



Opportunities and Research Gaps for Promoting Irrigation and Mechanization Markets in Niger

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List of Acronyms

Acronym	Meaning
3N (I3N)	<i>Les Nigériens Nourrissent les Nigériens</i>
AFD	French Development Agency
AfDB	African Development Bank
AHA	<i>Amenagements Hydro-Agricoles</i>
AMCOW	African Ministerial Council on Water
AMG	African Market Garden
ANID	<i>Association Nigérienne pour l'Irrigation et le Drainage</i>
ANPIP	<i>Association Nigérienne pour la Promotion de l'Irrigation Privée</i>
AUDA-NEPAD	African Union Development Agency-NEPAD
BMZ	German Federal Ministry for Economic Cooperation and Development
BOAD	West African Development Bank
CFA	West Africa CFA franc (<i>Communauté financière d'Afrique</i>)
CGIAR	Consultative Group for International Agricultural Research
CSA	Climate-smart agriculture
CILSS	<i>Le Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel</i>
DC	Dimitra community listeners' club
DWFI	Daugherty Water for Food Global Institute
ECOWAS	the Economic Community of West African States
FLI	Farmer-led irrigation
FLID	Farmer-led irrigation development
FMNR	farmer-managed natural regeneration
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GDP	Gross Domestic Product
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
ILIMS	Innovation Lab for Irrigation and Mechanization Systems
INRAN	<i>Institut National de la Recherche Agronomique du Niger</i>
IRC	International Rescue Committee
IWMI	International Water Management Institute

KfW	German Development Bank
LSMS-ISA	Living Standards Measurement Study--Integrated Survey of Agriculture
MCC	Millennium Challenge Corporation
NASA	National Aeronautics and Space Administration
OIREN	<i>ONG Internationales Représentées au Niger</i>
ONAHA	<i>Office National des Aménagements Hydro-Agricoles</i>
PANGIRE	National Action Plan for Integrated Water Resources Management
PASADEM	Food Security and Development Support Project in the Maradi Region Program
PCS	<i>Périmètres de Contre-Saison</i>
PIP2	Private Irrigation Promotion Project
PISA	<i>Promotion de la Petite Irrigation et de la Sécurité Alimentaire</i>
PIIP	Pilot Private Irrigation Project
PRECIS	Project to Strengthen Resilience of Rural Communities to Food and Nutrition Insecurity
RISE	Resilience in the Sahel-Enhanced (Project)
RTI	Radar Technologies International
SLWM	sustainable land and water management
SPIS	solar-powered irrigation systems
SSI	Small-scale irrigation
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WAEMU	West African Economic and Monetary Union
WMS	Water Management Synthesis (Project)

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I am also grateful to Nicole Lefore and Jude Cobbing for their support, including their comments and inputs to the study. Nevertheless, it must be clear that I am responsible for the contents of this paper. It does not represent the views of DWFI, the University of Nebraska, or USAID.

Executive Summary

Niger, located in West Africa, is one of the poorest countries in the world. Most of its people reside in rural areas and are farmers or raise livestock. Millions of people face food insecurity, malnutrition, and poverty. Most agriculture is rainfed, and rainfall is erratic and unpredictable: large parts of the country face droughts regularly, and some areas are prone to severe flooding. The productivity of rainfed agriculture is low and unpredictable; large areas are characterized by land degradation, further reducing productivity. Physical insecurity because of the activities of various terrorist groups is a growing threat.

This study identifies potential agricultural water management and research opportunities. It is based on a report submitted to the University of Nebraska's Daugherty Water for Food Global Institute (DWFI). It draws on a large body of academic and official documents available online. The findings and recommendations were aimed specifically at potential bilateral development investments, but they are of broader interest.

Since independence, Niger has invested in developing irrigated agriculture with the support of international financial institutions and bilateral donors. Although most of the funding has been directed at developing large- and medium-scale government-managed irrigation schemes, various types of small-scale irrigation systems have also been developed, some with government or donor support, and some initiated by farmers ("farmer-led irrigation"). Further, significant efforts have been made to reverse the degradation of rainfed land and make it more productive. These interventions include a variety of climate-smart agricultural practices, especially land and water management interventions such as planting pits and bunding. Large areas have been restored through a practice known as farmer-managed natural regeneration, which seeks to encourage indigenous trees to re-grow, restore the soil quality, and retain water.

This study describes the most important irrigation and climate-smart agricultural interventions and the roles of major financial institutions, donors, NGOs, farmers, and government programs. It assesses the performance of these interventions to the extent possible and identifies potential research questions that should be addressed to improve investments.

Most of the large-scale schemes are in the Niger River Valley. Most are pump-based and irrigate rice, though some also irrigate other crops. Historically, their per-hectare productivity has been acceptable, but the schemes face serious challenges: farmers have very small holdings and do not generate sufficient profit to be able to pay the fees intended to cover the operational costs; the physical infrastructure therefore deteriorates, reducing production. Since the 1980s, major efforts to reform the institutional structure and policies have been carried out, with mixed success. These schemes account for about 16 percent of the estimated area irrigated.

Small-scale irrigation (SSI) is not new in Niger; farmers have been using basic technologies to irrigate for hundreds of years; and the government has supported the development of small irrigation schemes for decades. During the last two decades, the government and its partners began putting more emphasis on developing SSI. The World Bank and others piloted programs to develop market-based value chains to make individualized irrigation technologies such as pumps and drip irrigation kits available and provided subsidies to farmers to adopt them. Parallel to this, some farmers have invested in irrigation on their own. Much of this irrigation is based on groundwater: studies have shown that, particularly in southern Niger where the bulk of the population lives, aquifers offer a large potential for sustainable use. Within

this SSI category, market gardens for growing vegetables and fruits have expanded and efforts have been made to increase their productivity, for example through the “African Market Garden” model.

While there are studies on the impacts of the various agricultural water management interventions, there are no field-based systematic impact assessments. Some studies raise serious questions about the social equity, including gender, impacts in a country whose gender equality index is one of the lowest in the world. The paucity of studies may be an indicator of the relatively low national investment in capacity for research in this area.

The main areas where research can make a difference, briefly, are:

- Climate-smart agriculture, focusing on social and economic impacts including identifying ways to enhance equity and long-term sustainability.
- Promoting SSI is a potentially transformative strategy to increase food production, reduce food insecurity and malnutrition, promote economic growth, and enable farmers to adapt effectively to the ravages of climate change. Solar-powered irrigation has an especially huge potential. However, there are many questions regarding the long-term social and economic impacts, financing, sustainability, and strategies for their promotion and support.
- There is evidence that inequality and disempowerment in rural areas are increasing along multiple dimensions: gender, large versus small farmers, cultivators versus pastoralists, urban versus rural, and among various ethnic groups. These issues can be addressed as part of the topics discussed above, but it is critical to raise their profile.
- Two areas with very little research are the use of wastewater for irrigation, and how to promote mechanization (in addition to irrigation technologies) to improve agricultural productivity. There is no data on the extent of wastewater irrigation or its challenges, but it is likely widespread and a basis for a portion of market gardens.

The last chapter offers specific research questions under each area identified.

Finally, the study concludes by identifying a few potential partners for research institutions and other development organizations. This section is limited to what is available online. There are likely more potential partners than have been identified.

1. Introduction

1.1 Purpose

Based on a wide-ranging review of available information, this desk study aims to identify research and development opportunities for strengthening irrigation and mechanization markets and potential research-for-development partners. It was commissioned by the Daugherty Water for Food Global Institute (DWFI), University of Nebraska, as part of the Feed the Future Innovation Lab for Irrigation and Mechanization Systems (ILIMS) Program.

The study synthesizes key lessons from past experiences in Niger by addressing the following questions:

1. What are the most pressing research questions as they relate to irrigation and mechanization in Niger, and which international partners might be able to engage meaningfully?
2. What are the most promising directions for the sector, particularly regarding the intersection between small-scale irrigating farmers and the larger irrigation command areas?
3. What institutions in Niger could be possible research partners?
4. What important factors outside these terms of reference should still be considered when refining a research strategy?

The study concludes by identifying a set of specific research questions and makes recommendations on possible national partners.

1.2 Methodology

Irrigated agriculture has existed along the Niger River for over a thousand years. Since independence, Niger has invested in irrigation schemes with the support of multiple donors and international finance institutions. There is considerable documentation of the donors' investment projects, some but not many official impact evaluations, and a large published and unpublished literature on the performance of irrigation, lessons learned, and attempts at reform aimed at increasing the performance of irrigation. These studies vary in quality.

In 2014, I led an assessment of irrigation investment opportunities in Niger for the MCC (Merrey & Sally 2014). This study builds on and updates the findings of that study. Much has changed since then; therefore, this study's focus is on more recent developments and experiences.

This study draws heavily on the documented experiences of donors. International finance institutions have invested in irrigation in Niger. These include the World Bank, the African Development Bank (AfDB), the International Fund for Agricultural Development (IFAD), and, to a lesser extent, the West African Development Bank (BOAD). In addition, several bilateral donors have also invested in Nigerien irrigation and more broadly land and water management. While there are a lot of irrigation investment projects, there is very little data on agricultural mechanization; I found one paper on the use of animal-powered tools (carts, plows, seeders) (Arifa et al. 2022). Further, some donors' websites include blogs or articles claiming success, but the sites contain no detailed data.

I have used Google Scholar to identify academic literature published since 2014. This body of literature is substantial, though of varying quality. I also drew on sources produced by CGIAR researchers and recent policy documents related to irrigation. Finally, I explored documents and policies produced by various regional and sub-regional institutions such as the Economic Community of West African States (ECOWAS), the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS), Food Security

Information Network (FSIN), African Ministerial Council on Water (AMCOW), and African Union Development Agency-NEPAD (AUDA-NEPAD).

1.3 Limitations

I have never visited Niger outside the airport. I am familiar with conditions in the country through the study I led for MCC in 2014 and through colleagues who have worked there. Another limitation is that the study draws largely on English language reports. I have used some French language policy documents and extracted the gist of the policies, but I am not sufficiently fluent in French to read complex documents with complete understanding. It is also important to note that much of the published and unpublished literature is of mixed quality. Further, except for the World Bank, most donors do not make detailed reports and evaluations of their investments public. Some donors' websites include blogs or articles claiming success, but they contain no detailed data.

1.4 Outline of the report

Sections 2-4 briefly describe the context: natural resources, climate, population, economy, poverty levels, and the types and performance of irrigation in Niger. The following two sections (5-6) present summaries of irrigation policies and institutions, and donor engagement in irrigation. Section 7 synthesizes key lessons from past experiences while section 8 outlines possible research options, including key research questions and potential partners.

2. Overview of Land and Water Resources and Climate

At 1.26 million km² (490,000 miles²), Niger is the largest country in West Africa. However, 75% of the land is desert, and Niger is landlocked. It is one of the hottest and driest countries in the world. Over 75% of the country is a “hyper-arid desert”, with very little rainfall and low population densities (World Bank 2000). The climate is hot, with very high temperatures year-round; mean temperatures range from 21.9° to 36.4°C (and rising over time). October to May is a long intense dry season, followed by a brief, irregular rainy season. Annual rainfall varies from year to year but generally is lower in the north (100–200 mm) than in the south (500–600 mm) and is limited to the summer months of June–September. The rainy season ranges from one to two months in the north to four to five months in the south¹.

Soils are mostly deficient in organic matter, phosphorus, and water-holding capacity; more importantly, most are degrading. Indeed, studies have shown the close linkages among severe poverty, vulnerability, land degradation, and low agricultural productivity. This observation is consistent with popular lore in Niger that environmental shocks, especially land degradation, are more important causes of poverty and vulnerability than population growth and drought (World Bank 2010; Diwakar & Lacroix 2021). Management of land to prevent or reverse degradation requires better management of water.

The main source of surface water is the transnational Niger River, 550 km of which flows through southwest Niger. The country's total of annually available surface water is estimated to be around 30 billion m³, mostly but not all in the Niger River. There are several largely seasonal tributaries to the River in Niger, and part of the country also falls within another shared basin, the Lake Chad Basin (including a

¹ <https://climateknowledgeportal.worldbank.org/country/niger/climate-data-historical> (Accessed 11-7-2024).

portion of the Komadougou River). These basins have all seen large declines in overall water availability because of climate change, exacerbated by over-exploitation, at least for the Lake Chad Basin. The Niger River has occasionally even gone dry at Niamey, while the drastic decline in Lake Chad has left the Niger portion of the basin bone-dry. On the other hand, the Niger River is subject to flooding which can be severe, as it was in Niamey in 2020 and again in 2024; climate change is likely to lead to more frequent and severe flooding in the future (Massazza et al. 2021).

