma Y., and Bhattarai, Madhusudan, 2010. Sustainable Micro-Irrigation Systems for Poverty Alleviation in The Sahel: A Case for "Micro" Public-Private Partnerships?, Poster presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19-23, 2010

[16] http://www.sima-niger.net/publications-hebdo.php

Farmers who depend on rainfed cultivation mostly sustain themselves using the subsidies provided by the Government for seeds and fertilizers. When there is a crop failure due to drought, such as the one in 2009, the government provides additional support in the form of food grains. Farmers practicing irrigated farming mostly work in groups or with farmer's cooperatives. These cooperatives facilitate credits from various financial (including banks) and micro finance institutions to individual farmers and have devised their own credit mechanisms to ensure that farmers pay back the availed credits.

Company A provides financial support for farms, agro-pastoral, and agro-industrial units for agricultural development. As part of the revival of the agro-pastoral sector, Company A granted a line Credit of USD 20,000 (FCFA 1 billion) to farmers and those dependent on pastoral activities in May 2011. The Government of Niger supports the sector through micro-finance institutions by improving the credit lending and response capacity. It has adopted a framework of law on Public Private Partnership (PPP) to encourage private investment in agriculture development in the country. The PPP model, in addition to increasing the finance in this sector, can also promote the realization of investments, transfer of knowledge and technology, job creation, and development of natural resources. The Economic Community of West African States (ECOWAS) and West African Economic and Monetary Union (UEMOA) have developed several mechanisms for financing investments in this sector through Agricultural Development Fund and Regional Development Fund respectively[17].

Company A, under Presidential Ordinance, launched a three funds program in 2011 to offer improved financing credit solutions to farmers through the Guarantee Fund, Interest Subsidy Fund, and Calamity Fund. However, these are yet to start for various reasons. The penetration rate of the banking sector in Niger is 2% and banks divert their credit programs for non-agricultural activities. The micro finance organizations and DFIs in the country have a better reach in rural farming communities even though their interest rates are higher than that of banks. As a common practice, debtors have to deposit around 10% (agriculture) to 30% (commerce) of the loan and have to pay an additional 3% as administrative fees. In 2010, agriculture represented 43% (about USD 12.1 million or FCFA 6,050 million) of the financial services provided by DFIs.

Banks do not have enough guarantees to finance agriculture in its present state in Niger. Solvency is obviously at stake, as very few stakeholders in the agricultural sector can be considered as creditworthy. Common practices in terms of guarantees include fixed-term deposits (from USD 10,000 to 30,000 (FCFA 5 to 15 million)) for SMEs being granted small short term credits, in addition to the credit cost which is already around 14%. The farmers do not have any collateral and credits are often guaranteed by cooperatives. The land ownership and titling must be undertaken, as this is the strongest agricultural guarantee for DFIs or other financial institutions.

Warrantage initiated in Niger under the FAO program is rapidly developing, drawing a new perspective on guarantees for DFIs and increasing the credit line to farmers by pledging non-perishable crops and production as assets.

Local borrowing is an informal, undocumented practice, which is practiced in rural Niger. Farmers borrow money for buying seeds and fertilizers from neighbors during the start of the season and pay back in kind (crop produce) or cash during harvest.

Survey data shows that 30% farmers have taken loans, mostly through cooperatives, for buying seeds, fertilizer, and irrigation equipment. The average loan amount of the sample was USD 286 (FCFA 143,000). A majority have taken small loans for a season with amounts

[17] Republic of Niger, Initiative 3N To the Food and Nutritional Security and Sustainable agricultural development "the Nigeriens Nourishes The Nigeriens", strategic document 2012-15

ranging within a couple of thousand FCFA. A few large rice-cultivating farmers in Tahoua took big amounts of more than USD 200 (FCFA 100,000).

4.8 Impact of Climate Change on Agriculture

The IPCC report states with 'high confidence' that climate change and climate variability are likely to severely affect agricultural production and food security (including access to food) in many African countries and regions. This is because, African economies and their livelihoods are highly dependent on agriculture, which is mainly practiced in already harsh climatic conditions (viz., high temperature, marginal environments and considerable water stress)[18].

The impacts of climate variability and change (viz., increase in frequency of drought and flood, temperature rise, change in wind direction, crop pests, etc.) on the Sahelian ecosystems are apparent. Agriculture, water resources, and forage production are most affected as is evident from land degradation and the decrease in productivity of crops and livestock. Impacts on these sectors have negative effects on the people given the fact that rural areas account for more than 80% of the entire population.

Furthermore, higher temperatures associated with greater variability in rainfall will cause shifts in the cropping seasons, disrupt the biological cycles of crops, and reduce agricultural production.

Rainfall is the most decisive climate variable in the Sahelian region, which affects agriculture and forage production. Variations in rainfall increase the frequency of drought and flood and thus affect agriculture as well as the lives of people who depend on it. This is especially so since rural populations and agricultural production in Africa rely mainly on rainfall for water supply (with as little as 4% of cultivated land under irrigation[19]).

In the Sahel region, rising temperature is another decisive climate variable affecting agriculture and forage production. The simulations in the tropics using agro-meteorological models enable analysis of the response of crops to rising temperatures. The optimum development and growth of plants is when temperatures are around 30°C. Hence, in tropical zones, yields fall significantly when the temperatures rise by 1° or 2°C.

Recent studies of the CILSS/Agrhymet[20], [21] have shown that yields of crops such as millet and sorghum are likely to fall by over 10% in the case of a temperature increase of 2°C even though rainfall variations are assumed at insignificant levels in 2050 (Figure 4-8). Similarly, a 3°C increase in temperature will result in lowering crop yields by about 15% to 25%.

[18] Rashid M. Hassan, 2010. Implications of Climate Change for Agricultural Sector Performance in Africa: Policy Challenges and Research Agenda, Volume 19, Issue suppl 2, Pp. ii77-ii105, Journal of African Economies, Economics & Social Sciences, Oxford Journals

[19] ibid

[20] Dr. Benoît SARR, Dr. Seydou TRAORE, 2010. Impacts of climate change on food security, Climate change in the Sahel, A challenge for sustainable development, Monthly Bulletin, Permanent Interstate Committee for Drought Control in the Sahel, AGRHYMET Regional Centre

[21] Dr. Abdou Ali, 2010. Climate variability and change in the Sahel, Climate change in the Sahel, A challenge for sustainable development, Monthly Bulletin, Permanent Interstate Committee for Drought Control in the Sahel, AGRHYMET Regional Centre

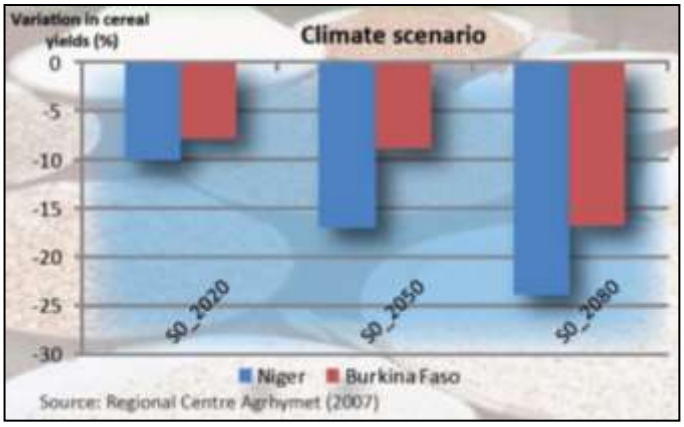

Figure 4-8: Impact of Climate Change on millet/sorghum yields in Niger and Burkina Faso

Source: CILSS/Agrhymet[22, 23]

Note: S0_2020, S0_2050, and S0_2080 indicate 1.0°C, 1.5°C, and 3.0°C temperature increases respectively.

For these three scenarios, no change in rainfall compared to the current period was considered.

Simulations conducted across the globe (FAO 2008)[24] show a relatively large decline in the yields of cereal crops (20% to 50%) across the Sahel region by 2050 (Figure 4-9).

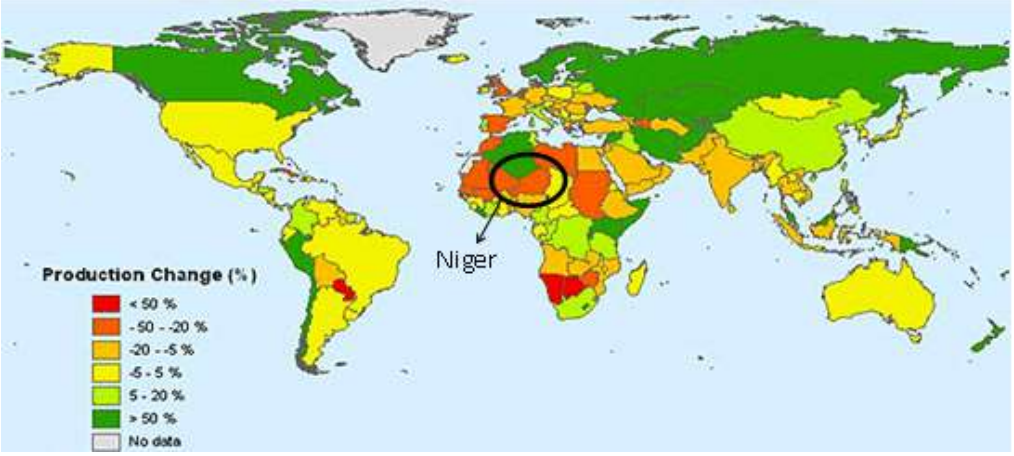

Figure 4-9: Projected impacts of climate change on the potential of rainfed cereal production, trends in 2050 compared to the average 1961–1990

(Source FAO, 2008)

[22] Source: Charles L. Abernethy, Hilmy Sally, Kurt Lonsway and Chégou Maman 2000, Farmer-Based Financing of Operations in the Niger Valley Irrigation Schemes, International Water Management Institute, Sri Lanka.

[23] World Bank 2008, Irrigation Development in Niger: Diagnosis and Strategic Options, Journal of Irrigation Sector, Agriculture and Rural Development, AFTAR, Department AFCF2 countries Africa Region

[24] FAO, 2008. Food Climate E-newsletter, Dec.14 p

Furthermore, according to the same study, yields of cereal crops are expected to decline generally in the tropical and sub-tropical regions, while increase is predicted in the higher latitudes.

On top of these negative physiological effects on the agricultural production potential, there are other crucial factors related to climate change that influence the region. The degradation of soil quality resulting from deforestation, erosion, and salinization of coastal land, groundwater, and surface water due to sea level rise and water pollution are a few significant instances.

Though temperature rise favorably affects land fertility, it also promotes the growth of crop pests and extends their geographical territory.

Therefore, in the future, one can expect an expansion of arid and semi-arid zones, a reduction in areas suitable for agriculture and agricultural production potential thus making access to food more difficult throughout the West Africa region, particularly the CILSS countries.

Although the above climate trends information is of good credibility, unfortunately knowledge of their economic impacts is seriously limited. Figure 4-10 shows a sharp decline in per capita food production for Africa since the early 1970s with some recovery after the mid-1980s in contrast to a steady improvement in the world index[25].

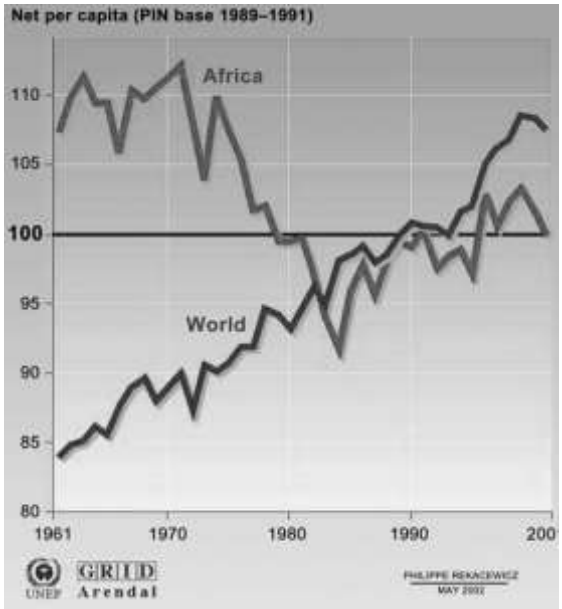

Figure 4-10: Food Production Index in Africa (UNEP Grid Arendal, 2002)

(Source: UNEP Grid Arendal, 2002)

4.8.1 Adapting Farming Practices to Climate Change

It is evident that the productivity losses resulting from climate change can exacerbate the recurrent food crises in Niger. To mitigate the negative impacts discussed above, adaptation options on improving the resilience of farming systems through improved methods and technologies have been identified within the various National Action Programmes for Adaptation (NAPA). Some of the prominent measures considered are:

[25] UNEP-GRID-Arendal (2002) http://www.grida.no/climate/vitalafrica/english (accessed 11 March 2006).

- Redefinition of agricultural calendars, playing on planting dates and cropping cycles of varieties to better manage the rainfall variability
- Development of varieties adapted to water stress and/or heat
- Development of agricultural water management methods: water and soil conservation and crop protection against extreme climate events, supplemental irrigation, and pure irrigation from surface water (rivers, ponds, retention basins, groundwater)
- Development of improved irrigation agriculture and crop diversification and intensification
- Adoption of rational management methods of soil fertility etc.

5 Market Assessment on Improved Irrigation System

5.1 Improved Irrigation Systems across the World

In the light of projected climate change impacts on agricultural production and food security, improved irrigation systems have a very high potential in Niger. Table 5-1 shows some of the major improved irrigation systems being used across the world. The selection of irrigation systems is highly dependent on the availability of water, the types of water sources, climate, soil and terrain, kinds of crop, and costs of investment. Niger, being a water deficit country, will benefit from pressurized irrigation systems due to their economical use of water (30% to 70% lower water consumption) compared to traditional gravity systems. In developing countries, donors and development managers also consider local traditions and skills while selecting appropriate irrigation technologies.

Table 5-1 Comparison of some of the major improved irrigation systems

S. no.	Improved irrigation type	Advantages	Disadvantages
1.	Drip Irrigation	• Highly water efficient system • Small wetted area (less evaporation) • No runoff (reduced soil erosion) • Controls weed growth • Reduces fungal growth on plants and crops by eliminating splashing of water and soil • Saves fertilizer when this is applied through the drip system • Saves labor costs	• Emitter clogging disrupts uniform distribution of water • Drip tubes and other components can be damaged by rodents • Needs management and technical skills to maintain and operate • High initial cost • Requires periodic leaching of drip nozzle in case there is salt content in water
2.	Sprinkler irrigation (different kind explained below)	• Elimination of the channels for conveyance and conveyance loss • Suitable to all types of soils, except heavy clay • Suitable for irrigating crops where the plant population per unit area is very high • Mobility of system to larger area • May also be used in undulating areas • Saves land as no bunds etc. are required • Areas located at a higher elevation than the source can be irrigated • Labor saving for application of fertilizers and chemicals	• Installation and maintenance costs are high • Appropriate for large farm holdings and some specific crops • Installations may be damaged by wind • Water consumption is higher compared to drip and subsurface irrigation • Water loss due to evapo-transpiration • Continuous wetting of stocks and leaves can encourage fungal growth and other diseases • Encourages weed growth • Requires periodic leaching of nozzle in case there is salt content in water

S. no.	Improved irrigation type	Advantages	Disadvantages
		• Less problems of clogging of sprinkler nozzles due to sediment laden water	
3.	Sub surface irrigation	• Highly water efficient system • Small wetted area (less evaporation) • No runoff (reduced soil erosion) • Controls weed growth • Reduces fungal growth on plants and crops by eliminating splashing of water and soil • Saves fertilizer when this is applied through the system • Saves labor costs	• Needs technical skills for installing, maintenance, and operations • Rodents may damage tubes

5.1.1 Drip Irrigation

Drip irrigation is a highly water efficient means of irrigation that can be used and operated by small farm holders. Water is applied directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, etc.) operated under low pressure; with the applicators being placed either on or below the surface of the ground. This is also called trickle or micro irrigation.

Donors, multi-lateral funding agencies, and NGOs are promoting this highly water efficient system particularly in Africa. The system ranges from simple methods to irrigate small landholder gardens using a bucket kept 6 feet above ground to complex systems with overhead tanks and distribution systems irrigating larger areas.

Research studies indicate that this system provides 40%-70% water saving and 90% to 95% water use efficiency, which is considerably higher than the 40% to 50% water use efficiency of conventional furrow or flood irrigation. The yield increases over conventional methods of irrigation range from 10% to 130% depending upon soils and crops. The benefit cost ratio for drip systems in India as reported by INCID[26], excluding the proportion of water saving, ranges from 1.31 to 2.60 for various crops (excluding grapes). In the case of grapes, it is about 13.35. If water saving is also taken into account, the ratio goes up from 2.78 to 11.05 for various crops and 30.00 for grapes. In addition to this, the technology saves labor, energy, and fertilizers, conserves soil nutrients, and controls weed growth.

5.1.2 Sprinkler Irrigation

In sprinkler irrigation systems, water is applied by means of perforated pipes or nozzles operated under pressure to form a spray. These systems are available as automated sprinkler systems, traveling gun sprinkler systems, and rotation sprinkler systems. The three kinds are described briefly below.

[26] INCID (Indian National Committee on Irrigation and Drainage). 1994. Drip Irrigation in India, Indian National Committee on Irrigation and Drainage, New Delhi.

Automated sprinkler irrigation has an automatically rotating sprinkler pipe or boom, supplying water to the sprinkler heads or nozzles. Water is delivered to the center or pivot point of the system. The pipe is supported above the crop by towers at fixed spacing and propelled by pneumatic, mechanical, hydraulic, or electric power on wheels or skids in fixed circular paths at uniform angular speeds. Water is applied at a uniform rate by progressively increasing the nozzle size from the pivot to the end of the line. The depth of water applied is determined by the rate of travel of the system. Single units are ordinarily about 1,250 to 1,300 feet long and irrigate a circular area of about 130-acres.

The traveling gun sprinkler irrigation systems consist of a single large nozzle that rotates and are self-propelled. The name refers to the fact that the base is on wheels and can be moved by the irrigator or affixed to a guide wire.

Rotation sprinkler systems discharge an allotted quantity of water to crops at set intervals. The system expels water and rotates with the centripetal force created by the expelling of water or through mechanical force. Among sprinkler methods, traveling gun and rotation sprinklers are relatively more water efficient compared to automated sprinkler irrigation.

International studies show that sprinkler irrigation has an average water saving of 50%, yield increases in the range of 11%-130%, and a benefit cost ratio 2.0 to 2.5 for maize-wheat crop rotation[27]. The average life of the system is 20+ years. The normal cost of maintenance of the system is 7%-10% of the investment cost and the Internal Rate of Return (IRR) is 33%.

5.1.3 Sub Surface Irrigation

This method applies water below the ground surface either by raising the water table within or near the root zone or by using a buried perforated or porous pipe system that discharges directly into the root zone.

As this is another kind of drip irrigation, most of the benefits of drip irrigation system are applicable to it. The cost is slightly higher and shifting of the irrigation system, once laid, is not easy.

The water efficiency of this irrigation system is up to 50% and the yield improvement varies from crop to crop with an average of 24%.

5.2 Irrigation Systems in Niger

The main water resources of Niger, both surface water and ground water, are of trans-boundary nature. There are two major river basins – the Niger River basin covering the eastern part of the country and Lake Chad basin in the southwestern part. Apart from these, some prominent trans-boundary aquifers feed these rivers, and bore wells and open wells. These include Iullemenden Continental Sedimentary Aquifer (Sokoto basin, Nigeria), Tin-Séririne basin in the Tassili Oua N'Ahaggar mountain complex (basin du Tafassasset), Djado - Bilma Basin, l'Aïr (discontinued) crystalline basement aquifer, Liptako-Gourma, (discontinued) crystalline basement aquifer, and Chad Aquifer Basin[28]. The country's renewable water sources include about 31 billion cubic meters of surface water, 2.5 billion cubic meters of groundwater, and 2,000 billion cubic meters of non-renewable water.

[27] Dr. Muhammad Mehboob Alam, Dr. Muhammad Nawaz Bhutta And Dr. Aftab H. Azhar, Use and Limitations Of Sprinkler and Drip Irrigation Systems In Pakistan

[28] Transboundary aquifers in Africa; identified in the Workshop (compiled by Bo Appelgren) http://www.isarm.org/dynamics/modules/SFIL0100/view.php?fil_Id=191

According to the government estimate, almost none of the non-renewable sources and just 20% of renewable water resources are being tapped[29].

Approximately 200,000 households of farmers, representing more than one million people, are involved in the production of irrigated crops. This does not include those upstream, who provide inputs and services and are involved in the downstream processing, handling, marketing, and transportation[30].

Table 5-2 Some key statistics showing prospects of development of irrigation agriculture in Niger

Indicators	Year	Quantity
General	**Year**	**Quantity with unit**
Total population	2010	15,203,822
Rural urban population ratio	2010	79.6:20.4
Population aged 0-14 years (%)	2010	50.1%
Population aged 60+ years (females and males, % of total)	2010	3.7 and 3.3%
Dependent population	2010	> 56%
Total land area	2011	126.7 million Ha
Total cultivable area	2010	14.72 million Ha (11.62%)
Total area presently cultivated	2010	4%
Economically active population in agriculture	2008	87%
Labor force in agriculture (% of total population) Female Male	2005	86% 48% 52%
GNI: Gross national income per capita	2009	USD 341.6 (FCFA 170,800)
Average rainfall		
Actual renewable water resources per capita total	2004	2,411 m^3/ year
Irrigation		
Total irrigated area	2012	107,000 Ha
Irrigation potential	2007	270,000 Ha
Irrigation, full / partial control: equipped area	2005	32,000 Ha
Ratios of total irrigation equipped (formal) areas to total cultivated area	2005	1.6
Equipped lowlands	2006	56,000 Ha
Total area equipped for irrigation	2005	82,000
Part of equipped area actually irrigated	2005	89.1%
Total area with water control	2005	100,000
Irrigation of large landholding (> 25 Ha)	2003	13,350 Ha

Source: National Investment Report, NIGER, High Level Conference on: Water for Agriculture and Energy in Africa: the Challenges of climate change Sirte, Libyan Arab Jamahiriya, 15-17 December 2008.

The cultivable area of Niger is 14.72 million ha (11.62% of the total geographic area) of which only 4% is presently under irrigation [IFC notes that this statement requires further verifications.]. Majority of the farmers (more than 90%) are practicing rainfed agriculture.

[29] http://www.irinnews.org/Report/89432/NIGER-Thirsty-as-well-as-hungry

[30] National Investment Report, NIGER, High Level Conference on: Water for Agriculture and Energy in Africa: the Challenges of climate change Sirte, Libyan Arab Jamahiriya, 15-17 December 2008

Approximately 200,000 households of farmers, representing more than one million people are directly involved in irrigated agriculture. This does not include those upstream who provide inputs and services and are involved in the downstream processing, handling, marketing, and transportation.

The country has experienced a significant growth in the area under irrigation of 38% (from 65,600 ha to 107,000 ha from 2009 - 2012). The traditional irrigation practice in the country is mainly flood irrigation and 35% of the irrigated area is under rice cultivation. The irrigation activities are mostly concentrated in the Niger River valley and Komadougou River valley region, through large-scale traditional donor investment projects and owned and maintained by public institutions. Irrigated areas per department are shown in Table 5-3.

Table 5-3: Department wise distribution of land under irrigation

Department	Irrigated area (Ha), 2005
Agadez	3,371
Diffa	5,250
Dosso	1,285
Maradi	5,219
Tahoua	36,544
Tillaberi	18,284
Zinder	3,710
Total	**73,663**

Source: http://www.fao.org/nr/water/aquastat/irrigationmap/ne/index.stm

The level of diffusion of irrigation agriculture in Niger is limited for various reasons and is driven mainly by the development aid projects. However, the experience of PPIP and PIP2 in the last 2 decades shows very promising trends among Niger's small scale farming communities in adopting improved irrigation for agriculture. As part of these two projects, about 20,000 pumps, 5,000 tube wells, and 17,000 low-pressure distribution systems were put in operation, covering an irrigated area of 16,000 hectares, and benefitting about 30,000 people. The calculated return of investment is about a year in these projects and the community has experienced a 30% increase in revenue by using these improved systems.

It is important to have substantial investment in small-scale irrigation agriculture to improve production and food security of the country. Various donor funded projects targeting small landholding farmers have contributed to substantial increases in the use of improved irrigation systems in the country. These include:

- More than 18,000 bore wells were constructed using hand auger drilling in the last one decade. The cost of this is much cheaper (from USD 18 to 200 (FCFC 9,000 to 100,000)) than motorized drilling (USD 1,200 to 1,600 (FCFA 0.6 to 0.8 million)) and can be carried out using local skill and resources
- Installation of about 15,000 treadle pumps mainly targeting farmers with land holding from 0.2 to 0.4 ha. The cost is cheaper (USD 60-190 (FCFA 30,000-45,000)) compared to motor pumps USD 350-500 (FCFA 175,000-250,000))
- More than 10,000 motor pumps (cost per unit USD 500 (FCFA 250,000)) to cater to larger landholding 0.5 ha
- Imported drip and California irrigation systems to irrigate more than 2,000 ha of land

Some of the key irrigation projects targeting small landholding farmers include the Pilot Private Irrigation Project (PPIP) project (the World Bank, 1995-200), Support to Food Security through Small-scale Irrigation (ASAPI) projects (European Union 2001-2006), Private Irrigation Promotion Project (PIP2) (the World Bank 2002-2008), the Special program of Food Security (PSSA) project (IsDB, Libya, FAO 2003-2005). In addition to this, some of

the international NGOs and International research institutions have installed several community based improved irrigation systems on a pilot basis in the country.

The PPIP emphasizes on support to farmer's organizations and promotion of irrigation technologies with a small advisory component on finance, while the PIP2 operation emphasizes on matching grants for irrigation equipment, which generate ownership to farmers.

5.2.1 Rainfed vs. Improved Irrigation in Niger

As per the National Statistical Office of Niger (Direction de la statistique et de la comptabilité nationale (DSCN), about 63 % of Niger's population (5.3 million) is below poverty line. There is a disparity in income within this group and the variability is mainly because of bad rains, which affect rainfed agriculture. The survey results also show that the farmers who depend on agriculture crops are poorer than those having a mix of agriculture and livestock. While 65% of the farmers, who solely depend on agriculture, have an average annual income below USD 140 (FCFA 70,000), but while considering income from both agriculture and livestock its only 51%. The choice of crops also determines the income of the farmers even though 70% of the farmers surveyed use most of their harvest for their own consumption. The remaining 30% farmers sell 30-50% of their farm produce.

The average landholding size of rainfed farmers is bigger than those cultivating irrigated crops. About 12% of the farmers surveyed have landholding size < 0.5 ha [IFC notes that this statement requires further verifications.], while 17% are having landholding size of 2-5 ha. About 30% of the farmers practice both rainfed cultivation and irrigated farming. Average income of farmers practicing rainfed agriculture is provided in Table 5-4. For the convenience of comparison, the average landholding size of 2 ha is considered.

Table 5-4: Average annual income of farmers practicing rainfed agriculture

Crops	Area in ha	Average annual income	
		USD	FCFA
Millet	2 ha	120	60,000
Sorghum	2 ha	66	33,000
Cowpea	2 ha	22	11,000
Peanut	2 ha	46	23,000

Irrigated farming of high value vegetable crops fetches better return to farmers. However, the average land holding size of vegetable farming using irrigation is 0.1 ha. The investment on irrigation is the key factor that limits farmers from going in for bigger landholdings. The income from vegetables (tomatoes, potato, onion, etc.) of average landholding size of 0.1 ha for onion, potato, vegetables and green pepper is provided in

Table 5-5. Even though there are issues of weak supply chain and poor distribution infrastructure, the present quantities of vegetables are mostly consumed in the local market. Farmers' federations have tie up with big food processing groups like Nestle to ensure sale of selected farm produce.

Table 5-5: Average income of farmers practicing irrigated agriculture for selected crops

Crops	Area in ha	Average annual income	
		USD	FCFA
Onion	0.1 ha	44	21,822

Potato	0.1 ha	119	59,610
Vegetables	0.1 ha	150	74,760
Pepper	0.1 ha	74	36,900

The survey results show that there is a drastic variation in the production per hectare. This is mostly due to lack of proper training in the use of improved irrigation technologies. Some crops that can be cultivated both under rainfed and irrigated conditions show drastic output differences. In addition to the high chances of crop failure for rainfed farming, the increase in yield is to the tune of 4-8 times higher for irrigated farming. Farmers using improved irrigation systems opined that they could save water (50-70%), energy, labor, and fertilizers, and the production increased by 30% over rainfed farming practices.

Case Study: Improved irrigation system for small landholding farmers in Niger

Low-cost irrigation technologies were promoted in 1990s and 2000s through private-sector development targeting smallholding farmers in Niger and other West African countries. Some of the key irrigation project targeting to small landholding farmers in Niger are:

- Pilot Private Irrigation Project (PPIP) project (the World Bank, 1995-200),
- Support to Food Security through Small-scale Irrigation (ASAPI) project (European Union 2001-2006),
- Private Irrigation Promotion Project (PIP2) project (the World Bank 2002-2008),
- Special program of Food Security (PSSA) project (IsDB, Libya, FAO 2003-2005).

The PPIP emphasis on support to farmer's organization and promotion of irrigation technology with a small advisory component on finance, while the PIP2 operation emphasis matching grant for irrigation equipment which generate ownership to farmers. Other areas these project give trust are promotion of new low-cost technologies by the private sector through tests, demonstration sites, and strengthening the capacity of local, private, input suppliers and monitoring of environmental impact.

These have contributed to substantial increase use of improved irrigation system in the country:

- More than 18,000 bore wells were constructed using hand auger drilling in last one decade. The cost of this is much cheaper (from USD 18 to 200 (FCFA 9,000 to 100,000)) than motorized drilling (USD 1,200 to 1,600) and can be carried out using local skill and resources.
- Installation of about 15,000 treadle pumps mainly targeting farmers with land holding 0.2 to 0.4 ha. The cost is cheaper compared to motor pumps (USD 60-190 (FCFA 30,000-45,000) compared to USD 350-500 (FCFA 175,000-250,000)).
- More than 10,000 motor pumps (cost per unit USD 500 (FCFA 250,000)) to cater larger landholding 0.5 ha.
- Imported drip and sub-surface irrigation system to irrigate more than 2,000 ha of land

Majority of the farmers practicing irrigation are beneficiaries of PPIP or PIP2 irrigation projects in which the training and capacity building is given less priority. Only 15% of the farmers using improved irrigation equipment are exposed to operation and maintenance of the systems. The yield of tomatoes and onions under the PPIP is higher than the national average (national average of tomatoes is 24.53 tons and under PPIP is 32.00, while for onion national average is 35.58 tons and under PPIP is 41.00 tons). About 30,000

beneficiary farmers, under PIP2 project, experienced a net revenue increase of 200% for tomatoes, pepper, and rice, and 558% for onions.

5.2.2 Interventions Required

Majority of the irrigation systems in Niger are either supported through external aid (grants and loans) or built by the government/ONAHA. Some of the key hindrances in developing irrigation in Niger are:

1. High cost of initial investment
2. Investment is mostly through public institutions with a lack of a clearly defined economic model for sustaining the project, including O&M costs
3. Lack of identified water sources (surface and ground water)
4. Lack of financial resources with farmers to invest in irrigation systems
5. Lack of knowledge and technical skills for maintenance of such systems

The conventional irrigation systems, which were commissioned in the 90's are mostly large scale and have been established through public sector intervention. These are mostly on Niger River and support the rice cultivation in the region. The last decade has witnessed some interventions by grassroots organizations, which have installed improved irrigation systems on a pilot basis mainly in Maradi and Zinder. These initiatives are to support small farm holders and have proved successful. However, there are instances where extracting ground water has become expensive and uneconomical to practice agriculture due to the high cost of fuel and the receding ground water table.

Some of the key interventions required to develop improved irrigation systems particularly for small holding farmers in Niger are detailed below. Interventions are required at various segments and at various levels of administration. Policy and institutional interventions are also required to develop an enabling environment for farmers to buy improved irrigation systems.

Financial capacity: Niger's farmers are extremely poor [IFC: In general, this statement applies.]. and a majority practice subsistence farming. The lack of collaterals and high insolvency of farmers restrains them from taking loans for investing in improved irrigation agriculture. Interventions are needed in several areas to improve their financial capacity. The measures include devising safety net mechanisms through agriculture insurance, capacity building for managing finance, developing mechanisms to ensure farmers get base prices, and infrastructure development (roads) to help farmers transport raw materials and farm products.