Until recently, Niger was thought to have an estimated 2.5 billion meters³ of renewable groundwater, of which only about 20% was being used (Favreau et al. 2009). However, in 2019, MCC's Niger program contracted for a remote sensing study of groundwater aquifers in the southwestern agricultural belt, an area of 260,000 km². Using innovative technology, the study identified approximately 50 billion m³ of available groundwater with an estimated annual recharge of 2 billion m³. This "groundbreaking" discovery qualifies Niger as the most groundwater-rich country in the Sahel region (Kim 2023²).

Barbosa et al. (2022) used NASA Gravity Recovery and Climate Experiment (GRACE) data to estimate trends in groundwater levels in southern Niger³. They found that from 2002 to 2010, there was little change in groundwater storage but a steep rise from 2010–2021. Increased precipitation partially explains this trend. They concluded that groundwater resources are not being overused and can be developed further. In some parts of southern Niger, groundwater is relatively accessible and indeed groundwater levels are rising in southwestern Niger, paradoxically because of clearing the savannah for millet cultivation (Favreau et al. 2009). With clearing of the natural vegetation, runoff increases into ponds that recharge the groundwater. There are also several smaller areas where groundwater is exploited for intensive irrigation of dates and other cash crops.

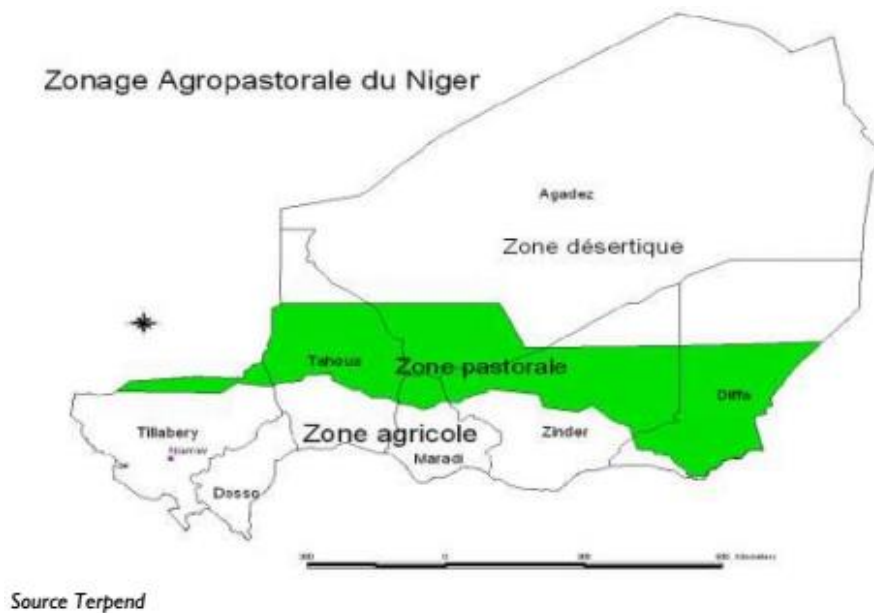
Average rainfall in the region had been declining since 1968 (Descroix et al. 2013), but since 2010, it has been increasing (FEWS NET 2012; Barbosa et al. 2022). Despite past rainfall declines, run-off coefficients have been increasing because of land use changes, mitigating the impact of rainfall declines on surface water in the upper basin (referred to as the "Sahelian paradox" [Descroix et al. 2013; Yonaba et al. 2021]); this is related to the rising groundwater in some parts of the country. Since 1998, land degradation (crusted soils) has increased the flows in two tributaries to the Niger River between Kandadji and Niamey, providing several billion m³ of additional inflow in recent years (Descroix et al. 2013).

There is a rainfall gradient from south to north (i.e., from higher to lower rainfall). The drier north is more dependent on livestock, the south on agriculture complemented by livestock. Livestock moves across borders in response to rainfall patterns. This south-north gradient is visible on the map in Figure 1 below showing the country's agro-pastoral zones⁴. Most of this area falls within the Sahel ecological zone, i.e. between the 200 mm and 600 mm average annual rainfall isohyets.

² This is a blog. The study itself remains unpublished.

³ This is a product of the *Development and Management of Groundwater Analysis and Information System in Niger*, a platform supported by SERVIR to improve and make available information on groundwater in Maradi and Zinder. [Development and Management of Groundwater Analysis and Information System in Niger | SERVIR GLOBAL](#) (Accessed 11-8-2024). See section 6.2.1.

⁴ Annex 1 provides a more detailed map of agro-pastoral zones.



Source : Ministère de l'Élevage, des Pêches et des Industries Animales. 2010, reproduced from Merrey & Sally 2014).

Figure 1. Agro-pastoral Zones in Niger

Overall, Niger has an estimated 1,585 m³ per capita (2017) of renewable water, but rapid population growth is eroding this figure⁵. It is low compared to neighboring countries; nevertheless, Niger is currently using only a small fraction – about 1% -- of its potential water supplies. Therefore, although large parts of Niger are characterized by physical water scarcity, the current scarcity is primarily “economic”: Niger does not have sufficient financial, institutional, and human resources to exploit its full potential (Seckler et al. 1998).

Climate change poses an existential challenge to Niger. Temperatures in Niger and neighboring countries are rising 1.5 times faster than the world average; by 2100 temperatures may have risen 3-6 degrees Celsius. This will increase food insecurity and water scarcity and likely drive continued conflicts and humanitarian crises (World Bank 2021). Niger, like its neighbors, is highly vulnerable to climate change with a low capacity to adapt⁶. The World Bank (2021) estimates that climate change will lead to large economic losses in Sahel countries, including Niger. The negative impacts through six modeled pathways (rainfed crop yields, livestock yields, heat-labor productivity, human health-productivity, flooding, and road and bridge damages) increase over time and are especially high under pessimistic climatic scenarios; they are large enough to lead to reduced real and per capita GDP by 2050 — and the estimates the Bank uses are likely to be underestimated. In recognition of the threats of climate change, the ECOWAS countries adopted a regional climate strategy and action plan in 2022 (ECOWAS 2022)⁷.

⁵ If the MCC groundwater study is correct, this figure would increase significantly.

⁶ <https://gain.nd.edu/our-work/country-index/rankings/> (Accessed 11-7-2024).

⁷ Niger, along with Burkina Faso and Mali, has withdrawn from ECOWAS as of January 2025 but all three agreed to a six-month grace period during which ECOWAS hopes to convince them to remain members. See: [Burkina Faso, Mali and Niger agree to grace period in ECOWAS withdrawal | Politics News | Al Jazeera](#) (Accessed 01-12-2025).

3. Population, Economy, and Poverty Trends

Niger's population is currently about 26.2 million (2022) million and growing at a rate of around 3.8% annually. Eighty percent of the population lives in rural areas and is engaged in agriculture (including growing crops, raising livestock, fishing, and forestry). Most of the population is concentrated in about 15% of the country's area, along the southern border with Nigeria and in the southwest portion of the country, the Niger River Valley. According to the World Bank, the poverty rate (at \$2.15/day purchasing power parity) exceeded 50% in 2023 and is increasing⁸. Niger's Human Development Index score ranks 190th out of 192 countries; its Gender Development Index score is also extremely low (189th) (UNDP 2024). In 2023 US dollars, per capita GDP is \$618⁹. High levels of both acute and chronic malnutrition are serious challenges; anemia and micronutrient deficiencies are particularly high among pregnant women and young children (USAID 2023a)

The number of people needing humanitarian assistance increased from 3.7 million in 2022 to 4.3 million in 2023. The combination of climate, political, and security crises has reduced economic growth and increased inflation. In early 2024 projections suggested economic growth would resume, largely because oil exports from the Niger-Benin oil pipeline will have begun; the poverty rate should decline somewhat¹⁰.

Per capita GDP growth has been modestly positive over the past decade. Niger's economy is dominated by agriculture, accounting for some 40% of GDP and most employment (*République du Niger* 2022). Niger exports uranium, gold, coal and limestone, crude oil, and some petroleum products. The major agricultural exports include onions and live animals, but Niger also exports cotton, peanuts, cassava, legumes, and high-quality rice. Niger imports cereals, especially rice and maize, edible oils, and other staple grains when droughts reduce local production. The main crops include various types of millet, sorghum, cassava, cowpeas, pigeon peas, groundnut, green gram, chickpeas, and irrigated rice largely for the urban market. Millet is the most important crop, occupying nearly half of the total harvested area. Millet, sorghum, and maize are imported in most years; but in good years, some may be exported to Nigeria. Imports meet ten to twenty percent of rice demand.

The major crops can be grouped into two categories, rainy season and dry season. Rainy season crops include millet, sorghum, cowpea, groundnut, maize, chufa (*Cyperus esculentus*-tiger nut sedge), rice, sesame, Bambara groundnut, and common sorrel (a leafy vegetable). Dry season crops are irrigated, often in market gardens (e.g., onion, tomato, sweet pepper, squash, melon, carrot, eggplant, okra, lettuce, etc.), sweet potato, Irish potato, and some rice.

There are four livestock systems in Niger: 1) pastoral (transhumant, large ruminants, in the Sahelo-Saharan zone); 2) agro-pastoral (small herds of small and large ruminants between the pastoral and agricultural zones); 3) integrated into farms (in the southern agricultural zones); and 4) peri-urban. "Livestock" here refers primarily to cattle, goats, and sheep; but some pastoralists keep camels; donkeys and horses are also significant. In 2019, the total number of livestock species (except poultry) was estimated at 50.5 million and growing (ILLS 2022). According to a 2007 census, of about five million cattle, men owned 77% of them; women owned a higher percentage of sheep (40%) and goats (54%) (*République du Niger* 2008). In 2020, the livestock population was valued at more than four trillion West African francs CFA, or approximately US\$7.4 billion (ILLS 2022).

⁸ <https://www.worldbank.org/en/country/niger/overview>; <https://ourworldindata.org/from-1-90-to-2-15-a-day-the-updated-international-poverty-line> (Accessed 11-7-2024).

⁹ GDP per capita (current US\$) - Niger | Data (Accessed 11-7-2024).

¹⁰ <https://country.eiu.com/niger> (Accessed 11-7-2024).

Niger's livestock sector comprises around 15% of total GDP, according to the World Bank¹¹. Livestock exports also contribute 21% of total export earnings with much of those exports going to the region. Livestock is also critical to livelihoods: over 80% of the population rear livestock (FEWS NET 2017). However, the Sahelian region including Niger faces a feed deficit for livestock for four to seven months of the year (Ayantunde et al. 2011; Amole et al. 2022), particularly during the dry season when natural pasture biomass decreases by 25 to 50% (Savadogo et al. 1999). In response, livestock keepers seek to purchase feed from markets (Ayantunde et al. 2014). Feed markets have grown, particularly around urban areas in the West African Sahel (Ayantunde et al. 2023). According to anecdotal reports, livestock keepers also purchase crop residues from sources across the southern border to use as feed.

While the feed deficit has been documented for decades, changes in weather patterns including longer dry spells, droughts, and higher temperatures are worsening feed constraints. For example, the rainfall deficit in Niger in 2021 contributed to lower-than-normal biomass production; the increased insecurity and livestock feed prices contributed to the food security crisis.

4. Irrigation Overview: Types and Extent

This section provides an overview of the status of irrigation and more generally, agricultural water management in Niger. It briefly explains the types and extent of the various systems. Investments in water management are discussed in section 5 while their performance is discussed in section 6.

4.1 Consequences of agricultural dependence on rainfall

As is true for other Sahelian countries, Niger's agriculture, including raising livestock, depends almost entirely on rainfall. In any given year, parts of Niger experience serious drought, i.e., below-average annual rainfall; and most areas are affected by long periods of no rain within seasons even when the average for the season is close to "normal". Therefore, production is invariably affected. Raising livestock is an important adaptation to aridity and unreliable rainfall, as animals can, in principle, be moved to better grazing areas. Nevertheless, serious droughts periodically devastate the livestock population. For example, the 2009 drought led to the loss of 2.7 million head of livestock by starvation, and an additional 357,000 animals were affected. People sold 1.48 million animals under distress. The total value of the capital lost in the crisis attributable to that drought was approximately US\$ 805 million (Fintrac/BEST 2011).

In mid-2023, the World Food Program (WFP) estimated that 3.3 million people were severely food insecure and 7.3 million were moderately food insecure because of insecurity, price inflation, and the lingering effects of the 2021 drought; that amounts to 41% of the total population (WFP 2023). Among the numerous risk factors facing Nigerien farmers, drought is by far the most frequent and most serious. However, floods, pests, crop and livestock diseases, and conflict are also major sources of shocks to rural households.

¹¹ <https://www.worldbank.org/en/news/press-release/2023/06/19/niger-strong-agricultural-season-boosts-economic-rebound-in-2022> (Accessed 01-12-2025).

For rainfed crop producers, this pattern of frequent shocks has several important implications. First, it makes investing scarce cash in inputs such as fertilizer or improved seeds too risky for most smallholders. Second, it means that households often cannot produce sufficient food to meet household needs for the full year. Dependence on a single cropping season is inherently risky; there is no second chance until the following year. Access to inputs, including financial services, is low — agriculture exhibits a low level of commercialization. One study showed that if farmers had reliable weather predictions at the beginning of the season, they might invest more in profit-maximizing inputs (Wouterse & Odjo 2021).

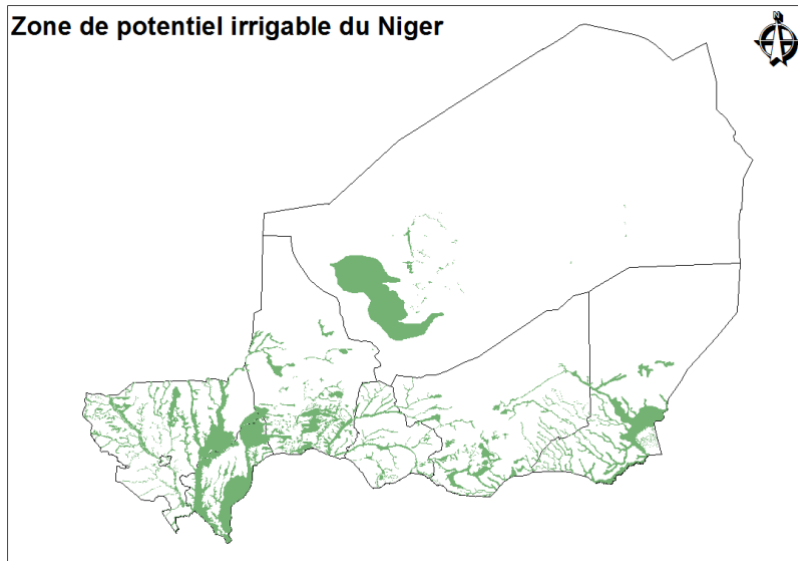
Men, women and children are often forced to migrate to cities or irrigated areas — even to neighboring countries — to search for work. These lean periods come regularly and have significant impacts on the health and nutritional status of women and children. Most smallholders and pastoralists are therefore caught in a severe low-productivity poverty trap. Even if they have a surplus in the rare, good year, in other years they are unable to grow sufficient food or earn enough income to purchase food; they are forced to sell their most productive assets, their livestock, usually at unfavorable prices; and malnutrition and ill health reduce the productivity of labor and may entail costs for treatment. It is a vicious spiral. Niger is at the bottom of the World Bank's Human Capital Index (189th out of 193 countries) (UNDP 2024). This loss of social capital further reduces resilience to the next crisis.

Finally, chronic insecurity because of armed groups and intercommunal conflict is cited by many studies as a major challenge¹². Combined with droughts and floods, insecurity directly impacts local communities and government and NGO service providers and exacerbates food insecurity in rural areas. There is evidence in the Sahel that the combination of soil moisture deficits and low Falkenmark index scores (water stress) during dry periods are linked to water conflicts (Nkiaka et al. 2024). In northern Niger, a major surge in insecurity has reversed gains made in land restoration under the [Regreening Africa program](#) (Singbo et al. 2020; see section 7.2).

4.2 The status and state of agricultural water management

Estimates of Niger's irrigable land potential vary depending on the assumptions used. Officially, Niger has an estimated irrigable land potential of 270,000 ha of which around 140,000 ha is in the Niger River valley (*République du Niger* 2017; Aboubacar 2023). MCC (2014) reported a decade ago that this figure was being recalculated. Much depends on assumptions about groundwater; a Ministry of Agriculture study of irrigation potential concludes the potential is 10.9 million ha depending on the depth of aquifers (*République du Niger* 2021; Aboubacar 2023). Figure 2 is a map of potential irrigation areas of Niger. The MCC groundwater study results, discussed above, seem to support this large potential.

¹² [World Report 2024: Niger | Human Rights Watch](#) (Accessed 11-7-2024).



Source: République du Niger 2021, Figure 5.

Figure 2. Areas with groundwater potential for irrigation

4.2.1 Sustainable land and water management: Climate-smart agriculture

Farm sizes average around 4.1 ha; only nine percent are owned by women. Nearly all of it is rainfed. Soil depletion and environmental degradation are on a downward spiral, worsening food insecurity and poverty. However, climate-smart agriculture (CSA) has shown considerable promise (see section 7.2). I have adopted a broad definition of CSA, including management of rainfed agriculture and pastures, and land restoration programs — especially farmer-managed natural regeneration (FMNR). Nearly all agricultural and pasture lands in Niger are rainfed. CSA — or sustainable land and water management (SLWM) — practices include a wide variety of interventions or packages of interventions for crop management: water capture and retention such as contour stone bunds, water spreading bunds and weirs, planting pits (*zai*), and half-moons, complemented by agroforestry, and soil fertility management systems such as applying manure or compost and micro-doses of chemical fertilizers, early sowing, and contracting with pastoralists to have their animals stay in their fallow fields to provide additional manure (Moussa & Toughiani 2020).

FMNR is a low-cost way of growing and reproducing trees and shrubs that provide useful food, fuel, or fodder, and restores land fertility. This practice depends on living tree stumps and root systems, which grow more quickly than saplings from seeds. By protecting these stumps and shrubs, and pruning away the weaker stems, they can grow into full-sized trees. Some of these trees have useful traits; for example, *Faidherbia albida* sprout leaves during the dry season, protecting the crops below; in the rainy season, they drop their leaves, fertilizing the soil. Crop yields increase on regenerated fields (Reiji 2009; Dinesh et al. 2015).

4.2.2 Types of irrigation

Since water is the most critical constraint on agricultural production, it is no surprise that irrigated land is more productive and profitable than rainfed land. What is surprising, after decades of investment, is that the area equipped for irrigation represents just 0.33% of the agricultural area. There are no accurate

data on the extent of irrigation in Niger. The current development plan (*République du Niger* 2022) estimates the total irrigated area is 210,010 ha, of which 175,370 ha are classified as “petite,” i.e., “small-scale irrigation” (SSI), and just 34,640 ha are formal schemes managed by the *Office National des Aménagements Hydro-Agricoles* (National Office for Irrigation Systems, ONAHA). But these figures may not be accurate. The figure for SSI likely includes various other subtypes, for example, both private farmer-led irrigation and *Périmètres de Contre-Saison* (PCS, small dry season schemes). Soumaila (2021) states that there has been no credible estimate of private irrigation for over ten years; he estimates the total farmer-led irrigation area to be between 35,000 and 40,000 ha. Further, the Kandadji Dam will add 45,000 additional hectares of large-scale irrigation when it is completed; however, its completion date has continued to slip; the latest estimate was the end of 2026, but this is now postponed because the contractor claims funding has been frozen¹³. This will exhaust Niger’s allocation from the Niger River (MCC 2014). Table 1 summarizes the types of irrigation in Niger¹⁴.

Medium and large-scale schemes (Amenagements Hydro-Agricoles, AHA)

Nearly all medium and large formal irrigation schemes (AHA) are pump schemes in the Niger River Valley (Figure 3). Most are rice schemes, though in some, high-value vegetable crops are grown in the dry season. These schemes account for about 16% of the irrigated land. Historically, they have attracted more investment funds than other types of irrigation. Cooperatives established by the government generally manage them; ONAHA supervises the cooperatives. Most of the holdings are small (around 0.25 ha); therefore, most households have diversified their livelihoods through rainfed agriculture, fishing, labor, etc. According to a study by the International Water Management Institute (IWMI) in the late 1990s, production averaged 4.5–5.0 t/ha/season, and household profitability was reasonable. However, the irrigation fees were high (\$425/ha/season), and, because of low payment rates, fee collection was not adequate to achieve financial sustainability (Abernethy et al. 2000). Some studies have shown that rice production is not privately profitable; others have been more optimistic (see Merrey & Sally 2014). The reasons include limited capital access, a non-competitive market, and the low quality of locally milled rice (Katic et al. 2013).

Most of the development of these schemes took place between the early 1970s to the mid-1980s; since then, with a few exceptions, the focus has been on “modernizing” existing schemes and management reform (except areas to be irrigated by the Kandadji Dam), but progress has been slow; this is discussed further in section 6.

Table 1. Irrigation system typology

Type	Features
Medium and large-scale schemes	Surface areas of 15–1,500 ha in plots of 0.25–0.5 ha. High levels of public investment; irrigated with water from the river (or a few aquifers) by pumping, surface gravity-fed distribution, rice, mixed farming, collective management, and state supervision by ONAHA.

¹³ [Construction of vital power dam in Niger halted due to sanctions | Africanews](#) (Accessed 01-12-2025).

¹⁴ The discussion of the types of irrigation schemes draws heavily on Merrey & Sally 2014, with updates where available.

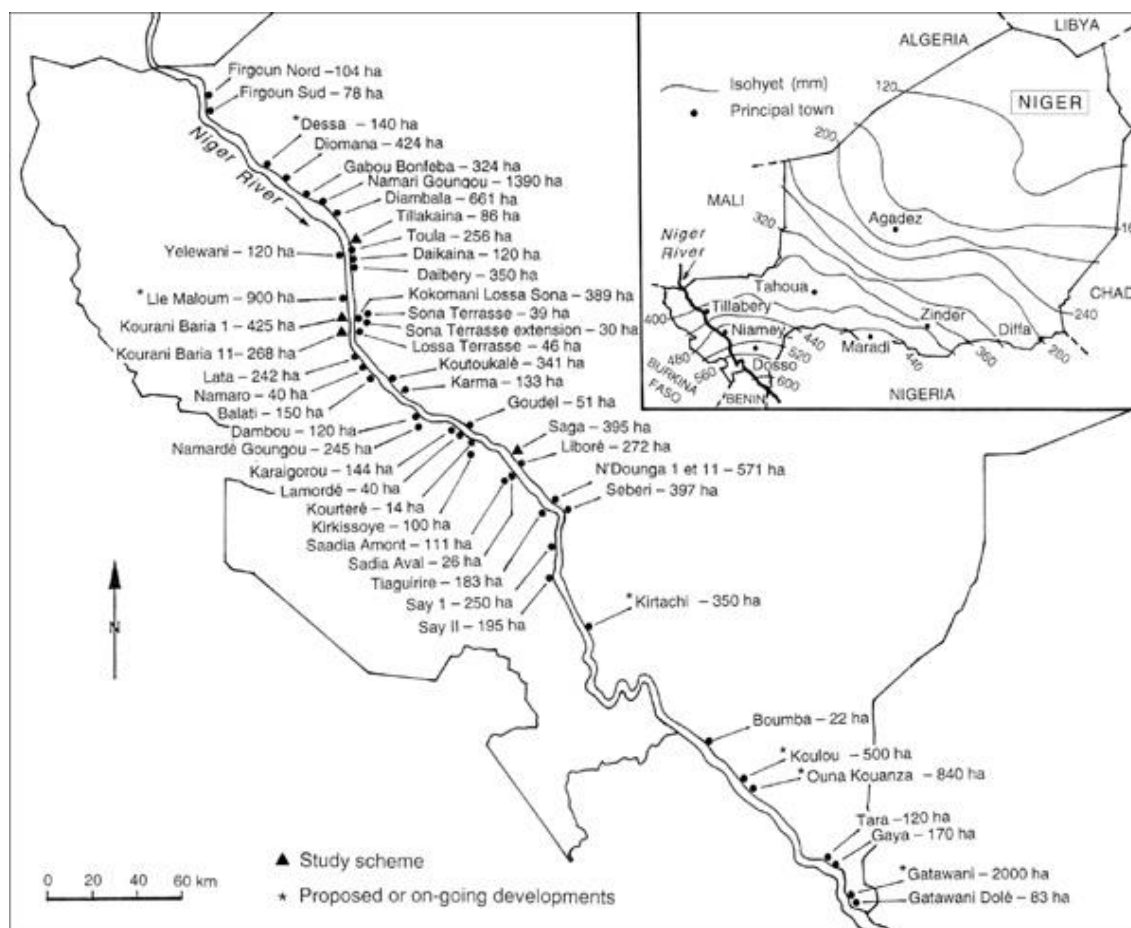
Type	Features
Large- and medium-scale commercial schemes	Areas ranging from 20 to 250 ha. High private investment required; irrigated by pumping water from the river or underground; water distribution by Californian network and drip irrigation; market gardening and cash crops.
Off-season irrigation schemes (<i>Périmètres de Contre-Saison</i>)	Areas of a few hectares. Often public investment, partial water control; irrigated from groundwater, rivers, ponds, reservoirs, or flood recession; collective management of water points but individual production; some market gardens may be included here.
Informal small-scale private irrigation	Small areas <1 ha (0.1–0.75 ha), mostly individual production. Low private investment; irrigated using groundwater, ponds, or rivers; motorized, manual, or animal pumping; manual, gravity-fed distribution, Californian type ¹⁵ or drip irrigation; market gardening.