Capital investment: Technical skills and capital investments are required to develop usable water resources for agriculture. Capital investments required for the installation of irrigation systems is high and need external financial support. Government should strategize program "bring water to farm" to enable farmers to carry out agriculture.

Energy costs: The cost of energy for pumping water is very high in Niger. Subsidizing the prices of electricity or petrol/kerosene can only work as a short-term relief. At the same time, this will increase the economic burden on the government. Alternate power sources like biogas are promising options for Niger and can be explored. The use of biogas will also help provide enhanced organic manure.

Agricultural methods: Adequate extension services should be accessible to rural farmers to help them adapt suitable agricultural practices. For example, farmers could be encouraged to use organic manures instead of subsidized chemical fertilizers. Farmers could also be encouraged to adopt rotation of crops especially with legume crops, which enrich soil qualities.

Skills and knowledge: The literacy rate among the largely pastoral population is very low (29% in 2008). The benefits of technological interventions such as improved irrigations practices are, therefore, known only to a small section of the population. The poor literacy also reinforces the general lack of skills and knowledge for using improved irrigation systems. Accessibility to extension services and awareness building measures is required to improve knowledge and skills for the introduction and use of improved irrigation systems.

Operation and maintenance of irrigation systems: Most of the traditional, large irrigation systems have been constructed by government departments or donor agencies and have been handed over to farmers' cooperatives under the supervision of ONAHA. The irrigation systems are being successfully maintained by these cooperatives through collection of fee for water under some successful PPP models. PPP or private sector investment promises to be an ideal solution for a sustainable O&M model.

Lack of infrastructure: The villages of Niger are remote and often poorly connected by a transportation infrastructure such as roads. Transportation of materials to farms and crops from farms to markets is difficult and expensive. Onion, carried on mules and camels, result in a lot of damage, which affect the price and the farmers adversely. Efforts need to be made to improve the rural infrastructure for collection of farm produce and increase storage space for farmers to store crop produce so that they can sell during the lean season.

Lack of proper crop procurement system: The country lacks a proper crop procurement system and the price recovered for farm produce depends on when farmers sell their produce. The base prices of crops need to be determined and implemented to ensure that farmers get adequate returns.

Organizations like Plate forme Paysanne du Niger organize barter events for farmers where they can bring their produce and exchange them for other products. The prices of products are set in such events. Such events take place along the border with Nigeria where people trade across the border. This avoids intermediaries who otherwise take a big share of the profits.

Fostering bilateral relationships to improve exports of crops to European markets: Niger exports its produce to European and West African countries. Efforts towards fostering bilateral relationships to improve exports of farm products are essential. For instance, France imports onion from New Zealand, which is more than four times more distant than Niger. In other words, it could easily import onion of international quality from Niger where it is available in surplus.

5.2.3 Irrigation Prospects in Niger

The Federal Government is augmenting water resource utilization in the country through the construction of the Kandadji Dam on Niger River. The construction started in August 2008 and is expected to improve agricultural production in the Tillaberi Department by providing irrigation water for 6,000 hectares initially and for 45,000 hectares by 2034.

As stated earlier, the country holds a high potential for developing irrigation and thereby improving food productivity. The benefits of the use of modern irrigation systems are well documented for the Western African region. For example, the pilot project of World Bank 2003 supplied 900 drip irrigation kits and assessed the efficiency of this technology over traditional flooding approach. The benefits have been found to be very promising both in terms of increasing water efficiency and in terms of increasing yields. For instance, tomato farmers who used drip irrigation experienced yields on average of 7,200 kg, up from an

average of 2,000 kg for the same-sized farms using conventional irrigation. The increased yields boosted revenues by more than 500%[31].

Niger's rich aquifers also provide good prospects for exploiting ground water for irrigation. This could be cost effective and easy to manage by rural communities with distributed overheads.

Taking into consideration the terrain, soil types, climatic conditions, available water resources, and farmers preferences, RMSI suggests two types of improved irrigation systems for Niger, namely, the low pressure surface drip irrigation and the low pressure subsurface irrigation (locally called California type) systems. Both these improved irrigation systems are relatively easy to install and maintain and are highly water efficient. Economics of investment for both these irrigation systems are presented below. These irrigation systems have already been piloted under various projects and programs in Niger and have proved successful.

The following parameters were considered while selecting suitable irrigation types for Niger:

1. Soil type and terrain
2. Water availability and source type
3. Market, cost, and technical complexity of installation and maintenance of irrigation equipment
4. Crop preferences of communities and suitability of appropriate irrigation systems
5. Farmers' perceptions and preferences

Physical factors like soil type, terrain, water availability, and source type were given the highest weightage as the rest of the factors can be improved through appropriate interventions.

[31] http://www.trust.org/alertnet/blogs/climate-conversations/drip-irrigation-can-help-sahel-adapt-to-climate-change/

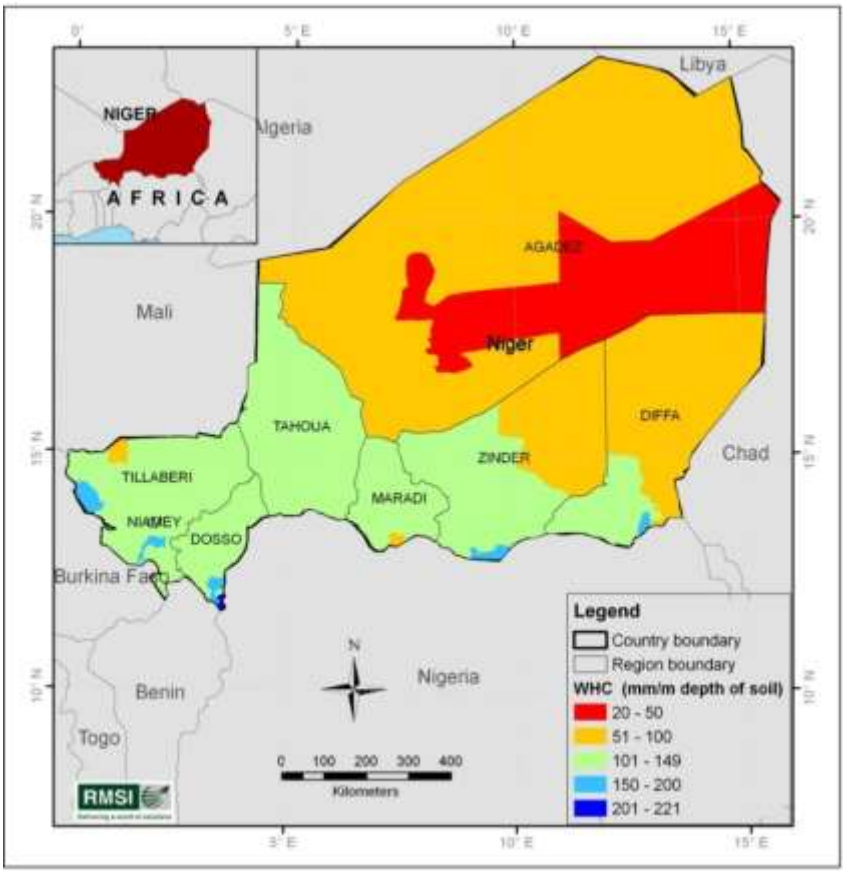

Figure 5-1: Water holding capacity based on soil type and elevation

Figure 5-1 shows the water holding capacity of soils in Niger. The southern and southwestern parts of the country marked in light green color are suitable for developing both the suggested irrigation systems. The terrain characteristics of these areas are relatively low-lying and several locations have ample ground water reserves.

Baseline information of the surveyed sample is provided in the Table 5-6 below.

Table 5-6: Key observations from survey data

1	**Sample surveyed**	**180**
2	Regions covered	Diffa, Dosso, Maradi, Tahoua, Tillaberi, Zinder
3	Profile of the sample	Samples randomly selected 25% of the sample are practicing group farming 35% of the farmers in the sample are using irrigation for agriculture of which 9% are using modern irrigation system The land holder size varies < 0.5 – 63%, 0.5 to 1 hectare – 16% 1-2 hectares 4% > 2 hectares – 18% Key combination of crops raised (for irrigated crops): Number of cropping season per year – 2
4	Key crops and their yield	

Crops	Average yield kg per hectare	
	Irrigated	Rainfed
Millet	-	5,115
Sorghum	-	1,359

		Cowpea	1,386	540
		Peanut	833	437
		Rice	4,016	278
		Onion	17,631	
		Maize	3,799	270
		Okra	254	140
		Pepper (Capsicum)	7,058	-

5	Average income from agriculture (irrigated and non-irrigated crops)	Crops	Average annual income			
			Irrigated		Rainfed	
			USD	FCFA	USD	FCFA
		Millet	-	-	260	130,000
		Sorghum	-	-	360	180,000
		Cowpea	490	244,900	135	67,400
		Peanut	346	173,000	176	88,200
		Vegetables	5,440	2,720,000	-	-
		Rice	9,470	4,735,000	-	-
		Onion	13,494	6,747,000	-	-
		Maize	1,100	550,000	92	46,000
		Pepper (Capsicum)	1,035	517,500	-	-
6	Skill and perception	85% of farmers do not have training in modern irrigation and 66% responded that they do not have training in culturing climate resilient seed varieties. Of this, majority are individual farmers. Only 14% responded that they are aware of modern irrigation and 32% showed awareness on climate resilient seed varieties.				

Note: There is a big difference in the income and yield across the region and year. The sample used for the analysis gives a broad overview of the incomes across regions and crops.

5.2.4 Type 1: Low pressure surface drip irrigation

Surface drip irrigation systems are suitable for all types of cultures, particularly market gardening, cereal, legume crop, cotton, fruit trees. Cultures like okra, maize, tomato, cabbage, lettuce, pepper, potato watermelon/melon perform well in drip irrigation.

These systems can be operated with 1 m head for small landholdings and is being successfully used by women groups in several African countries. For smallholdings, water can be fetched manually and poured into a drum or bucket kept at an elevation from which water is served to the drip system. For bigger landholdings, drips are designed using overhead tanks and water is pumped to the overhead tanks. The height and size of the water tank and power of the pump depends on the size of the landholding.

As the cost of diesel/electricity for operating pumps is high in Niger, biogas or solar energy options can be considered for water pumping. In case of biogas, the investment cost is USD 600 (FCFA 300,000), which is about 50% more than the present investment. However, this will substantially reduce the operation cost as this will save the cost of energy required for irrigation and produce enhanced manure. The locally available pumps operating on

kerosene/petrol can be used for the biogas system. This means that the technical skills for repairing the pumps are already available at the local level.

Several authors[32],[33] and farm-based experiments suggest that solar water pumping systems are economical in the long run when compared to diesel/electricity in West African countries. However, there are some key disadvantages in context of Niger, including high investment costs and a lack of availability of adequate suppliers, and lack of technical people for repairing these system. As the investment cost is high, the cost recovery period is longer. The investment cost is almost 100% higher when compared to diesel/electricity based pumps. The cost includes the panels and the pump cost minus the fuel cost for ten years. The cost for maintenance is considered the same even though there is a low chance of repair for the first 10 years. The life of solar panels and pumps is considered as 20 years.

Depending on the depth of the water table, terrain, and farm holding size, one of the below mentioned options of water source can be adopted:

(i) AMG permanent well, motorized pump and concrete tanks
(ii) AMG permanent well, bucket fetch to barrel system
(iii) Borewell, motorized pump and concrete tanks

In the present analysis, the cost for construction of a well is estimated for one hectare and is shared by four farmers. This will reduce the investment cost substantially. In case a water source is already available, the investment cost for developing the water source will be nil.

In addition to the water source, an initial investment is required for - pump unit, overhead tank, drip distribution system grids, wire fence, hedge, and fruit trees. The capital cost required (including the construction cost of water source) along with depreciation is provided in Table 5-9. Crops suitable for the summer, winter, and wet seasons need to be considered for optimizing yield. The crop calendar of these suggested crops and number of days for harvest is provided in Table 5-8.

A combination of crops is preferred for a unit hectare of land with two crop seasons a year. This will help increase the revenue and mitigate the risk of crop failure and the risk of low returns due to low market prices due to surplus supply. The investment cost can be recovered in less than 3 years, assuming that crops are cultivated two crop seasons annually. To ensure soil productivity, it is important to practice rotation of crops with different cultures particularly with legumes. Table 5-7, Table 5-8, and

[32] Practical Action, technical brief Solar (PV) water pumping, The Schumacher Centre for Technology and Development, UK. (http://www.stanford.edu/group/solarbenin/references/solar_pv_waterpumping.pdf)

[33] Mohanlal Kolhea, Sunita Kolhea, J.C. Joshib, (2002), Economic viability of stand-alone solar photovoltaic system in comparison with diesel-powered system for India, Energy Economics 24, page 155 to 165.

Table 5-10 provide details of key culture characteristics, details of depreciation applied during the calculation, and the key figures of IRR calculation. The values for the cost estimation are derived from the PPIP and PIP2 projects of Niger.

Table 5-7: Culture characteristics

Development	**Polyculture: 2 crop season annually**	
Developed area	1 ha	
	Irish potato	Associated
Crops grown	Onion	
	Pepper (Capsicum)	
	Maize	Associated
	Cowpea	
	Potato	Pure cultures
	Tomato	Pure cultures
	Cabbage	Pure cultures
Source of water	Well	
Pumping	Motor pumps	
Distribution	Surface drip network	
Irrigation technology	Total control of water	

Table 5-8: Crop calendar and average number of days for harvest of selected crops in Niger

Cropping window	Crops	Length of the cropping cycle
July to November	Maize Cowpea	90 days
December/January to February/March	Tomato Cabbage Onion Potato/Irish potato Lettuce (not in the proposed list)	70 days
April to June	Okra Pepper (transplanted)	60 days

Table 5-9 Farm investment and depreciation costs

Investments	Costs		Depreciation Rate (%)	Annual Sum (FCFA)	
	USD	F CFA		USD	F CFA
Agricultural tools	260	130,000	33%	87	43,290
Fencing	1,000	500,000	10%	100	50,000
Overhead tank	1,000	500,000	20%	100	50,000
Pump (cost of 2 pumps)	1,000	500,000	20%	200	100,000
Distribution system	6,000	3,000,000	20%	600	300,000
Well/borewell	2,000	1,000,000	10%	200	100,000
Total investment cost	11,260	5,630,000			
Total depreciation				1,287	643,290

Table 5-10 Return of Investment calculation for surface drip irrigation system in USD [IFC notes that the payback period figure requires further verifications.]

		Currency USD		
Item ref.		**Year 1**	**Year 2**	**Year 3**
A	**Income through selling of farm product**			
	Irish potato	840	910	979
	Onion	1,700	1,841	1,982
	Tomato	1,300	1,408	1,516
	Pepper	2,500	2,708	2,915
	Cabbage	425	460	496
	Cowpea	320	347	373
	Maize	360	390	420
Sub total A	**Farm products (outputs): Subtotal**	7,445	8,063	8,681
B	**Operating Expenses**			
	Organic manure	46	50	54
	Plowing /Tillage	46	50	54
	Leveling	33	36	38
	Preparation of beds and furrows/channels	40	43	46
	Seeds	145	157	169
	Plant protection product	40	43	46
	Chemical fertilizers	86	93	100
	Fuel	158	172	185
	Lubricant	92	100	108
	Repair & Maintenance	26	29	31
	Packaging	92	100	108
	Harvest transport	264	286	308
	Labor	132	143	154
Sub total B	**Farm input cost: Subtotal**	1,201	1,301	1,401
B1	**Capital Investment**	**11,260**		
C	**Gross margin A-B**	6,244	6,762	7,280
D	**Deprecation**	1,987	1,987	1,987
D1	**Interest (@12% on loan)**	**1,351**	**1,216**	**1,081**
E	**Net margin C-D**	2,906	3,559	4,213
F	**Cash flow = D + E**	4,893	5,546	6,199

		Currency USD		
Item ref.		**Year 1**	**Year 2**	**Year 3**
Final	**Discounted cash flow to 14%**	4,292	4,267	4,184
	Net Present Value	**10,668**		
	Internal Rate of Return (IRR)	**22%**		
	Capital recovery time (Pay back period)	**2.2 years**		
	Cost benefit ratio	**0.6**		

Note: Table 10-1 annexure 10.1 shows these figures in FCFA

Assumptions

1. Input cost will be on credit and will be paid at the end of the harvest
2. The investment cost is loaded in the first year of gross margin
3. The price of crop considered is the farm gate price
4. Two crop seasons with combination of crops are raised in a year in 1 ha plot
5. Inflation rate considered as 8.3%, which is the 2011 inflation rate of Niger
6. The life of the project is considered as 5 years and shelf life of investment of water source and irrigation development considered with no salvage value and straight line depreciation
7. Interest to the loan amount will be 12% per annum. Farmers pay on quarterly basis after harvest
8. Even though the crop productivity for drip irrigation is higher than subsurface irrigation, we have considered the modest option of same production as for sub surface irrigation methods.