Source: Adapted from Aboubacar 2023: Table 2

Large- and medium-scale commercial schemes

In principle, large-scale export-oriented commercial irrigated agriculture has a high potential. However, it is not well developed and there is very little information on this sector. Online searches including Google Scholar turned up no references. Katic et al. (2013) seemed to endorse a transition from smallholder rice farming to a well-integrated “semi-industrial sector” that can compete with imported rice. They note this will require a common regional strategy to succeed. This proposal is unrealistic considering the dominance of small farms and the challenges of competing with imported broken rice.

¹⁵ This term is commonly used in Niger. It refers to water distribution through buried PVC pipes (Abric et al. 2011).



Source: Abernethy et al. 2000: Figure 1.

Figure 3. Location of irrigation systems in the Niger River Valley in the late 1990s (Inset: Isohyets of mean rainfall, 1961–1990)

Off-season irrigation schemes

Over half of Niger's irrigation schemes are *Périmètres de Contre-Saison* (PCS) systems. These schemes are collectively managed at the community watershed level. They generally feature partial water control and are overseen by district agricultural extension services (and in a few cases by NGOs and special projects). They are in traditional cultivation zones and sites specially set up to accommodate drought-affected populations. Investments have generally focused on collecting water and protecting plots, and in some cases, systems for lifting and distributing water. These include manual or mechanized irrigation from wells, streams, and ponds, and flood-recession agriculture. These plots, usually about one hectare in size, are used to grow crops such as maize, legumes, and vegetables during the dry season and are particularly important in years when the main rainy season harvest is poor. As of a decade ago, approximately 60,000 ha were under PCS covering all regions of the country, making this the largest type in terms of area. There are no recent figures, but the area is likely higher now. There are two types of PCS: (a) traditional sites in existence before 1984 and operated by their owners who may have benefited from government support (e.g., for well sinking and fencing); and (b) sites specially developed by the state after 1984 to accommodate residents who are annually displaced by drought. In the latter type of scheme, unlike in the first, cultivation in the dry season (October to May) is only carried out when the results of the rainy season are poor (*République du Niger* 2005).

Flood recession agriculture

Niger has approximately 12,000 hectares of “non-equipped” flood recession agriculture (MCC 2014). These areas are cultivated after river floods and seasonal ponds recede, i.e., as the rainy season ends. They are found mainly but not only in the Lake Chad and Niger River basins but are mentioned as being found in other areas as well (e.g., ADF 2006). It is unlikely that there is potential to increase these areas, but there may be some potential to improve their productivity.

Small-scale private irrigation

Small-scale private irrigation has been expanding rapidly in sub-Saharan Africa, often spontaneously, but sometimes with support from donors, governments, and NGOs. In Niger as well, small-scale private irrigation has developed rapidly during the past two decades, supported by the World Bank and other development partners and an improving policy and market environment. Much of this is referred to as “*petite irrigation*” officially; otherwise, “farmer-led irrigation development” (FLID) is defined by Woodhouse et al. (2016) as an irrigation development process in which farmers are the drivers seeking to improve agricultural water use through investments in new technologies and market linkages (see also Abric et al. 2011; Soumaila 2021). In 2002 FLI was estimated to cover 16,800 ha, largely because of two phases of the World Bank’s Private Irrigation Promotion Project. An additional project financed the construction or rehabilitation of more areas, giving 24,350 ha by 2015 (Soumaila 2021 quoting World Bank sources)¹⁶. Since that time there has been no systematic monitoring of FLID in Niger; Soumaila (2021) estimates the total FLI area to be 35,000-40,000 ha but with a large margin of error. This figure may not account for the likelihood of considerable informal expansion resulting from the growing availability of low-cost pumps (see African Union 2020).

According to Soumaila (2021), the sources of irrigation include PVC tubewells, small dams, other wells, ponds, and water channels. Groundwater is the most common source. Low-cost manual well-drilling technologies are used where the soil is soft; in 2011, there were an estimated 18,000 such wells and 42 manual drilling teams (Abric et al. 2011); these numbers must have expanded substantially since then. The energy sources are small motor pumps, electric pumps, manual or treadle pumps, and, increasingly, solar pumps. Generally, SSI systems are less than a hectare, though the figures include a few larger ones serving small groups of farmers.

Market gardens

A subtype of petite irrigation is the market garden. These are nearly all farmer-led and are generally very small, intensively cultivated gardens growing fruits and vegetables for the market. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) developed, and field tested in Niger, an intensive gardening model based on drip irrigation and small pumps, the “African Market Garden” (AMG). There are four AMG models based on scale, and all are said to be very profitable (Woltering et al. 2011a, 2011b). Burney et al. (2010; 2018) demonstrated the potential viability of solar pumps in West Africa, including Niger, for intensive smallholder gardening. Subsequent studies, reviewed below, have assessed the performance and challenges of market gardening in Niger.

¹⁶ Much FLID is spontaneous; these projects are examples of externally induced “FLID”.

5. Irrigation Policy and Institutional Landscape

5.1 Agricultural and water policy issues

Niger has produced, often with support from partners, many policies and strategies related to rural development and policy reform¹⁷. The *Strategy for Sustainable Development and Inclusive Growth* adopted in 2011 articulates an overall vision of Niger's national development by 2035. The Ministry of Planning develops comprehensive five-year economic and social development plans; the current plan covers 2022-2026 (*Ministère du Plan* 2022).

Regarding water and agriculture specifically, in 2017, the government adopted an integrated water resources management plan (*PANGIRE NIGER; Ministère de l'Hydraulique et de l'Assainissement* 2017). In 2011, under the aegis of the Niger President, the 3N (or, sometimes, I3N) Initiative, "*Les Nigériens Nourrissent les Nigériens*" for food and nutrition security and sustainable development was launched. In 2012, the 3N strategy and investment plan for 2012-2015 was approved (*Haut Commissariat à l'Initiative 3N* 2012). 3N is aligned with the regional and continental level agricultural policy frameworks including the *Comprehensive Africa Agriculture Development Plan*, the *ECOWAS Common Agricultural Policy*, and the West African Economic and Monetary Union (WAEMU) *Agricultural Policy* (Merrey & Sally 2014).

A small-scale irrigation strategy paper was also produced in 2012; it was finalized and published as a ten-year plan in 2016 (*Ministère de l'Agriculture et de l'Elevage* 2016). It covers all types of agricultural water management except AHAs and large-scale commercial irrigated agriculture. A committee chaired by the head of the 3N Initiative oversees it. It proposes a decentralized demand-driven approach to SSI, with communes playing a critical implementation role; and a strong effort to support women. It explicitly emphasizes its consistency with the *Strategy for Sustainable Development and Inclusive Growth*; and it articulates ambitious quantitative targets in terms of increasing the area under SSI, farmers' incomes, and other targets.

During the 1960s-1970s, large-scale government-managed irrigation projects were prioritized in the West Africa region including Niger (Redicker et al. 2022). However, by the 1980s, as in other Sahelian countries, the focus shifted to management reform and partial turnover of schemes to farmer organizations. Investments to expand irrigation shifted to SSI; most schemes constructed since 1995 are small-scale (Redicker et al. 2022). Medium and large schemes face serious maintenance and operational challenges and require constant subsidies to continue. The World Bank (2017) pointed to various reasons, including insufficient farmer engagement, inadequate consideration of profitability combined with no access to finance for farmers, technical design errors, poor construction quality, non-transparent land allocations, and lack of clarity on operation and maintenance responsibilities. Various reform programs have failed to remedy these challenges.

One issue that is almost always present when attempting to implement agricultural policy in the field is the question of access to land and land tenure. Although there exists a substantial body of legal and policy texts, the implementation of rural legislation often encounters difficulties related to (a) the strength of entrenched attitudes, particularly among some administrative personnel who are not always well-versed with currently applicable texts and are reluctant to give up references to earlier texts, (b) the delay in the setting up of land tenure commissions and the mixed results of their actions on account of local specificities and power struggles, and (c) the lack of clarity in the functions and status of the permanent secretariat of the Rural Code which is expected to play a prominent role. In addition, the

¹⁷ Merrey & Sally (2014) summarize these up to about a decade ago.

decentralization law that establishes the legal framework for transferring public facilities to local authorities does not include AHA infrastructure. Therefore, more work is required to address gaps, correct anomalies, and harmonize legislative texts applicable to agricultural water management. Presently, both weak institutional and technical capacity and duplication of functions among actors characterize the agricultural water management subsector (Merrey & Sally 2014).

5.2 Institutional issues affecting agriculture and water

5.2.1 Government institutions

State institutions dominate all Nigerien economic sectors. Since independence in the 1960s, the areas of intervention by public administration have been growing and have led to establishing a rather heavy institutional setup. In 2013, there were 34 ministries; after the 2023 coup this number was reduced to 20 ministries¹⁸. Fragmentation of responsibilities leads to difficulties in inter-agency cooperation, compounded by poor knowledge of internal management rules. In addition, Niger's institutional organization has been affected by periods of instability that have not been conducive to development actions (Merrey & Sally 2014). For this report, the two key ministries are the Ministry of Agriculture and Livestock, and the Ministry of Hydraulics, Sanitation, and the Environment.

The Agriculture and Livestock Ministry has the following units (based on Merrey & Sally 2014; the government website does not show any changes):

- The General Directorate of Rural Engineering (*Direction Générale du Génie Rural*) is responsible for the development, implementation, and monitoring of national policy related to land and water development for agricultural, forestry, pastoral and related activities.
- The National Bureau for Irrigation Schemes (*Office National d'Aménagements Hydro-agricoles, ONAHA*) is responsible for the development and management of medium- and large-scale irrigation facilities.
- The General Directorate of Agriculture (*Direction Générale de l'Agriculture*) conducts advisory support activities on dry season irrigation schemes (PCS) not supported by ONAHA.
- The Directorate of Cooperative Action and Promotion of Rural Organizations (*Direction de l'Action Coopérative et de la Promotion des Organismes Ruraux*) is responsible for designing, developing, and implementing national policies for rural cooperative and mutual organizations.
- The National Institute for Agronomic Research of Niger (*Institut National de la Recherche Agronomique du Niger, INRAN*) is responsible for conducting applied research programs, including activities related to irrigated agriculture; see section 5.2.3.
- The objective of the High Commission for the 3N Initiative is to "contribute to protecting the Nigerien population from hunger and guaranteeing them the conditions for full participation in national production and the improvement of their income" and to "strengthen national capacities for food production, supply and resilience in the face of food crises and disasters". SSI has been a major focus of the program. According to the Future Policies website¹⁹, the 3N Initiative is a large-scale, cross-sectoral initiative to increase livestock, agricultural, and forest productivity, while augmenting the resilience of farmers and herders to climate change and food insecurity. Thanks to the Initiative, Niger is said to have made significant progress in its fight

¹⁸ <https://www.gouv.ne/index.php/les-ministeres> (Accessed September 25, 2024).

¹⁹ Niger's 3N Initiative: 'Nigériens Nourishing Nigériens' - futurepolicy.org (Accessed 11-7-2024).

against land degradation and hunger and reduced the proportion of people suffering from hunger by 50 percent since 2011. For its inclusive and participatory design and implementation, as well as its significant achievements, the 3N Initiative was recognized with the Future Policy Bronze Award 2017, awarded by the World Future Council in partnership with the United Nations Convention to Combat Desertification (UNCCD). *Haut-Commissariat à l'Initiative 3N* (2023) describes in detail the plan of work up to 2025 (in French).

The Ministry of Hydraulics' Water Resources Directorate collects and analyzes information on surface water and groundwater resources. It is also responsible for carrying out inventories, planning water resources and controlling their use, and disseminating water resources information. The Nigerien entity responsible for the development of the Kandadji Dam is the Independent Implementation Entity (*Agence du Barrage de Kandadji*). Finally, the National Directorate of Agricultural Engineering is responsible for off-season irrigation schemes (Soumaila 2021).

5.2.3 Government universities and research organizations

Until recently, most Nigerien universities and agricultural research organizations were government controlled. In recent years, some private universities have been established. Agriculture and natural resources research organizations are all government controlled. Table 2 provides information on universities that may be possible partners or may have faculty who would be interested in collaboration.

The premier agricultural research institution is the National Agricultural Research Institute of Niger (INRAN). Administered by the Ministry of Agriculture, it researches crops, livestock, natural resources, socioeconomics, and agricultural engineering. Before the coup, it was the main partner of CGIAR centers working in Niger.

[The ICRISAT Sahelian Center](#) (ISC) is a potential research partner. It is located on a 500-hectare site in Sadoré. The ISC was inaugurated in 1989 and has cutting-edge research facilities, equipped with specialized laboratories for soil and plant analysis, crop physiology/biotechnology, aflatoxin analysis, millet genetics, and entomology. In recent years, the Center has broadened from genetics to include water and land management.

Table 2. Nigerien Universities with Agricultural or Rural Development Faculties

University	Website	Notes
Abdou Moumouni University	https://www.uam.edu.ne/activites.php	Public university; has a <i>Faculté d'Agronomie</i> .
Agadez University	http://www.univ-agadez.edu.ne/universite/apropos	Public university. Arid zone agriculture

University	Website	Notes
		is mentioned as a specialty.
'Université Dan Dicko Dankoulodo de Maradi (UDDM)	https://www.uddm.edu.ne/	Public university. Has a <i>Faculté d'Agronomie et des Sciences de l'Environnement</i> .
Annahda International University	https://annahdauniversityniger.net/	The website is in English as well as French; may be private. No agriculture but does have social science, science, and economics.
University of Diffa	https://univ-diffa.ne/	May be private. Has two faculties with a wide range of agricultural, natural resource, and rural development expertise. Very promising.
Universite Djibo Hamani de Tahoua UDH	https://udh.edu.ne/	Public university. Has agronomic science faculty.

5.2.4 Non-government institutions (NGOs)

NGOs play important roles in the sector, despite some limitations in capacities. Merrey & Sally (2014) listed the following: in some cases, these may have government links:

Professional Organizations

- Niger Committee on Dams (*Comité Nigérien des Barrages, CNB*) (no website found)
- [Niger Association on Irrigation and Drainage](#) (*Association Nigérienne pour l'Irrigation et le Drainage, ANID*)
- Niger Association for Water and Soil Conservation (*Association Nigérienne pour la Conservation des Eaux et Sols, ANCES*) (no website found)

Farmer Organizations

- The AHA cooperatives are responsible for all cropping activities, as well as the operation, maintenance, and management of their irrigation schemes.
- Other farmer organizations:

- *Association Nigérienne pour la Promotion de l'Irrigation Privée* (ANPIP) and the [Fédération Nationale des Coopératives Maraîchères](#) (FNCM) are federations representing producers on small-scale and private irrigation schemes (no website found for ANPIP-may be defunct)
- [Réseau National des Chambres d'Agriculture du Niger](#) (Network of Agriculture Chambers). Its website has a lot of useful information including documents on Nigerien agriculture including irrigation.

Consulting firms

An internet search failed to identify any consulting firms based in Niger that work in the agricultural or natural resources management sectors. Most are focused specifically on audit, finance, and management. There may well be small consulting firms with useful capacity. There are companies in Niger that import, sell, install and service a wide variety of irrigation technologies, including solar and mechanical pumps and other irrigation equipment. It may be possible to partner with some of these firms to strengthen the value chain or support more equitable access by women and poor farmers.

Development NGOs

Numerous international NGOs and some local ones are working in Niger. Most are focused on humanitarian relief and gender issues not related to agricultural development. Based on an extensive Google search, I found several websites that provide lists of and links to NGOs working in the country. Table 3 lists these websites and identifies NGOs that appear to be working with rural communities on agriculture, including small, irrigated gardens.

Table 3. NGOs working in Niger with an interest in agricultural development

Name of NGO	Website & Contact (All websites accessed 11-7-2024)	Notes
OIREN	https://www.oiren.org/	An organization representing 45 INGOs in Niger (List is at: https://www.oiren.org/membres/)
NGO Base	List of Ngos, Charities and non-profits in Niger (ngobase.org)	Most are humanitarian/ relief, few are on agricultural development.
Save the Children-Niger	https://www.developmentaid.org/donors/view/103182/save-the-children-niger Address: Quartier Plateau PL 54 - Rue des Lacs – Niamey, Niger. Website: niger.savethechildren.net/ Contact person: Hadiara Marou Souley-Head of Programs. Phone: +22720725474 , 75752552 , 53	Good potential.
World Vision International	Niger Field Office World Vision International Quartier Nouveau Marché Boulevard de la Liberté, N.M. - 2 CN3 12713 - NIGER (+227) 20753427 / (+227) 20754135 (+227) 20753430	Good potential.
IRC	https://www.rescue.org/country/niger	Possible

Name of NGO	Website & Contact (All websites accessed 11-7-2024)	Notes
Plan International-Niger	Plan International Niger (plan-international.org) : Angle Boulevard des Djermakoye, Rue de la Magia Issa Béri, PO Box: 12247, Niamey +227 20 72 44 44-45 niger.co@plan-international.org.	Potential
CARE International	Niger CARE International (care-international.org) No local office listed	Good potential.
Caritas-Niger	Niger - Caritas . Address: CADEV – Niger National Executive Secretariat, BP: 11 580 or 10 270 8000 CTN, Niamey, Niger Telephone: +227 20 740 040 Email: cadevnig@intnet.ne www.cadevniger.org	Possible; need to understand the extent to which they target Christians.
N-DEV	N-DEV. https://ndev.ngo/ address: Siège social derrière la Pharmacie Bobiel, NIAMEY NIGER BP: 10297.	Good potential.
RAIN for the Sahel and Sahara	Rain for the Sahel and Sahara – A non-profit working in Niger, Africa (rain4sahara.org) . No local office is listed. Rain for the Sahel and Sahara PO Box 1503 Portsmouth, NH 03802 603-371-0676 info@rain4sahara.org	Women's Community Gardens in Niger: RAIN transforms a potentially vulnerable situation by empowering rural women to grow food and earn funds in their shared 5,000 sq meter drip irrigated Community Gardens, yielding enough crops to create an income-generating surplus while acting as an onsite learning center for nutrition and sustainable organic farming techniques.

Regional organizations

This section discusses two regional organizations that may be potential non-government partners in agricultural water management. It excludes regional economic institutions such as ECOWAS.

Le Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (Permanent Inter-State Committee for Drought Control in the Sahel, [CILSS](http://CILSS.org)) is a regional institution that invests in research for food and nutritional security and fighting the effects of climate change in the Sahel and West Africa. A technical arm of ECOWAS, it monitors food security in 17 countries, runs a large satellite data center, and, through an institution based in Mali, supports agricultural research. It also operates a regional training center in Niamey for agronomists and weather specialists, [AGRHYMET](http://AGRHYMET.org) (derived from “Agrometeorology, Hydrology and Meteorology”). Diasso (2022) evaluates its considerable capacities. Many donors, including USAID and the World Bank, partner with CILSS.

The West and Central African Council for Agricultural Research and Development ([CORAF/WE CARD](http://CORAF/WE CARD.org)) is a sub-regional organization consisting of the national agricultural research systems of 23 countries. Its mandate is to coordinate and facilitate innovative and cutting-edge research products to unlock the agricultural potential of West and Central Africa. It operates nine centers of excellence for various agro-systems. Like CILSS, many donors provide support.

6. Donor Engagement in Irrigation Development

This section focuses on donors' support for irrigation and, more broadly, agricultural water and land management interventions. Both multilateral and bilateral donors have provided support to Niger since its independence; some, such as the World Bank, have remained engaged almost continuously. Since the 2023 coup, many bilateral donors have withdrawn development assistance but continue to provide humanitarian aid to reduce hunger and food insecurity. The donor institutions vary in the amount of detail available publicly, i.e., on their websites. The World Bank offers access to many documents; others provide only blogs or brief descriptions with no indication of the results of their investments.

The section begins with multilateral donors, then bilateral, and finally, other initiatives.

6.1 Multilateral financial institutions

The major international financial institutions supporting agricultural water management development in Niger are the World Bank, the International Fund for Agricultural Development (IFAD), and the African Development Bank (AfDB). Several others have provided support but information on their investments is sketchy; these include the *Banque Ouest Africaine de Développement* (West African Development Bank, BOAD) and the Islamic Development Bank.

6.1.1 The World Bank, including the International Development Association (IDA)

The World Bank has been Niger's largest and most influential financial partner for promoting irrigation for decades. For example, in 1978 the Bank agreed to co-finance with KfW (a German development bank) the first major irrigation project, the Narmaragounggu polder, which was also intended to develop the capacity of ONAHA (World Bank 1978). This was the beginning of a long-term engagement with ONAHA. In 1985, following a comprehensive review of irrigation rehabilitation requirements, the Bank launched an irrigation rehabilitation project (World Bank 1985). Among others, a significant objective was to reorient ONAHA to support farmers' self-management of irrigation schemes through cooperatives. This 1985 Appraisal Report claims the Narmaragounggu project was a resounding success that increased rice production significantly and enhanced ONAHA's capacity. Nevertheless, significant shortcomings were identified and provided the basis for the rehabilitation project.

In 1995, the Bank turned its attention to SSI under the Pilot Private Irrigation Project (PPIP, World Bank 2002). Its objective over four years was to assist Niger to test local private sector irrigation development, improved low-cost SSI technologies, improved credit schemes and erosion control, and monitoring of replenishable shallow aquifers. Its expected impact was to create a local value chain ecosystem involving local artisans. As a result of disappointment with the performance of government agencies, the project supported the creation of the Niger Private Irrigation Promotion (ANPIP) as the implementing agency. The project completion report (World Bank 2002) rated the overall performance as satisfactory: its main objectives were met and some were exceeded, though sustainability remained a question. The Bank's Independent Evaluation Group assessed the outcome of this project as "highly satisfactory" (World Bank 2008:3-4): it "successfully demonstrated the potential of the small-scale irrigation sector to bring about substantial productivity improvements and thereby increasing food security."

Building on this success, the Bank financed PIP2. Its development objective was narrower than PPIP: "to increase production and profitability of high-value, irrigated crops by private, smallholder farmers with simple, low-cost technologies" (World Bank 2009). This project did not go as well as the first phase; for

example, ANPIP's performance was unsatisfactory, and the implementation responsibility was given to the government at midterm. Nevertheless, the project fully achieved its development targets. According to Abric et al. (2011), the two projects distributed about 20,000 pumps and 17,000 low-pressure distribution systems and constructed 5,000 tube wells. The projects covered 16,000 hectares and benefited about 30,000 people. The incomes of participating farmers were 1.5 to 3 times larger than average incomes. Further, at the end of PIP2, an irrigation technology supply chain and advisory services were in place. However, they were heavily dependent on project support and subsidies which ended with the project.

The Bank perceived that demand for its services exceeded the supply, leading it to include continued private SSI support in its Agro-Sylvo-Pastoral Exports and Markets Development Project (World Bank 2009). A later study by the International Finance Corporation (IFC 2013) confirmed that a private-sector irrigation and seed production investment model is preferred to build climate resilience in Niger's agricultural sector. However, the targeted beneficiaries were larger commercial farms (1-5 ha) and not the smallholders previously targeted (Abric et al. 2011). I found no studies of its outcomes.

In 2013, the Bank facilitated a six-country regional consultation that produced an agreement among Sahelian governments, including Niger, on the "Dakar Declaration". It was supported by regional economic communities (ECOWAS, WAEMU), the Bank, and CILSS. It resulted in the launch of the Sahel Irrigation Initiative, a political commitment to launch a "new paradigm" of irrigation development (World Bank 2017; ECOWAS et al. 2017).

In 2017, the Sahel Irrigation Initiative Support Project was launched. It aimed to support regional collaboration to take a more comprehensive approach to irrigation development. CILSS is the regional implementing agency. This Initiative seeks to overcome the continuing obstacles to rapid irrigation development in Sahelian countries, partly by learning lessons from other countries' experiences. As the World Bank (2017:3) Appraisal states:

Many medium and large schemes face maintenance challenges and require recurrent subsidies to ensure continued operation. In addition, sectoral outcomes have been below expectations due to a variety of factors including: (a) insufficient engagement of local populations in decision-making processes; (b) inadequate consideration of commercial viability; (c) errors in technical design; (d) poor construction quality; (e) absence of a transparent irrigated land allocation process; (f) limited access to finance; (g) unclear responsibilities for scheme operation and maintenance (O&M); and (h) poor coordination between stakeholders.

The Bank believes a regional approach will be more effective than separate national projects, despite its additional complexity. The project builds on success stories over the full range of types of irrigation. In 2024, a modification dropped Chad as a participating country; the overall project performance was rated as "moderately satisfactory" (World Bank 2024). The project website²⁰ has no reports on the outcomes and lessons learned. Other projects have included elements of irrigation investments being tested under this Initiative, for example, the Agricultural and Livestock Transformation Project (World Bank 2019).

6.1.2 International Fund for Agricultural Development (IFAD)

IFAD has a long history of investing in local-level land and water management projects. This section provides an overview of a few of the many programs and projects co-financed by IFAD.