Note: As per our field observations, the cost of construction of well/borewell varies drastically depending on the water table, soil, and access to location. Various authors observed the cost in a similar range. In the present analysis, we have considered the cost for construction of a well as USD 2,000 (FCFA 1 million). The cost of construction of a well/borewell in Niger valley, where there are rich aquifers, would be substantially lower.

Sensitivity analysis

Three scenarios (Table 5-11) were considered to carry out the sensitivity analysis.

Table 5-11: Sensitivity analysis of investment

Sensitivity	Net Present Value (NPV)		IRR	Pay back period including capital cost	Cost benefit ratio
	USD	FCFA			
10% increase in the input cost	10,196	5,098,099	21%	2.5 years	0.6
10% decrease in the	8,209	4,104,251	15%	2.6 years	0.7

output price					
10% increase in the input cost and 10% decrease in the output price	7,832	3,915,873	13%	2.8 years	0.7

Sensitivity analysis shows the IRR is robust and is profitable even if the investment costs increase by 10% and the output price decrease 10%. In the worst-case scenario, where there is a 10% increase in the input cost as well as 10% decrease in the output price, the IRR is still 13%.

5.2.5 Type 2: Subsurface irrigation (California) system

Subsurface drip irrigation is highly suitable for high-value crops such as strawberry, tomato, potato, onion, and other vegetables, which need light and frequent irrigation. To improve water efficiency, farmers in some countries use subsurface drip irrigation in conjunction with plastic mulches to reduce water seepage.

In Niger, crops like peanut, cowpea, okra, maize, sweet potatoes, squash, tomato, cabbage, lettuce, pepper, potato, watermelon / melon, etc. can be grown using subsurface drip irrigation.

Depending on the nature of water availability and farm holding, one of the below mentioned options of water resources can be used:

(i) AMG permanent well, motorized pump and concrete tanks
(ii) Bore well, motorized pump and concrete tanks

In the present analysis, the cost for construction of a well is estimated for one hectare and is shared by four farmers. This will reduce the investment cost substantially. In case a water source is already available, the investment cost for developing the water source will be nil.

The investment cost is slightly higher for subsurface irrigation systems compared to the surface drip systems mainly due to the higher cost of subsurface grids and labor. As this system needs moderate pressure, manual operation of bucket to barrel does not work.

In addition to the water source, an initial investment is required for - pump unit, overhead tank, drip grids, wire fence, hedge, and fruit trees. The capital cost required (including the construction cost of water source) along with depreciation is provided in Table 5-13. This investment can be recovered in 2.4 years, assuming that crops are cultivated in two crop-season annually. [IFC notes that this statement requires further verifications.] The crop calendar and duration of harvest of selected crops is provided in Table 5-8. To ensure soil productivity, it is important to practice rotation of crops with different cultures particularly with legumes. Table 5-12, Table 5-13, and Table 5-14 provide details of key culture characteristics, details of depreciation applied during the calculation, and the key figures of IRR calculation respectively.

Table 5-12: Culture characteristics for California irrigation system

Development	**Polyculture: 2 crop season across the year**	
Developed area	1 ha	
	Irish potato	Associated
Crops grown	Onion	
	Pepper	
	Maize	Associated
	Cowpea	
	Potato	Pure cultures
	Tomato	Pure cultures

Development	Polyculture: 2 crop season across the year	
	Cabbage	Pure cultures
Source of water	Well	
Pumping	Motor pumps	
Distribution	California network	
Irrigation technology	Total control of water	

Table 5-13: Calculation of depreciation for California irrigation system

Investments	Costs		Depreciation Rate (%)	Annual Sum	
	USD	FCFA		USD	FCFA
Agricultural tools	260	130,000	33%	87	43,290
Fencing	1,000	500,000	10%	100	50,000
Overhead tank	1,000	500,000	20%	100	50,000
Pump	1,000	500,000	20%	200	100,000
Distribution system	6,600	3,300,000	20%	660	330,000
Well	2,000	1,000,000	10%	200	100,000
Total investment cost	11,860	5,930,000			
Total depreciation				1,347	673,290

Table 5-14 Return of Investment calculation for California irrigation system in USD

		Currency FCFA		
Item ref.		Year 1	Year 2	Year 3
A	Income through selling of farm product			
	Irish potato	840	910	979
	Onion	1,700	1,841	1,982
	Tomato	1,300	1,408	1,516
	Pepper	2,500	2,708	2,915
	Cabbage	425	460	496
	Cowpea	320	347	373
	Maize	360	390	420
Sub total A	Farm products (outputs): Subtotal	**7,445**	**8,063**	**8,681**
B	Operating Expenses			
	Organic manure	46	50	54
	Plowing /Tillage	46	50	54
	Leveling	33	36	38
	Preparation of beds and furrows/channels	40	43	47
	Seeds	145	157	169
	Plant protection product	40	43	46
	Chemical fertilizers	112	122	131

		Currency FCFA		
Item ref.		**Year 1**	**Year 2**	**Year 3**
	Fuel	211	229	246
	Lubricant	53	57	62
	Repair & Maintenance	73	79	85
	Packaging	92	100	108
	Harvest transport	264	286	308
	Labor	198	214	231
Sub total B	**Farm input cost: Subtotal**	**1,353**	**1,466**	**1,578**
B1	**Capital Investment**	**11,860**		
C	**Gross margin A-B**	**6,092**	**6,597**	**7,103**
D	**Deprecation**	**2,007**	**2,007**	**2,007**
D1	**Interest (@12% on loan)**	**1,423**	**1,281**	**1,139**
E	**Net margin C-D**	**2,662**	**3,310**	**3,958**
F	**Cash flow = D + E**	**4,668**	**5,316**	**5,964**
Final	**Discounted cash flow to 14%**	**4,095**	**4,091**	**4,026**
	Net Present Value	**9,494**		
	Internal Rate of Return	**18%**		
	Capital recovery time (Pay back period)	**2.4 years**		
	Cost benefit ratio	**0.6**		

Note: Table 10-2 in annexure 10.1 shows these figures in FCFA

Assumptions

1. Input cost will be on credit and will be paid at the end of the harvest
2. The investment cost is loaded in the first year of gross margin
3. The price of crop considered is the farm gate price
4. Two crop seasons with combination of crops raised in a year in 1 ha plot
5. Inflation rate considered as 8.3%, which is the 2011 inflation rate of Niger

6. The life of the project is considered as 5 years and shelf life of investment of water source and irrigation development considered with no salvage value and straight line depreciation
7. Interest to the loan amount will be 12% per annum. Farmers pay on quarterly basis after harvest

Sensitivity analysis

Three options of the scenario were considered to carry out the sensitivity analysis:

Risk	Net Present Value (NPV)		Internal Rate of Return	Pay back period including capital cost	Cost benefi t ratio
	USD	FCFA			
10% increase in the input cost	5,221	3883,794	12%	2.8 years	0.7
10% decrease in the output price	6,473	3,236,255	9%	2.9 years	0.7
10% increase in the input cost and 10% decrease in the output price	3,864	1,932,249	1 %	2.8 years	0.7

Sensitivity analysis shows the IRR is robust and is profitable even if the investment costs increase by 10% and the output price decrease 10%. In the worst-case scenario, where there is a 10% increase in the input cost as well as 10% decrease in the output price, the IRR is 1%.

5.3 Capacity and Perception Analysis

Most farmers still consider irrigation as a means to diversify their agricultural activities rather than as an opportunity to increase production and income. In general, if the rainfall is good, farmers tend to cultivate rainfed culture rather than supplementing with irrigation.

During the survey among farming communities, 35% of the farmers interacted with are using irrigation for their agriculture and most of them are cultivating vegetables. However, out of 35%, only 9% are using modern irrigation methods – drip and subsurface irrigation. Majority of the farmers interacted with are using drip irrigation and wells as the source for water. None of the farmers surveyed have taken insurance even though 30% of the farmers have availed loans for buying seeds, fertilizers, irrigation, and livestock. Only 20% of the sample is getting technical support on operation and maintenance of modern irrigation systems and a majority has expressed interest on availing training in the use of modern irrigation for their agricultural activities. Presently, agricultural extension services, farmer's cooperatives, and NGOs are the key players who provide technical support to the farmers in this country.

Majority of the farmers using improved irrigation system are beneficiaries of NGO and Government funded projects (45% and 36% respectively) while 19% of farmers has taken loans from DFIs or banks through cooperatives. Considering the low penetration rate of banks and micro finance institutions in the country and their low investment in the agriculture sector, the 19% farmers investing on their own is a promising sign. There is a clustering of farmers using improved system in some parts and is mainly attributed to two reasons – primarily the farmers have received the system through some donor projects and secondly the water source is easily accessible.

One of the key barriers observed during the investigation was the lack of technical and managerial skills of individual farmers for using modern irrigation equipment. The organized network reach of farmer's cooperatives and unions provides a promising choice for providing

assistance to farmers. Majority (75%) responded that technical risks and availability of spare parts are the key risks they face in adopting improved irrigation systems.

5.4 Financial Capacity of Farmers to Pay and Willingness to adopt Improved Irrigation Systems

Financial capacity to pay depends on the economic status of farmers and credit worthiness for availing credit. Majority of the farmers in Niger practice subsistence farming and are poor. Almost 60% of the sample population has an average annual income below USD 200 (FCFA 0.1 million). The choice of crops also determines the income of the farmers even though 70% of the farmers surveyed use most of their harvest for their own consumption. The income distribution of farmers in the survey sample is provided in Table 5-15.

Table 5-15: Annual average income distribution (in percentage) of farmers

Region	< USD 200 (FCFA 0.1 million)	USD 200-600 (FCFA 0.1-0.3 million)	USD 600-1000 (FCFA 0.3-0.5 million)	USD > 1000 (FCFA >0.5 million)
Maradi	53.3	20.0	16.7	10.0
Niamey	50.0	10.0	20.0	16.7
Tahoua	60.0	30.0	3.3	6.7
Zinder	70.0	20.0	6.7	3.3
Total	**58.8**	**20.2**	**11.8**	**9.2**

However, there are a small number of prospective farmers practicing irrigated agriculture. The average income of irrigated and rainfed farmers is provided in Table 5-6. The vegetable, rice, and onion growers under irrigated farming are fetching reasonably good incomes even though the number of farmers in this higher income group is very small as the total households practicing irrigated farming is around 200,000 as per the World Bank.

The recurring expenditure for farmers using improved irrigation is about 20-25% of the total income generated from the crops. The average annual incomes of farmers practicing rainfed agriculture and those using improved irrigation are drastically different. The yield per hectare of farmers using improved irrigation is 4-8 times higher than farmers practicing rainfed agriculture. The average annual income of farmers depending on rainfed and irrigated farming is provided in Table 5-6.

The community's willingness to adopt improved irrigation systems depends highly on the diffusion on technology, information dissemination, and the experience of the community. The survey data clearly indicates this segregation against the response of the willingness of farmers to adopt improved irrigation systems. The percentage response from Maradi and Niamey are high, compared to other regions. A large number of garden farmers are using improved irrigation and the community is experiencing the advantages of the technology over traditional irrigation systems particularly in the Maradi region.

Table 5-16: Willingness to pay for improved irrigation system (% to total sample)

Region	Yes	No
Maradi	74.1	25.9
Niamey	62.1	37.9
Tahoua	17.2	82.8

Zinder	56.7	43.3

5.5 Training Need Assessment

Training, awareness and improved extension services are required specifically at community level in increase the diffusion of improved irrigation agriculture in Niger. The PPIP and PIP2 have extended several training and awareness activities at community level and this has increased the awareness and perception of community towards improved irrigation. The following activities are proposed to enable participation of various stakeholders:

1. Development of demonstration plots by agribusiness firms involving farmers
2. Training the farmers and engaging them to train other farmers in the use and maintenance of improved irrigation system
3. Conducting farmers' tours to the demonstration plots during various growing period
4. Agri business firms who can procure crop produce should engage contract growers providing technical and financial support
5. Supply chain strengthening to ensure that crop produce is procured from farmers. This can be done involving the farmer's cooperatives and agri business firm.

5.6 Technical Risks in Adopting Improved Irrigation Systems

Based on the information collected from communities and various stakeholders, following are the key technical risks that can be foreseen in adopting improved irrigation systems in Niger.

1. Skills and knowledge: Imparting skills and knowledge to farmers in installing, and operating and maintaining improved irrigation systems is important to avail optimum results. Considering the remoteness of the rural villages of Niger, mechanisms need to be adopted to provide extension services and knowledge centers where farmers/farmers' organization can walk-in to collect technical support and knowledge. Presently, the level of skills and knowledge about maintenance of improved irrigation systems of a majority of farmers in Niger is very low, as they are not exposed to such systems. The underlying risk from poor knowledge is that improved systems, even when introduced, will not provide optimum results.
2. Availability of accessories: A few agribusiness organizations in Niger supply improved irrigation equipment. All these suppliers import most of the spare parts from Israel, Turkey, and India. These agribusiness organizations have limited outlets in rural Niger, which hampers farmers from sourcing accessories for replacement.

5.7 Market Scenario

The agricultural market of Niger has not grown to its full potential even though 80% of the population depends on the sector, which contributes 40% to the country GDP.

There are only three key agribusiness firms in Niger – Company B, Company C, and Company D. Company B and Company C are established firms and their sales focus on agricultural equipment, fertilizers, pesticides, and seeds. The demand for irrigation equipment in the country is met through imported materials mainly from Israel, Turkey, and India. The firms place orders based on requests from their domestic clients. As the present market for irrigation equipment is small, the unit price is high due to the loading of shipment costs on the product. The shipment costs include the cost of transportation from the country of origin and road transport costs from Benin port.

The bulk of demand for irrigation equipment is mainly from the government, donor organizations, and NGOs under various development projects. The sale figures of the two leading agribusiness firms show that more than 50% of the sales pertain to chemical

fertilizers and pesticide, about 30% to seeds, and only single digit figures for irrigation and agriculture equipment. Under the 3N program, an extensive plan has been drawn for distribution of irrigation kits to small landholding farmers mainly focusing on women farmers.

The key linkages among various stakeholders in Niger's agriculture are shown in Figure 5-2. The linkages also show the roles of key government institutions and other organizations in the sector.

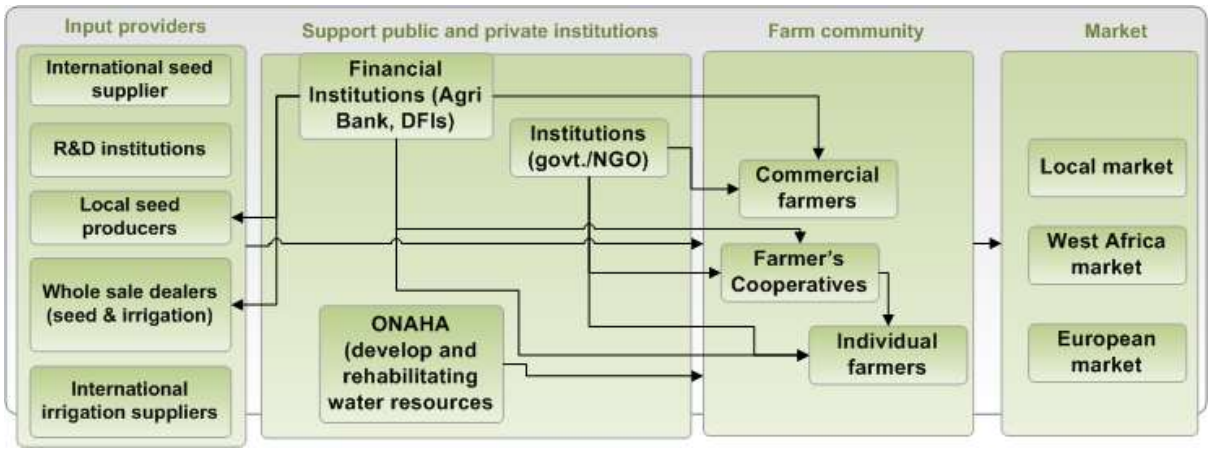

Figure 5-2 Key players and their linkages in the agriculture sector, Niger

When agribusiness firms like Company B and Company C supply irrigation equipment, they support installation and impart training to farmers for operation and maintenance. Firms like Company D, which is relatively new to this sector, even extend field visit facilities to support farmers who purchase irrigation equipment from them. Company C has store outlets at Maradi, Gaya, Zongo, Gamkalle, Agadez, Konni, and Zinder in addition to its sales and head office in Niamey. Company C has business operations in Nigeria through export sales.

5.8 Awareness and Willingness of Financial Institutions to Finance Improved Irrigation Systems

The financial institutions supporting the agriculture sector include banks and Decentralized Finance Institutions (DFIs). As in the West African Economic and Monetary Union (UEMOA) and the Economic Community of West African States (ECOWAS), banks in Niger contribute very insignificantly to agriculture financing. In Niger, there are 10 approved banks and 1 financial establishment in operation. At the regional level, the whole portfolio of agricultural banks was hardly 3% of the market in 2010.

5.8.1 Private Banks

Indeed, not only is the bank financing of agriculture very low, the entire country's financial investment in agriculture and livestock sector is very low. Lack of collaterals and credit guarantees are the key reasons for low penetration of banking in the agriculture sector in Niger. DFIs have a better penetration of the agricultural sector and some of them are able to secure collaterals, which most of the time consist at least of moral guarantees in communities as borrowers sign contracts with DFIs under the supervision of elders and chiefs. Nonetheless, in spite of the lack of solvency and the limited infrastructure, there are still some prospects to consider private banks as key players to support financing in the agriculture sector.

Table 5-17: Some key figures banking institutions in Niger,

Commercial Banks	Year of formation	Capital (million USD)	Balance (million USD)	Branch offices
SONIBANK	1990	9.5	259.2	8
BIA-Niger	1993	13.4	239.8	8
Bank of Africa	1994	9.5	264.2	16
Ecobank	1999	9.7	220.8	11
BanqueAtlantique	2005	12.4	213.8	13
BCN	1988	19	27.8	1
BSIC Niger	2003	13.8	84.4	11
BRS Niger	2005	3. 8	28	7
Banque Islamique pour le Commerce et l'Investissement	1997	2.7	23	1
Crédit du Niger	1957	3.3	1.3	1
SAHFI	2005	2.5	7.2	1

Source: UEMOA's Banking Commission (2010)

The Table 10-3 in annexure 10.1 shows these figures in FCFA

5.8.2 DFIs

There were 81 DFIs (as on December 2011) in Niger offering an outstanding credit volume reaching USD 30.3 million (FCFA 15,150 million), 90% of which was provided by the first 10 institutions (which also provided 80% of the savings volume). The savings volume reached USD 17.6 million (FCFA 8,800 million).

Two institutions (Company E and Company F) have a total credit volume of USD 10.6 million (FCFA 5,300 million) (1/3 of the entire outstanding credit volume) and are thus the only Nigerien DFIs controlled by the UMOA banking commission. Most other DFIs in Niger are usually considered as credit unions. In terms of coverage, DFIs have a slightly higher penetration of 15%, with a maximum of 35% in neighboring Benin. DFIs are concentrated around urban areas in the most populated regions. A distribution network of more than 190 distribution desks localized in cities back their operations.

DFIs offer financing for livestock feeding, short-term seasonal loans, loans for agricultural machines, warrantage, etc. In 2010, agriculture represented 43% (about USD 12.1 million (FCFA 6 billion)) of the financial services provided by DFIs.

For both Company E and Company F, livestock feeding is one of the main credit lines given to customers. Other agricultural activities generally account for less than 10% of the volume of credit and commerce and income-generating activities represent the biggest part of credit volume. The average credit in both institutions comprised of between USD 250 (FCFA 12,500) and USD 300 (FCFA 15,000) on a short-term basis (less than 3 months), while credits' monthly interest rates in the micro-finance sector are usually 2% to 2.5% and the wear rate is legally fixed to 24% per year.

6 Economic and Revenue Models of Investment in Improved Irrigation Systems

6.1 Economics of Improved Irrigation

The economics of investment of improved irrigation is provided in the Table 6-1. The IRR is 22% and 18% for surface drip and sub surface irrigation systems with a payback period of 2.4 and 2.6 years, respectively [IFC notes that this statement requires further verifications.].

Table 6-1: Investment and return from improved irrigation systems [IFC notes that the payback period figure requires further verifications.]

Irrigation systems	Capital investment cost		Life of the system (year)	Average farm output in a year		IRR	Payback period (year)
	USD/ha	(FCFA/ha)		USD/ha	(FCFA/ha)		
Drip irrigation	11,260	5,630,000*	5***	12,461	6,230,600**	22%	2.2
Subsurface	11,860	5,930,000	5	12,133	6,606,700	18%	2.4

* Investment cost considered here includes cost of construction of well/tubewell/borewell and sharing of one hectare of agricultural land by 4 farmers. In case water is extracted from a river or from an existing well/tubewell/borewell this investment cost can be drastically reduced.

** The farm output cost considers polyculture with two crop seasons with combination of crops in a year. Even though the crop productivity for drip irrigation is higher than subsurface irrigation, we have considered the option as same for both surface and sub surface irrigation methods.

*** Life of drip irrigation is considering the life of the system as 5 years.

Sensitivity analysis shows the IRR is robust with respect to a 10% increase in investment costs and even 10% decrease in the output price. In the worst-case scenario, where there is a 10% increase in the input cost as well as a 10% decrease in the output price, the IRR is 1% for subsurface irrigation.

6.1.1 Supply of Irrigation Equipment

The key suppliers of improved irrigation equipment in the country are Company B and Company C, two lead agribusiness firms in the country. There are other small organizations, which are in the process of establishing their business. These are in addition to regional organizations like Company G, and Company H with presence in the West Africa region. Most of these suppliers import irrigation equipment from Israel and Turkey. These agribusiness firms also provide technical support to private farmers along with the supply of equipment. In addition to these firms, there are donor organizations, international NGOs, technology solution providers like Company I, research organizations like INRAN and International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), who provide technical support through specific projects in the country.

Company B is one of the largest agri equipment providers in the country with a turnover USD 3 million (FCFA 1.2 billion). The firm imports irrigation equipment mainly from Israel and provides technical support including installation of units, training on how to operate and

maintain the system and visits to certain locations at frequent intervals. The firm also deals with sale of seeds, fertilizers, and pesticides in the country.

Company C is an established agri business firm with operations in Niger (78%) and Nigeria (22%). The firm engages in sale of seeds, fertilizer (liquid), pesticides, insecticides, and irrigation equipment. Company C has outlets at Maradi, Gaya, Zongo, Gamkalle, Agadez, Konni, and Zinder in addition to its sales and head office in Niamey.

The major share of irrigation equipment sales of these firms is mainly on account of donor-funded programs.

7 Market Assessment for Climate Resilient Seeds

7.1 Overview of the Current Seed use in Niger

Use of improved seeds can allow for increases in crop production by 30% to 40%. Even though genetics determines the worth of a seed, their performance is influenced by location-specific factors. In other words, performance of any seed is influenced by the climate in which it is grown. With climate change causing changes in the climate of a location, corresponding modifications in the genetics of seeds are required for sustained good performance. Creation and breeding of climate resilient seeds is achievable through genetic engineering. In a country like Niger, where food-security is under threat, the need to encourage production and use of climate resilient seeds by farmers cannot but be emphasized.

7.1.1 Climate Resilient Seeds

The National Agricultural Research Institute of Niger (INRAN), currently under the Ministry of Agricultural Development, was created in 1975 as a national R&D center. INRAN has made substantial contributions to Niger's agriculture sector by identifying and developing climate resilient seeds for some of the principal crops. Their collaborative efforts with some CGIAR centers like CIMMYT (International Maize and Wheat Improvement Centre), International Institute of Tropical Agriculture (IITA), ICRISAT, and World Vegetable Centre (AVRDC) have resulted in identification of some climate resilient varieties/hybrids, which need to be multiplied and made available to the farmer. Many of the seeds were developed through hybridization by selecting the traditional varieties, which are adapted to Niger's climate.

ICRISAT Center developed the following millet varieties that are reported to be climate-resilient:

- GB 8735
- ICRI-TABI
- ICMV IS 89305
- ICMV IS 92222
- SOSAT C-88
- ICMV IS 99001

ICRISAT has also developed a number of sorghum and peanut varieties that can withstand near-drought conditions, while IITA has developed some good varieties of cowpea with similar virtues. Since rice is grown under irrigated conditions, it should be possible to identify some good rice hybrids evolved in China, India, and IRRI that can perform well under Niger's climate.

Joint research efforts of CIMMYT and IITA produced several early maturing maize varieties that have low water requirements. These are given below:

Table 7-1 Maize Varieties Released under DTMA (Joint program of CIMMYT & IITA) in West Africa (2007-2011)

COUNTRY	YEAR of release	Release Name	Code/Pedigree	Maturity	COMPANY	HYBRID/OPV
Bénin	2007	2000 SYN EE W / Ku Gnaayi	2000 SYN EE W	Extra-early	IITA/ INRAB	OPV
Bénin	2007	EV 97 DT STR W / Mougnangui	EV 97 DT STR W	Early	IITA/ INRAB	OPV
Bénin	2010	TZE COMP 3 DT / Ya Kouro Goura Guinm	TZE COMP 3 DT	Early	IITA/ INRAB	OPV
Bénin	2010	BAG TZE COMPISITE 3 x 4 / Orou Kpintéké	BAG TZE COMPISITE 3 x 4	Early	IITA/ INRAB	OPV
Bénin	2010	IW DC2SYN F2 / Djéma- Bossi	IW DC2SYN F2	Intermediate/late	IITA/ INRAB	OPV
Bénin	2010	DT SR W C2	DT SR W C2	Intermediate/late	IITA/ INRAB	OPV
Ghana	2007	CSIR-Etubi	GH110 x Entry 85	Intermediate/late	CRI/IITA	Hybrid
Ghana	2010	CSIR- Enii-Pibi (Enibi)	GH110 x Entry 75	Intermediate/late	CRI/IITA	Hybrid
Ghana	2010	CSIR-Abontem	TZEE-Y Pop STR QPM C0	Extra-early	CRI/IITA	OPV
Ghana	2010	CSIR-Omankwa	TZE-W Pop DT STR QPM C4	Early	CRI/IITA	OPV
Ghana	2010	CSIR-Aburohemaa	EVDT-W99 STR QPM C0	Early	CRI/IITA	OPV
Mali	2009	Jorbana	EVDT97WSTRC1	Early	IER/IITA	OPV
Mali	2010	Brico	TZEE -Y Pop STR C4	Extra-early	IER/IITA	OPV
Mali	2011	Tieba	Top cross Hybrid white	Intermediate/late	IER/IITA	Hybrid
Nigeria	2009	Sammaz 18	Tillering Maize	Early	IAR	OPV
Nigeria	2009	Sammaz 19	S.14DKD DT	Intermediate/late	IAR	OPV
Nigeria	2009	Sammaz 20	TZE Comp3DT	Early	IAR	OPV
Nigeria	2009	Sammaz 22	MO826-1	Intermediate/late	IAR/IITA	3-way cross hybrid
Nigeria	2009	Sammaz 23	MO826-3	Intermediate/late	IAR/IITA	3-way cross hybrid
Nigeria	2009	Sammaz 24	MO826-7	Intermediate/late	IAR/IITA	Top cross Hybrid
Nigeria	2009	Sammaz 25	MO826-11	Intermediate/late	IAR/IITA	Top cross Hybrid

COUNTRY	YEAR of release	Release Name	Code/Pedigree	Maturity	COMPANY	HYBRID/OPV
Nigeria	2009	Sammaz 26	DTSR-WC1	Intermediate/late	IAR/IITA	OPV
Nigeria	2009	Sammaz 27	EV99DT-W-STR	Early	IAR/IITA	OPV
Nigeria	2009	Sammaz 28	TZEE Y Pop STRC3	Extra-early	IAR/IITA	OPV
Nigeria	2009	Sammaz 29	2000Syn EE-W-STR	Extra-early	IAR/IITA	OPV
Nigeria	2009	Oba Super 7	SYN/ZDL1/TZL1	Intermediate/late	Premier/IITA	3-way cross hybrid
Nigeria	2009	Oba Super 9	SYN/ZDL1/TZL2	Intermediate/late	Premier/IITA	3-way cross hybrid
Nigeria	2011	Sammaz 32	99TZEE-Y Pop STR QPM C0	Extra-early	IAR/IITA	OPV
Nigeria	2011	Sammaz 34	IAR Multicob Early DT	Early	IAR	OPV
Nigeria	2011	Sammaz 35	2000EV DT-Y STR C4	Early	IAR/IITA	OPV
Nigeria	2011	SAMMAZ 38	2000 Syn EE - W STR QPM CO	Extra-early	IAR/IITA	OPV

Maize varieties are early maturing and consequently escape being affected by drought to a greater degree. In the neighboring country, Mali, the World Vegetable Center (AVRDC), conducted some good work in the recent past on identification of a few exotic vegetable seeds that could perform very well under limited irrigation in Mali/Nigerien conditions. These are given below:

- Amarante *Amaranthus* sp 2 A2002 A2004
- Aubergine africaine *Solanum aethiopicum* L. 2 SoxnaL10
- Echalote *Allium ascolonicum* 2 Marena Khasso
- Gombo *Albelmoschus esculentum* 5 Keleya Sabalibougou Sasilon Batoumambé Safi
- Oignon *Allium cepa* L. 3 Violet de Galmi Lafia Founou-Founou
- Oseille de Guinée *Hibiscus sabdariffa* L. 3 THS22 L28 Samandah
- Piment fort *Capsicum annuum* 5 Nafama Nisondia Bafarima Demon F1 Beibeihong 695 F1
- Piment doux (Poivron) *Capsicum annuum* 3 Poivron Jan Wassa Séguifa
- Tomate *Solanum lycopersicum* 8 Formosa Estrela C20-5 SF8361 Bèbi yèrèyé Kénéya Nayéli Konica

7.1.2 Seed Regulations in Niger

The Government recently approved the **"Bill on Seed Plant"** which has provisions for seed regulations. In all, 100 articles are listed under XIII chapters covering important aspects of seed laws. Some of the articles provided in Section 10.4 on "Control of Seed Plants" may have an influence on the future seed industry in the country.

7.2 Market Assessment and Economics

Based on area of cultivable land, Niger needs 100,000 tons of various seeds while the current production is only 5,000 tons. There is a big gap between demand and supply and efforts need to be made to cater to the growing seed requirements in the country.

According to an estimate, demand for such seeds is likely to grow fast in the next four years, as suggested in the following table:

Table 7-2: Estimated market size of various seeds in Niger 2012-2015

Seeds	Seed requirements in tons			
	2012	2013	2014	2015
Millet R1	870	1 450	2 175	2 901
Millet R2	8,700	14,500	21,750	29,010
Sorghum R1	597	996	1,494	1,993
Haricot R1	1,254	2,089	3 133	3 342
Haricot R2	10,027	16,712	25,069	33,425
Arachide (coque) R1	3,819	6,366	5,949	6,366
Arachide (coque) R2	19,090	31,830	47,746	63,660

(Source: Company B)

7.2.1 Yield Potential of Climate Resilient Seeds

Yield potentials of climate resilient seeds vis-à-vis farmers' seeds, as estimated by INRAN scientists, are summarized in the following table:

Table 7-3: Comparison of yield of farmers' seeds and climate resilient seeds

Crop	Famer's yield	Imported seed - famer's yield	Potential yield (kg/ha.)
Millet	400	750	2,000
Sorghum	300	800	3,000

Crop	Famer's yield	Imported seed - famer's yield	Potential yield (kg/ha.)
Maize	900	1,500	3,500
Niébé	150	800	1,500
Sésame	400	700	1,000
Arachide (coques)	435	1,000	2,500
Onion (bulbs)	20,000	35,000	55,000
Onion (grains)	300	400	550

As shown in Table 7-3, the potential of such seeds is many folds higher than the yield levels harvested by farmers.