A 2011 country program evaluation (IFAD 2011a) noted that it had implemented "innovative interventions" such as farmer-managed natural resources regeneration, rehabilitation of degraded land,

²⁰ [Development Projects : Sahel Irrigation Initiative Support Project - P154482](#) (Accessed 11-7-2024).

and small-scale irrigation for market gardens. However, it observed that too little attention had been paid to irrigated agriculture, livestock husbandry, off-farm activities, and market access for the poor. It also suggested focusing on the Mardi region, home to about 20% of the poor rural population.

In response, the Food Security and Development Support Project in the Maradi Region Program was launched (PASADEM) (IFAD 2011b). This project explicitly supported the 3N Initiative, and focused, among others, on improving yields from rainfed farming, developing irrigation, livestock and fisheries, natural resource management, strengthening the population's resilience, and facilitating market access. Although SSI is mentioned as a component, it does not appear to have been central to the program. The report notes that it complemented other related rural development programs supported by IFAD.

After a change in IFAD's strategy, the Ruwanmu Small Scale Irrigation Project, initiated in 2012, was merged with PASADEM and was implemented in Maradi, Tahoua, and Zinder regions²¹. It was a multi-pronged program aimed at sustainably expanding SSI including home gardens with micro-irrigation, improving markets, and developing economic infrastructure (roads, produce collection points, etc.). The Project Completion Validation Report (IFAD 2019a) found mixed results: there were clear benefits for thousands of beneficiaries and a marked increase in production of market produce attributable to the project. However, the project fell short of its physical targets, and the sustainability of outputs was acceptable but not at the level targeted. The reasons included underestimating costs at the design stage and inappropriate micro-irrigation and other technologies (IFAD 2019a).

The Family Farming Development Programme in Maradi, Tahoua, and Zinder was launched in 2015 and is scheduled for completion in 2026. It aims to enhance food security and resilience for smallholder farmers in Niger by enhancing sustainable land and water management, market access, and climate resilience. Since 2015, a case study authored by the IFAD country representative (Rwabidadi & Saponaro 2024) claims the Program has restored over 200,000 ha of degraded land, established almost 6,000 ha of small-scale irrigation, and trained nearly 67,000 farmers. It has also constructed 574 km of rural roads and 33 market infrastructures to improve access to markets and livelihoods. In 2024, IFAD added more financing and extended the Program to the Dosso region. The most recent supervision report largely supports this positive view of the Program performance (IFAD 2023).

In 2019, the Project to Strengthen Resilience of Rural Communities to Food and Nutrition Insecurity (PRECIS) was launched in the Dosso, Tahoua, Maradi, and Zinder regions (IFAD 2019b). Focused largely on agro-pastoralists and with a strong stated emphasis on gender, PRECIS is a multi-pronged project with three components: 1) sustainable agricultural development and strengthening of rural household resilience (including sustainable surface water and land management); 2) promotion of youth entrepreneurship and market access; and 3) strengthened civic engagement. Another case study by the IFAD country manager (Rwabidadi & Saponaro 2024b) claims the project is meeting its ambitious targets.

6.1.3 African Development Bank (AfDB)

AfDB has a long history of investing in irrigation and local-level water and land management. Examples are the Tahoua Region Water Harnessing Project, the Water Mobilization Project to Enhance Food Security in Maradi, Tahoua, and Zinder Regions, and the Water Resources Mobilization and Development Project (AfDB (2008, 2011, 2012). These focused on simple local-level rainwater harvesting

²¹ [IFAD and Niger sign a US\\$21.46 million financing agreement to boost small-scale irrigation - Niger | ReliefWeb](#) (Accessed 11-7-2024).

interventions including dams, weirs, and SSI. I could not find information on the outcomes and impacts of these projects.

More recently, AfDB has focused on two priority areas (AfDB 2022):

1. Promote competitiveness of the economy to unlock its potential and foster job creation.
2. Promote the development of resilient agriculture for highly sustainable and inclusive growth.

It has also taken a more regional approach to project design. For example, the first phase of the Food and Nutrition Insecurity Resilience Program in the Sahel constructed 235 water transport and distribution structures, developed 5,500 hectares of irrigated land, and restored 12,000 hectares of degraded agricultural land; the second phase continues the program with more countries (AfDB 2023). The project is implemented by CILSS and the agricultural ministries of the participating countries. It invests in water collection facilities, irrigated areas, production and postproduction, nutrition, youth employment, and small and medium businesses. Continuing the theme of the early projects mentioned above, all infrastructure must be manageable by municipalities.

AfDB has also invested in supporting the Kandadji Dam project through the Kandadji Ecosystems Regeneration and Niger Valley Development Program²². This is a long-term government program. It appears AfDB has focused its investments on downstream activities related to dam construction and irrigation infrastructure, in collaboration with the World Bank and others. I could not find detailed evaluation reports, though they surely exist.

6.1.4 West African Development Bank (BOAD)

BOAD is a regional bank, part of WAEMU. It focuses on regional projects. I found just one project, with a 2023 date: the “Hydro-agricultural development with smart agriculture practices resilient to climate change in Niger (Aha Niger)” Project²³. It has two components: development of 1,000 ha and rehabilitation of 749 ha of agricultural land; and capacity-building actions for beneficiary populations, technical services, and environmental protection. No other details are provided.

6.1.5 Islamic Development Bank

I found one irrigation investment project in Niger: a 2014 project to support the development of the Kandadji Dam is described in a press release²⁴. I found no further details.

6.2 Bilateral donors

I have tried to identify the major bilateral donors supporting irrigation or land and water resources management more broadly. This section is not comprehensive; for example, some donors such as the Spanish Development Agency provide complementary funding to international financial institutions’ projects. Most Western bilateral donors have suspended financial support to the Nigerien government since the 2023 coup, though many continue humanitarian aid through NGOs.

²² [Niger - The Kandadji Ecosystems Regeneration and Niger Valley Development Programme \(KERNVDP\) - MapAfrica - African Development Bank Group](#) (Accessed 11-7-2024).

²³ [Hydro-agricultural development with smart agriculture practices resilient to climate change in Niger \(Aha Niger\) - La BOAD](#) (Accessed 11-7-2024).

²⁴ [IDB, Niger Republic to Speed up the Completion of Kandadji Dam | News | IsDB](#) (Accessed 11-7-2024).

6.2.1 United States

United States Agency for International Development (USAID)

USAID was involved in irrigated agricultural development and land and water management in Niger for decades. In 1984, it sponsored an assessment of Niger's irrigation subsector (Anders et al. 1984). This was followed up in 1987 by a team from the USAID-supported "Water Management Synthesis II Project" which carried out a rapid assessment of four different types of irrigation schemes in Niger (WMS 1987). Both reports observed that the cost of irrigation development in Niger is unusually high (\$10-25,000/ha), a point made in an early World Bank project report as well. These reports are the first detailed assessments of farmers' practices and the performance of irrigation schemes in Niger.

USAID's most recent Country Development Cooperation Strategy (USAID 2022) prioritized strengthening and empowering communities, improving inclusive economic opportunities, and strengthening government institutions. Within the community empowerment goal and based on a climate risk assessment, the Strategy emphasized programming in climate-smart agriculture, SSI, and watershed management aimed, among others, at increasing agricultural water productivity (USAID 2022: Annex B). The Strategy said USAID/Niger would work with the 3N Commission on food security and nutrition.

Niger was a US Government Feed the Future target country²⁵. Its portfolio was organized around agriculture-driven economic growth and prioritized resilience, poverty alleviation, economic growth, and natural resource management (USAID 2018a). Its food security work integrated humanitarian and development assistance. The Advancing Nutrition Project worked to build capacity to address malnutrition, especially among women and children, until 2023 (USAID 2023a). Resilience in the Sahel-Enhanced II (RISE II) was a regional project managed by USAID's West African Regional Office that formed the core of the food security program (USAID 2018b). The two West African (Sahelian) target countries were Burkina Faso and Niger. RISE II emphasized locally driven development and improving governance and women's empowerment. It elevated water security as an intermediate result. The RISE II program description (USAID 2018b) was very detailed, with considerable analysis behind it. Smith et al. (2023) is a useful baseline survey. Evaluations of the impact of RISE I found that despite increasing incidence and severity of shocks (drought, violence, COVID-19), the project had positive impacts on the resilience of households— though more so in Burkina Faso than Niger (Smith & Frankenberger 2020; Smith et al. 2022).

The Strategy Paper and RISE II documents noted that USAID was complementing the MCC program, for example, by supporting the creation of a National Groundwater Authority²⁶ and the Ministries of Hydrology and Sanitation and Agriculture and Livestock to leverage the extensive renewable aquifers for productive use and drinking water to improve health and hygiene.

USAID and NASA supported SERVIR West Africa, a project led by ICRISAT promoting the use of publicly available satellite imagery and related geospatial tools and products to help stakeholders and decision-makers make informed decisions in four areas: agriculture and food security; water security; weather and climate resilience; and ecosystems and carbon management²⁷. SERVIR was supporting the

²⁵ [Niger | Feed the Future](#) (Accessed 11-6-2024).

²⁶ This was initiated in 2022 under the President's Office but is no longer functioning under the present government. See: [MCC-financed study finds Niger to be most groundwater-rich country in the Sahel region](#) (Accessed 01-12-2025).

²⁷ [West Africa | SERVIR GLOBAL](#) and [About | SERVIR](#) (Accessed 11-8-2024).

development of a suite of geospatial information tools by Brigham Young University to support sustainable groundwater management, especially in southern Niger²⁸.

Because of coups in both target countries, USAID and other bilateral donors had suspended development assistance channeled through the government. Nevertheless, its Bureau for Humanitarian Assistance continued to provide emergency and early recovery, risk reduction, and resilience assistance in Niger, promoting self-reliance and enabling households to cope with recurrent shocks²⁹.

Finally, the USAID Bureau for Resilience and Food Security in DC and the USAID Mission in Niger supported research in Niger through investments in Feed the Future Innovation Labs led by U.S. universities in partnership with Nigerien universities and in some cases, public agencies and NGOs. The number of Innovation Labs and the amount of funds varied annually. Four Innovation Labs received support from the USAID Mission in Niger for fiscal year 2024 to conduct targeted research into key agricultural areas of interest to the Mission: Irrigation and Mechanization Systems (led by the University of Nebraska), Horticulture (led by the University of California, Davis), Livestock Systems (led by the University of Florida) and Current and Emerging Threats to Crops (led by Pennsylvania State University).

Millennium Challenge Corporation (MCC)

Around 2010, Niger became eligible for MCC support. MCC's early analyses confirmed that access to water for agriculture and livestock is a "binding constraint" to economic growth (MCC 2014); government business regulation and institutional barriers to trade were also identified (MCC 2023). It then commissioned this author to carry out a desk-based analysis of the opportunities for improving access to water for agriculture, livestock, and people in Niger (Merrey & Sally 2014). MCC drew on this report to design its investment program, though it did not follow our most emphatic recommendation. In 2016, the MCC Board approved the \$437 million Niger Sustainable Water and Agriculture Compact. It came into effect in 2018 and aimed to strengthen the agricultural sector by investing in water availability, roads, and market access. MCC's funding is entirely grant funding but must be spent within five years; no extensions are allowed.

MCC made ambitious assumptions about the potential of its irrigation and market access investments (MCC 2023:8-9). Its Irrigation Perimeter Development Activity invested in:

1. Rehabilitation of the 2,452-ha Konni irrigation system in the Tahoua region, including soil conservation in the catchment
2. In the Dosso region, a plan to construct a 1,754-ha system was modified to focus on the development of 173 ha of SSI as a demonstration project
3. Implementation of a national groundwater potential study.

Other sub-activities included work on land tenure issues and irrigation system management, forming and empowering irrigation Water Users' Associations, and strengthening agricultural services. Separate roads for market access, policy reform activities, a climate-resilient communities activity aimed at smallholders and agro-pastoralists, and a pastoralism support activity were also included (MCC 2023).

²⁸ [Sustainable Groundwater in West Africa](#) and [Development and Management of Groundwater Analysis and Information System in Niger | SERVIR GLOBAL](#) (Accessed 11-8-2024).

²⁹ [USAID-BHA Niger Assistance Overview-June 2024.pdf](#) (Accessed 11-8-2024).

In 2019, MCC contracted Radar Technologies International (RTI), in partnership with the University of Nevada Las Vegas, to use remote sensing to map aquifers in southwestern Niger, an area of about 260,000 km². Using RTI's proprietary software ([the WATEX™ System](#)) to analyze satellite data, they identified approximately 50 billion m³ of available groundwater with an estimated annual recharge of two billion m³. This finding qualifies Niger as the most groundwater-rich country in the region (Kim 2023). This is an important finding, but to date, no detailed peer-reviewed paper has been published — Kim (2023) is a blog written by a Congressional intern.