7.2.2 Seed Availability and Growing Demand

INRAN also produces seeds of various varieties and the volumes produced during the past few years are shown in Figure 7-1.

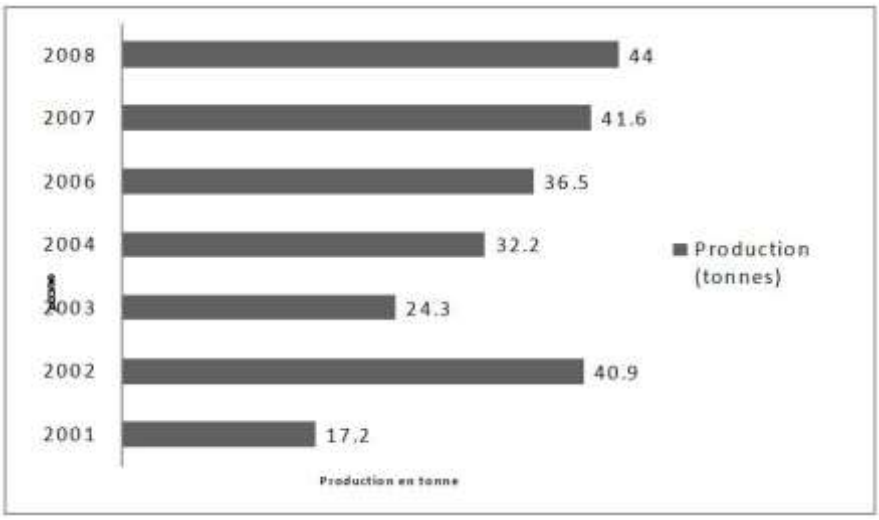

Figure 7-1: Quantity of seeds produced by INRAN

7.2.3 Seed Production, Processing and Sales Network

Some of the key seed producers in the country and their strengths and limitations are provided in the Table 7-4.

Table 7-4: Some key seed producers in Niger

Stakeholder	Advantage(s)	Limit(s)[Sensitive information has been removed from this column.]
Traditional farmer practices	Proximity, low costs	Lack of access to improved varieties, overly sensitive to natural disasters
Farmer seed cooperatives (G. Iddar, Saboua, Maizabi, Tera)	Well managed production of large quantities of quality seed	[Sensitive information has been removed.]
Sadia rice farm	Well trained farmers; steps in the production and processing chain well	Limited to rice

	followed	
APPSN (Association of private Seed Producers of Niger)	Expression of real market needs for seed with technical skill	Relatively new
Agrimex (private agricultural inputs company)	Excellent marketing network especially for vegetable seed and phytosanitary products	[Sensitive information has been removed.]
Manoma SA (private agricultural inputs company)	Big and established agri business firm in the country	Main focus is on agriculture equipment, fertilizers and irrigation system
National Cereal Project (1976-1983)	Infrastructure for seed treatment and warehousing	[Sensitive information has been removed.]
ONAHA Seed Project (wheat and sorghum 1998-2000)	Promotion of seed self-management / Follow-up of farmers	[Sensitive information has been removed.]
Project Inputs	Promotion of inventory credit (warranty) and self-management	Activities focus on fertilizer rather than seed
NGO Afrique Verte (cereal seed loans)	Favors direct marketing among producers	[Sensitive information has been removed.]
SIM (System of Information on the Markets)	Good knowledge of cereal offers throughout the country	Not directly concerned with seed
INRAN/Seed Unit	Production and promotion of good quality foundation seed and farmer training / self-management	[Sensitive information has been removed.]
INRAN/INTSORMIL/ WINROCK - ONFARM Project	Improvement of multiplier farmers' technical skills and income	[Sensitive information has been removed.]
FTDA/INRAN/ICRISAT Project	Good knowledge of varietal choice and good management of multiplier farmers	[Sensitive information has been removed.]
CCFAN (Consultative committee on the groundnut industry in Niger)	Partnerships between farmer organizations, private seed operators, NGOs, extension service, agricultural research, model for a national consultative structure	Relatively new

Source: ICRISAT, Niger

7.2.3.1 Public sector seed production and distribution

INRAN, through the Seed Unit Regional Centers for Agricultural Research (CERRA) and stations supporting research, provides basic seeds for the seed multiplication centers,

projects that support farmers' organizations and private seed companies for multiplication of large multipliers of base seeds.

Supply of basic seeds is often reported to fall short for producing large seed quantities of certified R1 and R2 seed categories. This deviation is primarily due to financial constraints of the centers. In the current scheme, INRAN is the only institution that provides basic seeds. Production sites are:

- Tillabéri / Lossa: sorghum, cowpea, millet
- Kollo / Bengu: sorghum, maize, millet, peanuts
- Gabougoura: sorghum, cowpea
- Konni: sorghum, millet, cowpea, maize
- Maradi: millet, sorghum, cowpea, peanut, corn, vegetables (onion)

The initial purpose of seed multiplication centers is to multiply R1 certified seeds from basic seeds produced at these seed farms. Due to a change in the mandate, the seed farm at Lossa has ceased to produce basic seeds. This necessitated regional centers to produce and provide seed-level R2, which was produced from R1 level seeds provided by the seed unit of INRAN.

These centers are under the supervision of the Regional Directorates of Agriculture (DRA). In order to cater to the increasing seed demand with limited land, the seed centers started using land and other resources of the neighboring farmers. Each seed center now signs an annual contract with individual farmer and also provides inputs and technical know-how. The seed production is done under the supervision of the center's staff to ensure prescribed seed standards for good quality seeds.

Campaign plans are established by the center manager and a budget is submitted to the DRA. The Regional Seed Fund (SRF) provides funds for necessary inputs and farm labor. Much of the harvest is collected by the centers to ensure the repayment of advances. Seeds are sold by the center or the DRA and the Department of Agriculture's regional offices.

CAIMA is a government agency under the Ministry of Agriculture. The key activities of CAIMA are to procure fertilizers, pesticides, equipment, and seeds and sell them to farmers at subsidized prices. CAIMA procures seeds from agribusiness organizations even though the amount of procurement is less compared to chemical fertilizers and pesticides.

7.2.3.2 Private sector seed production and distribution

There are two main agribusiness companies – Company B and Company C in Niger, which sell seeds along with other agricultural material. The production and sales of both the companies are on similar line. The base seeds are procured from INRAN and provided to farmers (seed producers). The produced seeds are then procured from these farmers. In addition to this, both the companies import HYV and climate resilient seeds from other West African and European markets. However, in terms of bulk sales, these firms have to wait for procurements by government departments, donor agencies, or NGOs. In addition to the formal sales through these firms, there is a large informal inflow of vegetable seeds from Nigeria and Burkina Faso.

Company J, another seed producing company, primarily procures base seeds from INRAN, multiplies them, and sells it to farmers.

Federation C is a federation of seed producers in Niger. The federation supports seed producing farmers to procure base seeds, trains them to grow quality seeds, and also sells seeds. Federation C sells seeds to farmers' cooperatives, agricultural firms, and the agriculture department.

7.3 Training Needs

Seed companies are supervised by officers of the Department of Agriculture responsible for the supervision of farmers in agricultural districts. Agriculture officers certify the seeds before they are sold and charge USD 6 (FCFA 3,000) for the process. The technical support provided to producers by the department includes:

- Site selection and soil preparation
- Techniques of isolation
- Techniques of fertilizer application (especially the micro dose)
- Techniques for seeding
- Cultivation techniques
- Techniques for thinning
- Techniques of purification (elimination of off-types, removal of diseased feet, etc.)
- Techniques for packaging
- Seed treatment
- Storage of seed production

This applies to others as well and all seed producers need to be educated well on the above aspects of seed production. Trainings need to be arranged on the following aspects:

- Seed processing, including grading, drying and seed treatment
- Seed packaging and printing required details on seed quality
- Warehousing and seed storage
- Seed Quality Assurance
- Seed Standards
- Seed sales and marketing
- Climate resilient seeds and their agronomy
- Seed regulations and seed policy
- WASA (West Africa Seed Alliance) and export opportunities

7.4 Perception Analysis

The knowledge on HYV and climate resilient or early maturing varieties of seeds is relatively low among Niger farmers. The associated costs, and the paucity of knowledge and skill required for growing restrain in usage of these seeds. The general perception towards agriculture as a subsistence activity also refrains farmers from venturing into using new varieties even though there are definite economic benefits.

7.5 Demand Supply Analysis

As stated earlier, based on the area of cultivable land available, Niger needs 100,000 tons of various seeds, while the current production is only 5,000 tons. There is a big gap between the demand and the supply and this is likely to widen further in the years ahead. Therefore, efforts need to be taken to bridge this demand-supply gap in order to cater to the growing seed requirements in the country.

Estimated seed market size and projection of one of the key agribusiness firms is presented in Table 6.2. As this is the statistics of a single agribusiness firm with a limited distribution network in the country, the figures need to be treated at the lower side and the actual demand. Harmonization of seed regulations conceptualized by WASA are likely to become a reality as many countries in West Africa have already enacted appropriate laws and others are in the process of enacting them soon. In such a scenario, Niger with augmented irrigation facilities, can cater not only to domestic requirements but also become a major exporter to its neighbors. There are three key factors, which can determine the success, namely:

- Encouraging private seed sector development and forging Public-Private Partnership (PPP)
- Developing required infrastructure like seed processing, warehouses, and R&D facilities by the private sector and NGOs
- Developing human resources to train farmers through appropriate trainings, etc. AFSTA could be tasked to collaborate and donors such as the World Bank, USDA, FAO, JASTA, and ISF could be invited to contribute monetary and technical inputs.

The Government is encouraging growth in the seed industry as evidenced by the "Bill on Seed Plant" and promoting the private seed sector for seed production and sales, while also continuing to give major R&D and basic seed responsibilities to INRAN. The "Seed Quality" responsibilities have been rightly allotted and the "Central Seed Board" has been put in place.

7.6 Finance Mechanism

The agribusiness firms in the country mostly work with their own capital. Agribusiness firms normally take cash credit based on demand requirements of development projects for procurement of bulk quantity materials. For instance, Company B took a loan of USD 120,000 (FCFA 60 million) from the Company K for implementing the Project A funded by USAID. The agribusiness firms also finance seed producers and provide base seeds.

Company J has plans to expand the seed production capacity using external finance and has the capacity to contribute to its share.

The financing mechanism for the seed sector should be integrated with the mechanisms to finance improved irrigation systems. The potential organizations/firms that can work and invest in production of seeds are Federation C and Company J. The financing should ideally be channeled through private banks and DFIs as suggested in the investment model under section 8.

As seed production cannot take place without base seeds, the pace of growth will depend on the availability of these seeds. This requires coordination and planning with the backup of public sector seed research organizations and coordinated efforts with international markets, particularly the West African markets.

8 Business Model for Investment in Improved Irrigation System and Climate Resilient Seeds

This business model was prepared based on the situation analysis and market assessment of the agriculture sector in Niger. Mechanisms of investment, investment sizes, key players, and economics of investments have been worked out for two suitable improved irrigation systems.

8.1.1 Public Private Participation

Some key aspects that need to be considered while suggesting an investment model include:

1. The high poverty of rural Niger and the low purchasing capacity of farmers
2. The low capacity of private organizations to handle large business operations
3. Mapping of key players and their linkages in agriculture sector
4. Existing policies and laws regulating and encouraging the agriculture sector in Niger
5. Analyzing demand supply side in agri-value chains (such as seeds, irrigation equipment) and availability of financial support to key players in the supply chain to enable an economic upliftment that gives impetus to agriculture growth

Crop processing is not considered here for two reasons:

(i) Even though there are a few companies engaging contract growers, the country has deficit crop production and crop processing needs substantial investments in the processing sector and infrastructure

(ii) Community follows the traditional practice of processing crop produces at home so that they can feed the residue to their livestock

The key stakeholders that can be part of a PPP for improved irrigation agriculture and climate resilient seeds are provided in Table 8-1.

Table 8-1: Key stakeholders for PPP for improved irrigation agriculture and climate resilient seeds

Segment of operation	Public	Private
Water (technical support)	ONAHA	
Water (technical support and policy regulation)	Water Resource Department	
Seed (R&D, training and base seed distribution)	INRAN	
Finance		Private Banks and DFIs
Input providers (seeds, irrigation system, training)		Agribusiness companies and Seed companies
End users (coordinate with individual farmers, knowledge brokers)		Farmer's Federations Seed Producer's Federation

The key requirement for implementing improved irrigation systems is the development of water sources. As surface water is available only in limited parts of the country, it is essential to depend on ground water resources. The development of ground water sources (wells/borewells) needs technical skills and investments. Since the farm community of Niger lacks both these, water source development should ideally be executed on a PPP mode. ONAHA can provide technical support, including location identification for water source development, type of well suitable for the location and estimated cost, while the Water Resource Department can provide support and regulatory services in ground water utilization. As the ownership of water sources lies with farmers or groups of farmers, the O&M will be taken care by them. The farmer's federation should develop a contingency fund at the district or regional level to support farmers for unforeseen expenses like failure of water source, etc.

INRAN can provide technical support, R&D, training, and base seeds. The seed companies and Seed Producer's Federation will multiply the seeds.

However, taking into consideration the linkages and roles of private sector players in the country, the option of a private sector investment model has been probed and recommended. This model is elaborated in the subsequent section.

8.1.2 Private Sector Investment

Taking into consideration the capacity and reach of various private players in rural Niger, a private sector investment model is preferred. A cascade investment model with private banks at the apex is suggested. The private banks will be funded by a loan from IFC and distributed to DFIs who have a better reach in rural Niger. The private banks and DFIS have the capacity, willingness and past track record in handling agriculture financing in rural Niger. The financial input requirements for the key players were identified in this sector and have been marked with the '$' symbol in Figure 8-1. The reasons for selecting the identified key players for financial support are:

a) Financial institutions: The present interest rate at which financial institutions are lending money to the agriculture sector is high. Concessional loans can help reduce the interest rate, thus attracting farmers to avail loans. A combination of private banks and DFIs is preferred to ensure maximum penetration to farmers in rural Niger.
b) Seed producers: Seed companies and seed producer's federation have the capacity to increase production with additional financial support. Presently, there is a deficit in seeds supply in the country.
c) Farmers' federations: Farmers are the eventual stakeholders who need credit to improve their financial capacity to buy irrigation equipment and climate resilient seeds. As farmers' federations are well organized, credit distribution through federations can be more efficient and financial institutions will be more comfortable as federations have a mechanism to provide guarantees.
d) Irrigation equipment suppliers: Presently, operating on their own capital and procuring equipment based on orders only, these suppliers have limited outlets for distribution.

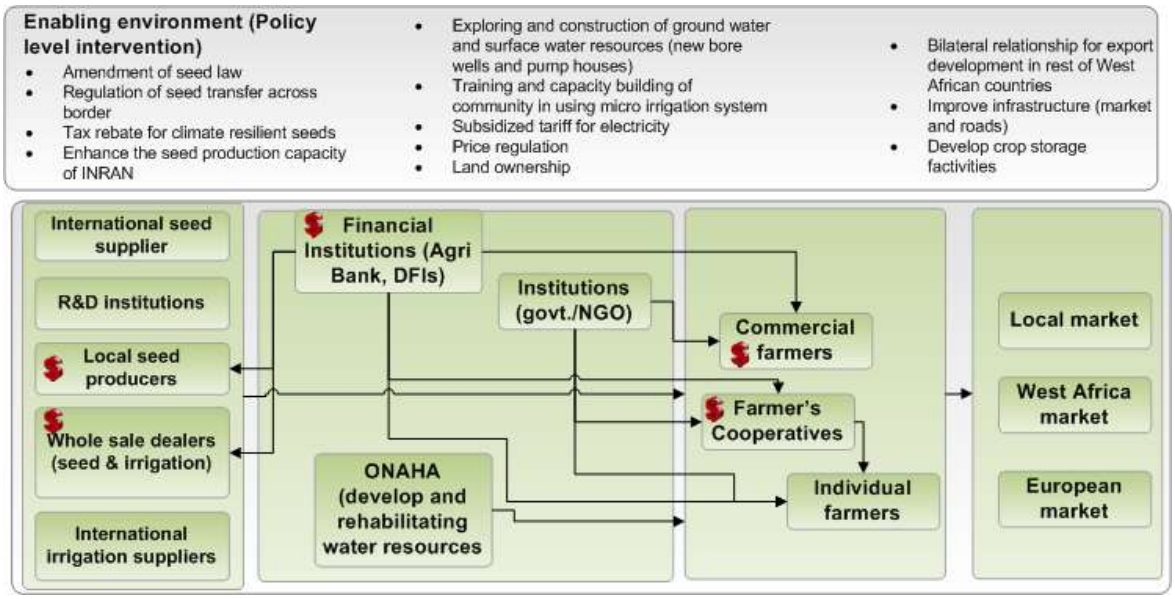

Figure 8-1 Key players of agriculture production supply chain and investment requirement, Niger

The following are some of the key enabling environments (policy level interventions) that also need to be considered for the success of the proposed investment model.

(i) Amendment in seed law to encourage multi-national seed companies to bring in climate resilient/early maturing seeds at least for a certain period of time
(ii) Regulation of free flow of seeds from neighboring countries
(iii) Providing tax rebates (e.g. reduction of VAT) for the sale of climate resilient seeds/early maturing seeds
(iv) Use of ground water sources for irrigation
(v) Training and capacity building of farmers in operating improved irrigation systems
(vi) Subsidized tariff for electricity for irrigation purposes
(vii) Price regulation, including fixing of minimum support price for farm produce, to protect farmers from intermediaries
(viii) As a long term plan, implementation of land legislation to ensure land ownership of farmers
(ix) Development of bilateral relationships to improve the export market for specific crops
(x) Developing crop procurement mechanisms and storage
(xi) Developing road and market infrastructure

The private sector investment model does not prescribe a total elimination of public sector players. The role of public sector institutions is important in terms of policy intervention, skills and knowledge development, and in developing water resources.

8.1.3 Investment Model

The private banks have the capacity to take and handle large amounts and should be at the apex to distribute funds to various stakeholders. Considering the presence of DFIs in rural Niger, these financial organization can front-end the farmer's federations for disbursing loans to farmers.

The farmer's federations and seed producer's association support individual farmers with technical support, facilitate in availing credit, and in sale of farm produces. As the construction of water sources is through farmer's investment, the O&M of the water source will be vested with the farmers.

Agribusiness firms presently operate on a cash credit system from private banks upon bulk order request. The agribusiness firms based on market development can now avail loans for stocking adequate resources.

8.1.3.1 Role of Farmer's Federations

Farmer's federations are very active and provide support to Nigerien farmers in terms of facilitating financing, technical support, purchase and sales of farm produce, market information, etc. As individual farmers have low credit worthiness, cooperatives and federations facilitate their members to avail credit from banks and DFIs. The cooperatives and federations provide guarantees to the financial institutions.

Federation A and Federation B are potential groups for financing small landholding farmers for improved irrigation agriculture.

Company J is a seed company and mainly involved in seed multiplication. It procures base seeds from INRAN and uses its own infrastructure and contract growers for seed multiplication. Federation C is one of the lead Seed Producer's Federations in the country and has a good network across West African countries. The federation sells the seeds, which are grown by its members. Both these organizations mainly grow millet, sorghum, cowpea and peanut seeds.

8.1.3.2 Fund Flow

Suggested financial flow of the investment model is shown in Figure 8-2.

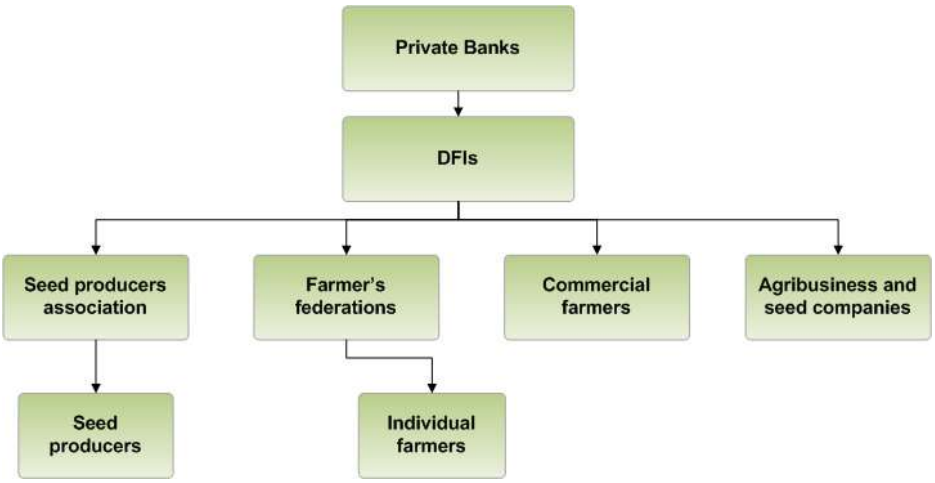

Figure 8-2: Suggested financial flow of the investment model

8.1.3.3 Cash Flow of Investment in Improved Irrigation System

Economic analysis of investment of surface and subsurface drip irrigation system is analysed and is detailed out in section 5.2.4 and 5.2.5. Capital investment for one hectare land including construction of well, fencing of land, purchase of pump, overhead tank and distribution system are considered. A combination of crops with two crop seasons in a year with high value vegetable crops are suggested. The economic model and cash flow of drip and sub-surface irrigation systems is provided in the Table 8-2 and Table 8-3**Error! Reference source not found.**. The cash flow becomes positive in the third year itself for both the cases.

Table 8-2: Cash flow of investment and return of drip irrigation (value in USD)

Item ref.		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Sub total A	Farm products (outputs): Subtotal	0	7,445	8,063	8,681	9,299	9,917
Sub total B	Farm input cost: Subtotal	11,260*	1,201	1,301	1,401	1,500	1,600
C	Gross margin A-B	-11,260	6,244	6,762	7,280	7,799	8,317
D	Depreciation		1,987	1,987	1,987	1,987	1,987
D1	Interest (@12% on loan per annum)		1,351	1,216	1,081	946	811
E	Net margin C-D	-11,260	2,906	3,559	4,213	4,866	5,519
F	Cash flow = D + E	-11,260	4,893	5,546	6,199	6,593	7,506
Final	Discounted cash flow to 14%	-9,877	4,292	4,267	4,184	3,903	3,898

Table 8-3: Cash flow of investment and return of sub surface irrigation (value in USD)

Item ref.		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Sub total A	Farm products (outputs): Subtotal	0	7,445	8,063	8,681	9,299	9,917
Sub total B	Farm input cost: Subtotal	11,860*	1,353	1,466	1,578	1,690	1,803
C	Gross margin A-B	-11,860	6,092	6,597	7,103	7,608	8,114
D	Depreciation		2,007	2,007	2,007	2,007	2,007
D1	Interest (@12% on loan)		1,423	1,281	1,139	996	854
E	Net margin C-D	-11,860	2,662	3,310	3,958	4,606	5,254
F	Cash flow = D + E	-11,860	4,668	5,316	5,964	6,612	7,260
Final	Discounted cash flow to 14%	-10,404	4,095	4,091	4,026	3,915	3,771

Note: The Table 10-4 and Table 10-5 in annexure 10.1 show these figures in FCFA

* Capital investment

8.1.3.4 Beneficiary and Size

Taking into consideration the prominence of aid based funding in the agriculture sector in Niger and private sector investment is new, a performance based investment model is suggested. The release of funds to farmer's federations would be based on the success rate of repayment and other monitoring indicators. Company J has estimated a growth plan to increase its seed production and contribute to 10% of country's seed demand (100,000 tons) in the next three years with an investment cost of USD 2 million (FCFA 1 billion).

Taking into consideration the input cost for improved irrigation of USD 12,500 (FCFA 6.2 million) (with a 5 year equipment life), the per head cost for farmers would be USD 3,115 of which 86% of the cost is capital investment (for installation of distribution network, development of water source, fencing of land etc). The one time investment cost can be reduced substantially if the farmers have existing water sources. In cases where groups of farmers collaborate for cultivation, several facilities can be shared, thus reducing the investment cost.

Assuming that the two federations together take a loan for 800 farmers in the first year with 30% increase in the number of farmers in the next two years, the total loan size would be to the tune of USD 4.42 million (FCFA 2.2 billion). This would benefit 1,352 farmers and bring 340 ha under irrigation.

9 Summary Findings and Recommendations

9.1 Summary Findings

- About 80% of the population depends on agriculture and subsistence farming and stock rearing contribute approximately 40% to the GDP (second only to services, which provide 42%). Nearly three-quarters of the labor force is employed in this sector. Agricultural activity in Niger is mainly rainfed and, therefore, is highly vulnerable to climate induced hazards particularly drought.
- Millet and sorghum as the key crops, which are cultivated as rainfed subsistence farming. Other crops such as maize, cowpea, peanut, rice, vegetables (onion, tomato, red chili), and sesame are cultivated in a few regions. In terms of acreage, millet contributes the highest share (44%) along with cowpea and sorghum (31% and 19% respectively). In terms of production also, these crops contribute the major share in Niger (60% and 18% respectively). Onion is considered as a cash crops and is cultivated under irrigation.
- There is a variation in crop cultivation and yields across the country. The annual production of staple crops – millet and sorghum is approximately 2.4 million tons and 0.72 tons respectively (as per 2011 agricultural statistics). The mean yield is around 450 kg/ha for millet and around 330 kg/ha for sorghum against the global average 1100 kg/ha and 750 kg/ha respectively. Other key crops, namely, peanut, pepper and onion have average yields of 350, 30 and 16,410 kg/ha respectively.
- The production statistics show sufficient headroom for increasing production in all the major crops even without increasing the area under cultivation. This is a clear indication that by supplementing Niger's agriculture sector with improved irrigation and climate resilient seeds there is a high potential for increasing the crop production.
- The country's renewable water sources include about 31 billion cubic meters of surface water, 2.5 billion cubic meters of groundwater, and 2,000 billion cubic meters of non-renewable water. Almost none of the non-renewable sources and only 20% of renewable water resources are being tapped presently.
- Only 11.6% of the land area in Niger is under agriculture of which 0.73% is under irrigation (107,000 hectares) [IFC notes that this statement requires further verifications.]. The western and southern districts, especially the banks of the Niger River, the Komadougou River valley, and the Lake Chad area are the main irrigated areas in Niger. Approximately 200,000 households of farmers, representing more than one million people are involved in the production of irrigated crops.
- The large-scale traditional irrigation systems of Niger are in the Niger River basin and Lake Chad basin mainly catering to rice cultivation. The water use fee for these traditional irrigation systems is high compared to international standards due to various reasons like high cost of energy for pumping and the inclusion of capital charges. The irrigation cost is estimated to range from 20-25% of the crop value. In addition to traditional irrigation practices, substantial small landholder farmers in the country are successfully using manual and mechanized power to cultivate vegetable crops.
- In general, the farmers in Niger still consider irrigation as a means to diversify their agricultural activities rather than as an opportunity to increase production. There is a need for awareness development, training and skill development among farmers on the benefit of using improved irrigation systems and climate resilient seeds.

- The average landholding size of farmers practicing rainfed agriculture is bigger than those cultivating irrigated crops. About 12% of the farmers surveyed have landholding size < 0.5 ha [IFC notes that this statement requires further verifications.], while 17% have landholding sizes of 2-5 ha. About 30% of the farmers practice both rainfed cultivation and irrigated farming.
- Majority of the farmers practicing irrigation are beneficiaries of PPIP or PIP2 irrigation projects. There is a lack of awareness and skill in operation and maintenance of irrigation systems
- Majority of the farmers in Niger practice subsistence farming and are poor. Almost 60% of the survey population has an average annual income below USD 200 (FCFA 0.1 million). The choice of crops also determines the income of the farmers even though 70% of the farmers surveyed use most of their harvest for their own consumption.
- The average annual incomes of farmers practicing agriculture using improved irrigation is high compared to farmers practicing rainfed agriculture. The yield per hectare of farmers using improved irrigation is 4-8 times higher than the farmers practicing rainfed farming.
- There are only a few private agribusiness firms in Niger, which deal in selling agriculture input materials - chemical fertilizers, pesticides, seeds, and irrigation and other equipment.
- There are several early maturing seeds in use in Niger. INRAN has developed seeds for several crops to adapt to the climatic conditions of Niger. The present seed demand in the country is estimated at 100,000 tons against which the available supply is only 5,000 tons. As per producers' statistics, farmers could double yields by using climate resilient seeds even though the potential yield is four times higher.
- The penetration rate of the banking sector in the country is very low. The DFIs have better penetration rates and provide greater support to agriculture financing in Niger.

9.2 Recommendations

Based on the state of agriculture in Niger, the following recommendations are proposed. All recommendations are rooted in current and projected climate scenarios and adaptations required to cope with this.

- Taking into consideration the terrain, soil, and water availability, surface drip irrigation and subsurface drip irrigation systems are best suited for improving agriculture production in Niger. These systems are highly water efficient (save more than 70%) and less complex to operate and maintain compared to other modern irrigation systems. These improved irrigation systems can increase the yield from 10 to 130% depending upon soils and crops over conventional methods of irrigation. In addition to increases in yield, the installation of improved irrigation can help farmers grow two or even three crop seasons with combination of crops annually, which will increase the per capita production. The economic analysis shows that it is economically viable to use surface drip irrigation systems with an IRR of 22% and the capital recovery time is 2.2 years. [IFC notes that this statement requires further verification.] Even while considering worse scenarios, the IRR values ranges from 21 to 13%. For subsurface drip systems, the IRR is 18% and the payback period is 2.4 years. [IFC notes that this statement requires further verification.] While considering the worst case, the IRR ranges from 12 to 1%. While comparing the IRR figures for two systems, surface drip irrigation is better than subsurface even though both provide assured returns.
- To enable the development of improved irrigation systems, interventions at various levels are required. This includes improving the financial capacity of farmers,

development of water sources, provision of affordable and sustainable energy sources, development of skills and knowledge of farmers for using improved irrigation and climate resilient seeds, infrastructure development, fixing of base prices of farm produce, and strengthening bilateral relationships to facilitate export of farm produces. There is a need to increase the extension service network of agriculture services either through the department or by involving NGOs for developing skills and knowledge of the operations and maintenance of improved irrigation systems. Impetus is required to various key players in the agriculture supply chain. This includes input producers – seed producers to increase the supply of seed production, financial institutions to increase their lending capacity, and farmers to increase their credit capacity so that they acquire the financial capacity to buy irrigation systems and climate resilient seeds.

- There is a big gap in the demand and supply of seeds in Niger and seed production has to be augmented through increased local production as well as by encouraging international seed suppliers to bring in crop specific seeds that are suitable for Niger. The seed law of Niger should be amended to facilitate the entry of multinational seed companies to Niger.
- The cost of climate resilient seeds are about 30% more compared to normal seed even though the climate resilient seeds has the advantage of drought resistance/early maturing and improved yield. To encourage farmers to buy climate resilient seeds government should provide tax rebate for climate resilient seeds thus the input providers can keep the price of seeds lower.
- A private sector investment model is preferred taking into consideration linkages between the various players in the sector. The private banks and DFIs should play a key role in channelizing finances to the key actors in the sector. Financial support is required to improve seed production and can be routed through seed companies and seed producers' federations. The farmers' federations can bridge the gap between DFIs and the individual farmer in accessing credit and the pay back should be on a quarterly basis at the end of the harvest.
- It is recommended to synergize the investments in improved irrigation and climate resilient seeds, which will provide a double-boost to the agriculture sector of Niger.

10 Annexure

10.1 Tables in FCFA

Table 10-1 Return of Investment calculation for surface drip irrigation system in FCFA [IFC notes that the payback period figure requires further verifications.]