MCC contracted with Mathematica to evaluate the outcomes and impacts of the Compact; however, I was not able to find even interim assessments with one exception: Hoppenjan et al. (2024) report that MCC invested in scaling-up innovative practices in natural resource management, soil, and water conservation, such as half-moon pits to capture rainwater on 70,000 ha. It targeted poor communities living on the edge of the desert. Interim results show that the interventions led to dramatic increases in millet, sorghum, and cowpea yields (though plentiful rainfall may partly explain these gains). Again, this is an MCC blog; there is no independent evaluation (see section 7.1).

As a result of the 2023 coup, MCC was required to close its Compact in January 2024³⁰.

6.2.2 Germany

The German Federal Ministry for Economic Cooperation and Development (BMZ) works primarily through its development agency, the *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) GmbH or GIZ, as well the German Development Bank (KfW).

GIZ

Before the 2023 coup, GIZ was an important supporter of programs to enhance food security including the expansion of irrigated horticulture³¹, and to support the capacity development of the Niger Basin Authority. Germany also supported land restoration and SSI projects³².

Sun4Water, financed by the German Climate and Technology Initiative as a contribution to the joint international initiative Water and Energy for Food (WE4F) is implemented by GIZ in East and West Africa including Niger³³. It promotes solar-powered irrigation systems (SPIS), primarily through capacity development activities and pilot projects. Its partners include Norway, Sweden, and USAID. It has produced a toolbox on SPIS in several languages including English and French³⁴. It consists of modules and tools to help design sustainable SPIS. I could not find any evaluations of the outcomes and impacts of GIZ projects in Niger.

KfW

KfW is supporting the Small-Scale Irrigation and Food Security Program (*Promotion de la Petite Irrigation et de la Sécurité Alimentaire*) to improve access to water for irrigation in the Agadez, Tahoua and Tillabéri regions³⁵. Phase I was completed in 2020³⁶; phase II is underway. Since 2017, inverted sills to

³⁰ [Niger Compact](#) (Accessed 11-7-2024).

³¹ [Supporting farmers with irrigated horticulture - giz.de](#) (Accessed 11-7-2024).

³² [Increasing the economic potential of agriculture | BMZ](#) (Accessed 11-7-2024).

³³ [Sun4Water – Promoting climate friendly, water- and energy efficient solar-powered irrigation systems - giz.de](#) (Accessed 11-7-2024).

³⁴ [Toolbox on SPIS - energypedia](#) (Accessed 11-8-2024).

³⁵ [NIGER: Pisa II program for irrigation in three regions | Afrik 21](#) (Accessed 11-7-2024).

³⁶ [Niger: Conquering hunger and defying climate change | KfW Development Bank](#) (Accessed 11-7-2024).

raise the groundwater level, wells, and small irrigation perimeters, among other things have been constructed.

IN 2015, KfW also supported the five-year Program for Rehabilitating Public Irrigated Perimeters in Niger through the Niger Basin Authority. It targeted the rehabilitation of ten public irrigation schemes with a total area of 2,532 ha, i.e., 25% of the national rehabilitation program planned by the 3N Initiative³⁷.

I could find no information on the results or lessons learned from these projects.

6.2.3 France

The [French Development Agency](#) (AFD) has been supporting Niger for over 65 years but like other donors, has suspended cooperation with the government. I could not find any useful information on specific irrigation or agricultural-related projects. AFD partners with international financial agencies to support the Kandadji Dam project³⁸.

6.3 Other financial supporters

There are a few non-traditional donors supporting irrigation development in Niger, though no information on the results or lessons learned. For example, the Orono Mining Company initiated the Irhazer agro-pastoral project in the desert areas of the Agadez Region in 2011³⁹. It is developing irrigation systems and supporting improved livestock management. By 2021, it had developed several hundred hectares of irrigation, but the sources do not provide much detail.

In April 2024, the Government of Niger launched the “Large-Scale Irrigation Development Program”, apparently funded from the national budget. It aims to develop 21,200 hectares by 2027. ONAHA, the implementing agency, will also rehabilitate 3,700 ha of existing irrigation⁴⁰. It is too early to assess the results.

7. Synthesis of Key Lessons from Past Experiences

This section draws on academic studies and available donors’ reports focusing on performance assessments. It is organized based on the three types of irrigation described in section 4 that offer the most promising investment opportunities.

7.1 Large- and medium-scale irrigation schemes

The experience with large-scale government-built and managed irrigation schemes in sub-Saharan Africa has been disappointing, with a few exceptions such as the Mwea Scheme in Kenya (Kikuchi et al. 2020). A recent survey of 79 such schemes found “overwhelming evidence” of poor performance no matter how it is measured, and no evidence of improvement over time (Higginbottom et al. 2021; see also Bjornlund et al. 2020; Inocencio et al. 2007). Higginbottom et al. attribute this to an emphasis on low-value crops, reducing the schemes’ economic viability; unrealistically large projects; and the limitations

³⁷ [PROGRAMME FOR REHABILITATING PUBLIC IRRIGATED PERIMETERS \(PRPIP\) IN NIGER REPUBLIC](#) (Accessed 11-7-2024).

³⁸ [Niger secures \\$80 mln from donors to advance dam project | Reuters](#) (Accessed 11-7-2024).

³⁹ [v1 it niger irhazer en.pdf; irhazer va.pdf](#) (Accessed 11-7-2024).

⁴⁰ [NIGER: a programme to irrigate 21,200 hectares of land by 2027 - AgriFocus Africa](#) (Accessed 11-7-2024).

of centralized government irrigation agencies. A related systematic assessment of West African irrigation investment performance comes to the same conclusions: 47 assessments of 147 schemes, including a few in Niger, found that 83% were underperforming (Redicker et al. 2022).

These findings on the disappointing performance of large- and medium-scale irrigation are replicated in studies carried out in Niger. In the 1990s, studies by IWMI and others found that the long-term sustainability of the mainly pump-based rice schemes constructed by ONAHA with the support of the World Bank and others was threatened. They identified management and organizational deficiencies at government and farmer levels and deferred maintenance (leading to the “build-operate-rehabilitate-operate-rehabilitate” cycle). The inability to generate sufficient resources for repair and renewal was cited as the most serious challenge (Abernethy et al. 1999; 2000). This is because of growing a low-value crop, rice, on pump schemes with high operating costs. Rice is not sufficiently profitable when grown in a high-cost irrigation system. Fifteen years later, a follow-up study found little had changed and noted the urgent need to rehabilitate large-scale schemes (Sally et al., eds. 2012; see also Merrey & Sally 2017). An additional constraint is that construction costs for large-scale schemes in sub-Saharan Africa, and specifically in Niger, are very high (Inocencio et al. 2007).

Over the past fifteen years, the emphasis has shifted to reforming the government irrigation sector. ONAHA was tasked with promoting the formation of Associations of Irrigation Water Users to manage water, reforming farmer cooperatives for marketing and agricultural support services, and strengthening their capacities. Several donors, including the World Bank, AfDB, BOAD, and MCC, have supported this. Three recent papers analyze the performance of the Konni Hydro-Agricultural Development, the site of MCC’s rehabilitation project, described briefly in section 6.2 (Abdoulkarimou & Mahamadou 2023a, 2023b, 2024). The scheme faces serious and increasing water shortages, especially in the dry season, forcing a reduction in the area irrigated. The main crops grown are onions, tomatoes, cabbage, corn, and sorghum, but yields and profitability are limited by multiple constraints. These include infrastructure degradation, the small size of irrigated holdings (0.375 ha), lack of access to quality inputs and other marketing constraints, household consumption of much of the crop produced, and financing limitations (Abdoulkarimou & Mahamadou 2023b). Abdoulkarimou & Mahamadou (2023a) found the training programs accompanying the organizational reform, especially the training for farmers, fall short of what is required to enable them to operate the water users’ associations and cooperatives effectively. Nevertheless, the participatory approach since 2020 has resulted in the development of relatively effective, functioning water users’ associations (Abdoulkarimou & Mahamadou 2024).

Even with all the challenges that have characterized investments in large-scale irrigation, the Government of Niger and many of its financial partners continue to invest. They are attracted by the huge potential, especially in the Niger River Basin (van der Wijngaart 2019). The successful completion of the Kandadji Dam and its associated infrastructure could substantially improve the country’s food security and economy. The recognized potential benefit of irrigation is the main motivation behind the World Bank-supported Sahel Irrigation Initiative Support Project, discussed in section 6.1. That project remains a work in (slow) progress, with some research raising questions about its social and environmental impacts (e.g., Ferrini et al. 2021; Maiga et al. 2022).

7.2 Climate-smart agriculture (CSA)

As described in section 4.2, land degradation caused by deforestation, expansion of cultivation, and over-use and mismanagement of land, exacerbated by low and uncertain rainfall, droughts, and floods, is a major challenge in the Sahel. Adapting to climate change is increasingly challenging for smallholder farmers (Zakari et al. 2022). Satellite assessments of changes in land use and cover found some 6.12 million hectares experienced change, of which shrublands and grassland accounted for the largest area.

Cropland expansion accounted for 57% of deforestation, followed by grassland expansion. In 2007 US dollars, the cost was estimated to be \$750 million, i.e., 11% of GDP. Investment in land restoration was estimated to provide a return of 6 to 1 (Moussa et al. 2016).

Niger and Burkina Faso offer relatively successful case studies in the adoption of CSA/SLWM practices and investments in FMNR. This is largely a result of institutional changes beginning in the 1990s that incentivized and rewarded the adoption of land restoration practices, combined with work by NGOs and international donors' support (including USAID). For example, communities could now own and benefit from trees (Moussa et al. 2016; Reiji et al. 2009; Sendzimer et al. 2011). A growing range of CSA technologies are being implemented. Most of these focus on water capture and retention such as contour stone bunds, water spreading bunds and weirs, planting pits (*zai*), and half-moons, complemented by agroforestry, soil fertility management systems, and farmer-managed natural regeneration (CIAT et al. 2020; Moussa & Tougiani 2020; Hassane & Reij 2020). Improving water retention and soil fertility has been a central focus in maintaining or increasing yields in degraded land. Adoption of some practices, especially *zai* pits, half-moons, and FMNR, has been widespread; Moussa & Toughiani (2020) describe the range of interventions used.

Many of these techniques demonstrate clear benefits (e.g., Reiji et al. 2009; Hassane & Reij 2020). Mishra et al. (2023) used Landsat 7 satellite data to analyze the effectiveness of the construction of water and soil retention structures called half-moons in 18 sites in southern Niger under a WFP program funded by USAID's Bureau for Humanitarian Assistance. They found that the vegetation greenness after the intervention was nearly 50% higher than in pre-intervention years and more than 25% greener than in control areas. They concluded that half-moons are an effective intervention to increase agricultural production in arid ecosystems. Another evaluation found that adapting to climate change using CSA adaptation strategies improves household income and food security (Zakari et al. 2023). A meta-analysis of 143 studies in Burkina Faso also found that adopting soil and water conservation practices had substantial benefits (Nyamekye et al. 2018).

Natural regeneration programs have also demonstrated significant impacts on production and poverty. Over five million hectares of land have been restored, producing substantial financial benefits and an estimated additional 500,000 tons of cereals a year plus fodder for livestock (Reiji et al. 2009; Pye-Smith 2013; Dinesh et al. 2015; CIAT et al. 2020). Dinesh et al. (2015) summarize the following benefits (as of about 2009): increased food and fodder production, livestock more productive (and producing more manure which is used for fertilizer), increased income from the sale of tree products, more firewood, and increased resilience. Community groups have enhanced social capital, and women have benefitted even more than men. The benefit-cost ratio is very high. However, adoption levels are affected by farmers' limited technical knowledge, high labor requirements, an unfavorable policy environment, and lack of access to inputs such as drought-resistant crop varieties (CIAT et al. 2020; Dinesh et al. 2015).

Francis et al. (2015), in a review of evaluations of FMNR, found that since its inception in Niger in 1983, it had spread to five million hectares (50% of the farmland). They list 24 social, environmental, and economic benefits. However, they note that there are significant gaps in the research, for example, formal impact evaluations, standardized measurements of impacts, and no systematic research strategy to support or strengthen programs.

A more recent Oxfam Case Study also offers a positive review of the evidence on the impacts of FMNR (Magreth 2020). The Government of Niger has made an ambitious pledge to restore 3.2m hectares of degraded land by 2030 (266,000 hectares per year). Regreening Africa claims five million hectares have

been restored in the Maradi and Zinder regions. World Vision, with Care International and ICRAF, is leading a restoration project to improve 40,000 ha⁴¹.