		Currency FCFA		
Item ref.		**Year 1**	**Year 2**	**Year 3**
A	**Income through selling of farm product**			
	Irish potato	420,000	454,860	489,720
	Onion	850,000	920,550	991,100
	Tomato	650,000	703,950	757,900
	Pepper	1,250,000	1,353,750	1,457,500
	Cabbage	212,500	230,138	247,775
	Cowpea	160,000	173,280	186,560
	Maize	180,000	194,940	209,880
Sub total A	**Farm products (outputs): Subtotal**	**3,722,500**	**4,031,468**	**4,340,435**
B	**Operating Expenses**			
	Organic manure	23,100	25,017	26,935
	Plowing /Tillage	23,100	25,017	26,935
	Leveling	16,500	17,870	19,239
	Preparation of beds and furrows/channels	19,800	21,443	23,087
	Seeds	72,600	78,626	84,652
	Plant protection product	19,800	21,443	23,087
	Chemical fertilizers	42,900	46,461	50,021
	Fuel	79,200	85,774	92,347
	Lubricant	46,200	50,035	53,869
	Repair & Maintenance	13,200	14,296	15,391
	Packaging	46,200	50,035	53,869
	Harvest transport	132,000	142,956	153,912
	Labor	66,000	71,478	76,956
Sub total B	**Farm input cost: Subtotal**	**600,600**	**650,450**	**700,300**
B1	**Capital Investment**	**5,630,000**		
C	**Gross margin A-B**	**3,121,900**	**3,381,018**	**3,640,135**
D	**Deprecation**	993,290	993,290	993,290

		Currency FCFA		
Item ref.		**Year 1**	**Year 2**	**Year 3**
D1	**Interest (@12% on loan)**	675,600	608,040	540,480
E	**Net margin C-D**	**1,453,010**	**1,779,688**	**2,106,365**
F	**Cash flow = D + E**	**2,446,300**	**2,772,978**	**3,099,655**
Final	**Discounted cash flow to 14%**	**2,145,877**	**2,133,716**	**2,092,179**
	Net Present Value	**5,334,066**		
	Internal Rate of Return (IRR)	**22%**		
	Capital recovery time (Payback period)	**2.6 years**		
	Cost benefit ratio	**0.6**		

Table 10-2 Return of Investment calculation for California irrigation system in FCFA [IFC notes that the payback period figure requires further verifications.]

		Currency FCFA		
Item ref.		**Year 1**	**Year 2**	**Year 3**
A	**Income through selling of farm product**			
	Irish potato	420,000	454,860	489,720
	Onion	850,000	920,550	991,100
	Tomato	650,000	703,950	757,900
	Pepper	1,250,000	1,353,750	1,457,500
	Cabbage	212,500	230,138	247,775
	Cowpea	160,000	173,280	186,560
	Maize	180,000	194,940	209,880
Sub total A	**Farm products (outputs): Subtotal**	**3,722,500**	**4,031,468**	**4,340,435**
B	**Operating Expenses**			
	Organic manure	23,100	25,017	26,935
	Plowing /Tillage	23,100	25,017	26,935
	Leveling	16,500	17,870	19,239
	Preparation of beds and	19,800	21,443	23,087

		Currency FCFA		
Item ref.		**Year 1**	**Year 2**	**Year 3**
	furrows/channels			
	Seeds	72,600	78,626	84,652
	Plant protection product	19,800	21,443	23,087
	Chemical fertilizers	56,100	60,756	65,413
	Fuel	105,600	114,365	123,130
	Lubricant	36,300	39,313	42,326
	Repair & Maintenance	46,200	50,035	53,869
	Packaging	132,000	142,956	153,912
	Harvest transport	99,000	107,217	115,434
	Labor	676,500	732,650	788,799
Sub total B	**Farm input cost: Subtotal**	36,300	39,313	42,326
B1	**Capital Investment**	**5,9,30,000**		
C	**Gross margin A-B**	3,046,000	3,298,818	3,551,636
D	**Deprecation**	1,003,290	1,003,290	1,003,290
D1	**Interest (@12% on loan)**	711,600	640,440	569,280
E	**Net margin C-D**	1,331,110	1,655,088	1,979,066
F	**Cash flow = D + E**	2,334,400	2,658,378	2,982,356
Final	**Discounted cash flow to 14%**	2,047,719	2,045,536	2,013,005
	Net Present Value	**4,747,591**		
	Internal Rate of Return	**18%**		
	Capital recovery time (Payback period)	**2.4 years**		
	Cost benefit ratio	**0.6**		

Table 10-3: Banking institutions in Niger, some key figures in FCFA

Commercial Banks	Year of formation	Capital (million FCFA)	Balance (million FCFA)	Branch offices
SONIBANK	1990	4,750	129,600	8
BIA-Niger	1993	6,700	119,900	8
Bank of Africa	1994	4,750	132,100	16
Ecobank	1999	4,850	110,400	11
BanqueAtlantique	2005	6,200	106,900	13
BCN	1988	9,500	13,900	1
BSIC Niger	2003	6,900	42,200	11
BRS Niger	2005	1,900	14,000	7
Banque Islamique pour le Commerce et l'Investissement	1997	1,350	11,500	1
Crédit du Niger	1957	1,650	650	1
SAHFI	2005	1,250	3,600	1

Table 10-4: Cash flow of investment and return of drip irrigation (value in FCFA)

Ref.		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
A	Farm outputs: total	0	3,722,500	4,031,468	4,340,435	4,649,403	4,958,370
B	Farm input cost: total	5,630,000	600,600	650,450	700,300	750,149	799,999
C	Gross margin A-B	-5,630,000	3,121,900	3,381,018	3,640,135	3,899,253	4,158,371
D	Depreciation		993,290	993,290	993,290	993,290	993,290
D1	Interest (@12% on loan per annum)		675,600	608,040	540,480	472,920	405,360
E	Net margin C-D	-5,630,000	1,453,010	1,779,688	2,106,365	2,433,043	2,759,721
F	Cash flow = D + E	-5,630,000	2,446,300	2,772,978	3,099,655	3,296,333	3,753,011
Final	**Discounted cash flow to 14%**	-4,938,596	2,145,877	2,133,716	2,092,179	1,951,694	1,949,196

Table 10-5: Cash flow of investment and return of sub surface irrigation (value in FCFA)

Ref.		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
A	Farm outputs: total	0	3,722,500	4,031,468	4,340,435	4,649,403	4,958,370
B	Farm input cost: total	5,930,000	676,500	732,650	788,799	844,949	901,098
C	Gross margin A-B	-5,930,000	3,046,000	3,298,818	3,551,636	3,804,454	4,057,272
D	Depreciation		1,003,290	1,003,290	1,003,290	1,003,290	1,003,290
D1	Interest (@12% on loan)		711,600	640,440	569,280	498,120	426,960
E	Net margin C-D	-5,930,000	1,331,110	1,655,088	1,979,066	2,303,044	2,627,022
F	Cash flow = D + E	-5,930,000	2,334,400	2,658,378	2,982,356	3,306,334	3,630,312
Final	**Discounted cash flow to 14%**	-5,201,754	2,047,719	2,045,536	2,013,005	1,957,615	1,885,470

10.2 Annexure 1: Questionnaire for farming community and guiding questions

Questionnaire number:

(First two letters of the district name and number in ascending order. Example: Niamey questionnaire number 1 will be NI01)

Name of the surveyor and date:

A. GENERAL DETAILS:

1. District Name: 1a. Village name:

2. Farming community (use ✓ in the choice below):

Group farming	Individual farming

3. Type of farming (use ✓ in the choice below):

Subsistence	Commercial

4. Name of the farming community or head of family and contact phone number:

5. Size of the farming community or household (number of members in case of group farming or household size in case of individual farming):

6. Name of principal crops raised:

#	Crops	Area (hectares)	Latest production (kg)	Irrigated (yes/no)	Source of irrigation (wells/canal/ bore well/ others)	Type of irrigation (flooding/ border/ furrow/drip/ sprinkler/ subsurface	Cropping season (Sowing date)	Cropping season (Harvesting date)	Rainfed (yes/ no)	Input cost (CFA franc)	Income (annual in CFA franc)
a											
b											
c											
d											
e											
f											

7. Name of livestock raised:

#	Livestock	Number	Meat production (kg)	Native or hybrid (yes/no)	Input cost (CFA franc)	Income (annual in CFA franc)
a						
b						
c						
d						
e						
f						

8. Availability of loan/financing:

#	Item	Loan	If availed loan specify source	Pledge any against security for loan?	Amount of loan (CFA franc)
a	Seed				

b	Fertilizers				
c	Irrigation				
d	Livestock				
E	Insurance				

9. Availability of subsidy:

#	Item	Subsidy	If availed subsidy specify source	Amount of subsidy (CFA franc)
a	Seed			
b	Fertilizers			
c	Irrigation			
d	Livestock			
e	Insurance			

10. Did you experience any crop yield loss due to drought, flood and pest in the last 10 years:

#	Extreme weather events	Frequency	Production loss (kg)
a	Drought		
b	Flood		
c	Pest		

11. Have you observed any changes in the rainfall and temperature over the past 10 years? Y/N

12. Is there any change in the cropping pattern you adopted due to change in weather pattern? Y/N
If yes:

#	Previous cropping pattern	Changed cropping pattern	Type of seed under changed cropping pattern (local/HYV/climate resilient)
a			
b			
c			

13. Ideally, how often do you think you need to irrigate to obtain good production?

#	Crop	Irrigation scheduling
a		
b		
c		
d		
e		

14. Knowledge on modern agriculture (improved irrigation system and climate resilient seed) (use ✓ in the choice below)?

Type	Not aware	Fully aware	Partially aware
Improved irrigation systems (MI)			
Climate resilient seed			

15. Do you get technical and managerial support and training regarding the modern agriculture (use ✓ in the choice below)?

Type	Yes	No
Improved irrigation systems (MI)		
Climate resilient seed		

If yes then what is the source?

#	Sources	Improved irrigation systems (Y/N)	Climate resilient seed (Y/N)
a	Agricultural universities		

b	Extension workers		
c	Newspapers		
d	Private sector		
e	NGO		
f	Agri-cooperative		
g	Agri-material supplier		
h	Others specify		

16. Are there any awareness camps/road shows conducted for awareness on modern agriculture? Y/N

If yes then

Type	How frequent	And by whom
Improved irrigation systems (MI)		
Climate resilient seed		

17. From where do you get financial support for the purchase and maintenance of improved irrigation system and climate resilient seed?

#	Sources	Improved irrigation systems (Y/N)	Climate resilient seed (Y/N)
a	Government		
b	Agri-cooperative		
c	Bank		
d	Agri-material supplier		
e	NGO		
f	Others specify		

18. Maintenance of irrigation system in your farm?

#	Sources	Y/N
a	Availability of spare parts	
b	Availability of technical experts for installation and repairing	
c	Availability of power (electricity, diesel)	
d	Anti clogging mechanism	

19. What is the technical risk in adopting improved irrigation system?

#	Risk	Y/N
a	Clogging	
b	Technical expertise for maintenance	
c	Availability of spare parts	
d	Availability of power (electricity, diesel)	
e	Operational skill	
f	Availability of insurance	
g	Others if any specify	

20. What is the technical risk in adopting climate resilient seed?

#	Risk	Y/N
a	Availability	
b	Technical expertise	
c	Quality	
d	Crop failure	
f	Availability of crop insurance	
g	Others if any specify	

21. What are the benefits of improved irrigation system?

#	Benefits	Improved irrigation systems	Climate resilient seed
a	Production (kg/ha)		
b	Water saving (cc/ha)		
c	Fertilizer saving (kg/ha)		
d	Grain quality (superior/inferior)		
e	Others		

22. What types of seeds do you use?

#	Crop	Local			Hybrid			Climate resilient		
		Source	Cost	Yield	Source	Cost	Yield	Source	Cost	Yield
a										
b										
c										
d										
e										

23. What kind of obstacles do you face with regards to procuring good quality seeds (Y/N)?

Financial	Technical	Others

24. How do you procure seeds?

Distribution network	Government	Cooperatives	Dealers come and deliver	Middleman	Others

25. How do you purchase your seeds?

Cash	Cash + credit	Credit	Embedded charges	Others

10.3 Annexure 2: Summary of meeting of the stakeholder workshop

A half-day stakeholder workshop was conducted to present and discuss the initial findings of the study. The stakeholder invited and attended includes officials from government departments, country focal contacts of PPCR program, representatives from farmers' federation, agribusiness firms, seed company, financial institutions (private banks and DFIs) and representatives from NGOs.

Date: October 10, 2012

Location and Venue: World Bank office, Niamey, Niger

Participants: List of participants is not presented to protect their identities.

The project team presented the key findings of the study preceding to a detailed stakeholder discussion. The key points discussed are summarized below:

1. The stakeholders appreciated the findings and importance of this study to ensure food security in the country.
2. The stakeholders are of the opinion that surface and sub-surface drip irrigation are the most suitable improved irrigation system for the country.
3. Once of the key concern raised by farming community representatives was the lack of availability of credit at affordable interest rate. They urged that loan at lower interest rate will help farmers to avail credit and make agricultural activities profitable.
4. Some suggested demonstration projects can help in creating awareness on the benefits of the improved irrigation technology and climate resilient seeds among farming communities.
5. Some stakeholders raised concern on the lack of availability of the power to lift the water for irrigation.
6. Stakeholders support the idea of mix culture while adopting improved irrigation system.
7. Farming community representative opine that it needs not only climate resilient seed but also varieties that are resistant to pest to ensure production.

10.4 Some Relevant Sections from Bill on Seed Plant, Niger

CHAPTER VII: CONTROL AND CERTIFICATION OF SEED PLANT

Article 29: The seed control is provided by the official inspection and certification. It is performed by sworn officers, hereinafter referred to as inspectors or controllers and are provided with business card they must submit as part of the exercise of their function.

Article 30: The control is exercised at all stages of the industry such as production, storage, packaging, storage, transportation, marketing and use of seeds. Subject to the provisions of the Code of Criminal Procedure on house searches, screener's seed quality can enter at any time on the farm, any place of storage, seed sales and access to records management.

Article 31: Every package containing certified seed has a certification label issued by the official certification. This certification label is different from the labeling done by Ie producer. The official in charge of quality control and certification is solely responsible for the printing, distribution and affixing the labels official certification.

Article 32: Enforcement officers have powers of inquiry and investigation in the places listed in Article 30.

Verification shall be in the presence of producer, distributor, or their representative. Screeners may require, as part of their mission, the assistance of the police.

Article 33: During the observations, if a lot is declared doubtful, written notice is sent to the owner of the seed lot and the lot provisionally seized. Samples are collected and seed analysis is performed by an accredited laboratory, which transmits the results within twenty one (21) days from the date of sample collection. This period may be extended for ten (10) days due to the special nature of the analysis. The agency responsible for ensuring quality seed shall inform the owner.

CHAPTER VIII: OF TRANSACTIONS

Article 34: The Head of the department responsible for quality control before seed can compromise judgment on the following offenses:

- lack of labeling;
- non-compliance seed quality standards;
- production, export or distribution of seeds for commercial purposes without prior authorization;
- false, misleading or infringing seed

Article 35: When the transaction amount is not paid within the period prescribed by the act of trading, it is preceded to prosecution

CHAPTER IX: PENALTIES

Article 36: Notwithstanding the provisions of the Penal Code and the Code of Criminal Procedure, shall be punished by imprisonment of three (3) months to two (2) years and a fine of Twenty Thousand (20,000) to One Million (1,000,000) francs or one of those penalties:

- Those who, unless exempted by the Minister for Agriculture, will be produced, marketed or introduced seeds or other plant genetic material not included in official catalogs of seeds;
- those who have fraudulently altered the label identifying the seed or have falsified a certificate dedicated to plant a seed;
- Those who have defrauded or attempted to defraud in the use or marketing of seed in transit in Niger;

- Those who produce seed without professional card;
- Those who have distributed for human consumption or animal feed, seed treated with substances hazardous to human or animal health and making them unfit for consumption;
- Those who have marketed seeds without license;
- Those who have imported or exported conventional seeds without prior notification.

Article 37: Any person who hinders the inspecting officers in the performance of their duties is liable to imprisonment for ten (10) days to three (3) months and a fine of Twenty Thousand (20,000) to Two Hundred Thousand (200,000) francs or one of those penalties.

Article 38: Violations of this law shall be notified by the minutes to the offender by officers or police officers and judicial officials sworn officers and commissioned for that purpose by the Ministry for Agriculture. The minutes are authentic until proven otherwise.

Article 39: The minutes must, if a transaction between the officer and the offender be sent within five (5) days of closing to the public prosecutor at the Tribunal de Grande Instance or Chairman of the District Court's jurisdiction.

Every law is good and made in the public interest but the outcome depends on its interpretation and implementation by the administration. Experiences in other countries suggest that stringent regulations often inhibited growth of the seed industry. It was also observed that slight deregulation by the Government spurred enormous growth leading to quantum jump in growth and eventually establishment of a vibrant seed industry in the country. In most of the cases, regulations encouraging "Private Seed Sector" and subsequently Public-Private Sectors Partnership (PPP) offered miraculous results. At this stage, it will be worthwhile to arrange workshop on" Public-Private Partnership on Seed in Niger". Experiences of other countries could as well be considered in this event.