Hassane & Reij (2020) assess the long-term impact of a soil and water conservation project implemented in the Tahoua region from 1988 to 1995. Funded by IFAD, it promoted easily replicable water harvesting technologies such as *zaï* planting pits and half-moon catchments. They report dramatic results, a barren plateau covered with trees and producing a surplus of vegetables for sale. Groundwater has risen about 14 meters, and a land market has been created. Farmers continued to adapt the new technologies after the project was completed.

FMNR and other agroecological initiatives have influenced the “Great Green Wall Initiative⁴²” being implemented by all the Sahelian governments. The African Union-supported Pan-African Agency of the Great Green Wall leads and coordinates the program among 11 countries. Donors committed to provide \$19.5 billion to support the program 2021-2025 (UNCCD 2023). The World Bank, UNCCD, Green Climate Fund, IFAD, AFD, and the Sahel Alliance have pledged support (World Bank 2022). Magreth (2020) suggests that it has evolved from a massive government tree-planting scheme to something more community-driven and adapted to the varied local contexts.

An evaluation of the socio-economic impacts on households in Niger, Nigeria, and Senegal between 2016 and 2020 found significant improvements in income and food security, confirming that the program is increasing vegetation cover while improving livelihoods (Sacande et al. 2021). On the other hand, another evaluation found that while numerical targets were often achieved, a rapid appraisal of nine sites in Niger found that there was little attention paid to the needs of the most vulnerable; some, like women whose husbands were absent, were excluded and pastoralists were ignored. Some activities led to the enclosure of reclaimed land, benefiting powerful people (Turner et al. 2021). Singbo et al. (2023) also found that bio-reclamation of degraded land did not benefit all women and recommended such projects should target locations with large percentages of degraded farmlands and the poorest farmers. Smith & Frankenberger (2020) found that RISE II interventions enhanced resilience to shocks in Burkina Faso but not Niger, raising questions about actual impacts and sustainability.

In conclusion, the secret to success in all these programs is full community engagement: in such areas, SLWM and FMNR practices spread spontaneously. Second, there is considerable hype regarding the impacts of SLWM practices, especially FMNR; the latter has been described as “*the greatest agroecological success story in Africa, and perhaps anywhere*” (Reiji et al. 2009). Definitive socio-economic assessments of these programs and their sustainability have yet to be completed. I hypothesize that large donor-funded programs face more challenges in terms of social impacts and sustainability than smaller NGO-driven programs.

7.3 Small-scale irrigation (SSI)

There are no strict boundaries among the SSI categories described in the literature and official documents; indeed, there seems to be considerable overlap. The schemes referred to as “off-season schemes” include those supported by the government and NGOs, and others that developed without outside assistance. “Private” SSI refers to individualized irrigation technologies owned by one farmer or a small group of farmers. Some have received government, donor, or NGO support (e.g., under PIP2);

⁴¹ [Niger | Regreening Africa](#) (Accessed 11-8-2024).

⁴² [Great Green Wall Initiative | UNCCD](#) (Accessed 11-8-2024).

others are due to farmers' initiatives – true “farmer-led” irrigation. I discuss irrigated “market gardens” as a subtype of SSI because they are the focus of a separate literature. I also discuss solar irrigation separately for the same reason and because it has great promise. Much of the irrigation in this category is used to grow dry-season vegetables, i.e., they are “off-season” schemes; but a substantial portion irrigates in both seasons. Although off-season schemes account for about half of all irrigation in Niger (see section 4.2), I was not able to find any specific assessments of their performance, even in French. However, some of the literature on SSI performance may include schemes falling under this category. Many off-season schemes depend on capturing rain run-off from watersheds, but most SSIs depend on groundwater.

Farmer-led irrigation is not new to Niger. Kalidou et al. (2024a) report on how indigenous knowledge drives the widespread use of small-scale irrigation in a rural community in southwest Niger. In most cases, the area irrigated is small and dependent on basic technologies. Despite the long history of promoting SSI in Niger, I was not able to find any systematic assessments of performance or sustainability. Most available studies are positive assessments of performance (e.g., Abric et al. 2011; Soumaila 2021; Tillie et al. 2018; Olayide et al 2020; Kafle & Balasubramanya 2022; Aboubacar, 2023; Tadesse et al 2024). For example, based on the World Bank's experience with PPIP and PIP2, Abric et al. (2011: xii) conclude that SSI “holds enormous potential for reducing poverty and increasing agricultural productivity in West Africa over the next decade.” However, they highlight the critical importance of strengthening input and output markets, financial support, and infrastructure development. The private sector is critical to success, for which policies need to be supportive.

Three studies (Tillie et al. 2018, 2020; Kafle & Balasubramanya 2022) draw on household and agriculture data from the Living Standards Measurement Study-Integrated Survey of Agriculture (LSMS-ISA). These data were collected in 2011; Kafle & Balasubramanya 2022 also used 2014 data to measure change over time. The studies are useful, but the data are over a decade old. The other studies are also based on modeling the potential irrigable area with SSI and the likely impacts and outcomes (e.g., Olayide et al 2020; Tadesse et al 2024). There are no field-based studies of actual performance and challenges faced. Aboubacar (2023) is a partial exception: the author drew on data collected at various agricultural fairs and available documentation.

Tillie et al. (2018, 2020), based on *ex-ante* simulations, argue that expanding SSI will have significant positive impacts on food security, income, and the area and yield of irrigation; a key insight is that vulnerable farmers who receive their equipment at no cost benefit most, resulting in reduced inequality. Tadesse et al. (2024) integrated biophysical and economic models to estimate the feasibility of treadle pumps, motor pumps, small reservoirs, and communal river diversions (or water diversions). They conclude these have a substantial potential for expansion, potentially reaching up to 4.6 million rural people. This would boost the national economy by about 5.5 trillion CFA⁴³, generate an agricultural value-add of about 4.0 trillion CFA, and reduce the number of the poor by about 648,612 people. The most feasible areas for expanding SSI are in western Niger.

On the other hand, Olayide et al. (2020) are less optimistic: their modeling study suggests SSI may be economically and environmentally viable in just a few areas with sufficient groundwater and good market access. Kafle & Balasubramanya (2022) arrived at the opposite conclusion. Using the 2011 and 2014 LSMS-ISA panel data, they found that access to irrigation is associated with reduced food insecurity even where formal markets are absent. Food insecurity decreased by 10%, food consumption increased by 9% and dietary diversity improved. Using irrigation led to more produce being sold and higher cash incomes, even for farmers selling in local informal markets.

⁴³ Approximately 8.5 million USD.

These studies are useful and suggestive. However, as with CSA, definitive socio-economic assessments of the performance, impacts, and sustainability of SSI are needed.

Market gardens

Market gardens are not new; irrigated horticultural cultivation is a major farmer-driven livelihood strategy for millions of farmers. They use traditional crop production and irrigation methods, such as buckets and watering cans, and are a critical source of food supply to cities and towns. Several studies of market gardens in Niger have found that they significantly enhance farmers' income and food security (e.g., Kalidou et al. 2024; Rabo et al. 2024). Nevertheless, market gardeners face many challenges, including water scarcity, land insecurity, market challenges, and lack of access to credit. Rabo et al. (2024) also suggest farmers need technical support to increase production and profits.

In the early 2000s, ICRISAT and its partners began experimenting with ways to intensify production and increase the profitability of market gardens. This work was largely done in ICRISAT's facility in Niamey. The result was the development of the "African Market Garden" (AMG). It consists of four components: 1) drip irrigation, 2) a water reservoir, 3) an integrated crop, nutrient, and water operation and management package, and 4) high-quality adapted vegetable varieties (Pasternak et al. 2006; Woltering et al. 2011a, 2011b). They developed four AMG models to suit different needs, from larger community-managed systems to small low-cost systems. Woltering et al. (2011a) describe the technology; Woltering et al. (2011b) assessed the economics of AMG. Experiments at the Niamey site demonstrated that, compared to traditional market gardens, productivity was higher, labor costs lower, and profits substantially higher – all at a lower environmental cost (Woltering et al. 2011b). Unfortunately, I could find no evidence that AMGs have significantly expanded in Niger.

Burney et al. (2010, 2018) evaluated a renewable-energy modification of AMGs, "solar market gardens" designed for women's groups in Benin. These include a solar photovoltaic water pump, conventional gravity-fed drip irrigation, and training and technical support. Their 2010 study showed solar-powered drip irrigation increased incomes and nutritional status, especially in the dry season, and was cost-effective compared to other technologies. Their 2018 study showed that the most productive groups used the system only in the dry season and the system would be profitable even with full cost recovery. Lower-performing groups would not recover costs. They suggest several possible scaling models and financing mechanisms. Solar-powered AMGs appear to have considerable potential.

Solar irrigation pumps

Off-grid solar-powered irrigation pumps are revolutionizing smallholder agriculture throughout Asia and sub-Saharan Africa. Their relatively high capital costs are declining rapidly because of technical innovations, increasing scale, and growing competition as governments, NGOs, and private firms enter the market. Their near-zero operational costs and reliable energy source make them more attractive than diesel- or gasoline-powered pumps (e.g., Shah et al. 2020; Xie et al. 2021; Falchetta et al. 2023; Lefore et al. 2021; Birhanu et al. 2023). Under most circumstances, they are more cost-effective than diesel pumps (Xie et al. 2021). They are not "silver bullets": Durga et al. (2024) identify many barriers to their uptake in SSA, most of which apply to Niger, and recommend a systems approach to designing context-specific solutions for incentive, capacity, and other challenges. Three studies of the technical and economic feasibility of solar irrigation in Niger found it to be more beneficial, even measured using different criteria, than diesel- or gasoline-powered pumps (Bhandari et al. 2021; Naroua et al. 2022; Imadan et al. 2024).

There have been several solar irrigation pump projects in Niger, many of them described in blogs claiming positive results. IDA funded the Niger Solar Energy Access Project, which included

the development of the solar irrigation market (IDA 2017). The project included consumer education on solar energy, and the provision of credit to solar system importers, wholesalers, retailers, installers, and service providers. The success of this project led to an even larger one, the \$800 million Niger Accelerating Electricity Access, a 10-year program approved in 2021 that focuses on providing a range of solar-powered systems including for irrigation⁴⁴.

Another project, the Niger Irrigation Program, is a small pilot project to test solar-powered drip irrigation systems in Tillabéri and Dosso, funded by the International Finance Corporation (IFC), Climate Investment Funds, and Netafim, a global micro-irrigation firm⁴⁵. Netafim installs drip irrigation systems that vary in size from 250 to 2,500 square meters⁴⁶. It used its local supplier, [Agrimex](#), to obtain the drip irrigation kits and Talibus, a local engineering company, to distribute and install the solar pumps. Netafim supported the creation of [Nirritech](#) to train local people as Community Field Agents who provided continuous technical support to those purchasing a system.

The project documents claim considerable success in demonstrating the feasibility of a private sector-driven approach to building Nigerien farmers' resilience to climate change. But this pilot was on a small scale (45 ha irrigated by 2020, 883 farmers trained including 461 women) and dependent on a multinational firm ([Netafim](#)). (IFC (2023) claims 60% of the farmers purchasing the system were women (see also IFAD & IFC 2022: Case Study 2). Other small pilot projects are experimenting with solar irrigation which may prove sources of lessons⁴⁷. The abundance of groundwater, especially in southern Niger means the risk of overexploitation of groundwater through solar pump development is low (Zuffinetti & Meunier 2024).

7.4 Gender

Section 3 noted that Niger's Gender Development Index score is very low (189th). Although official policies promote achieving greater equality between men and women (Adisa 2020; Issoufou et al. 2020), there is little evidence of change; Issoufou et al. (2020, based on research in Maradi and Zinder regions, argue that population growth and climate change may be worsening the position of women vis-à-vis access to land, an observation confirmed by detailed field work (Doka & Monimart 2004). There are two forms of land tenure: *gandou* are collective fields cultivated by the household under the supervision of the male household head. *Gamana* are individual plots cultivated by specific members of the household. Women work in both types of land but traditionally had access to a gamana plot they controlled. However, as land becomes scarcer, women lose access to gamana land or are given land whose quality is marginal (Doka & Monimart 2004; Issoufou et al. 2020). These restrictions on land access, combined with others based on tradition and religion, have significant impacts on the potential to provide women access to irrigation.

Surprisingly, although many NGOs and donors have promoted interventions to provide women with more income-generating opportunities, there are few studies of these cases, as noted by Adisa

⁴⁴ [Solar energy brings water to Niger's farms](#) (Accessed 11-03-2024).

⁴⁵ [Niger Irrigation Program | Climate Investment Funds](#) (Accessed 11-8-2024).

⁴⁶ [In Niger, drip-irrigation helps farmers battle climate induced water woes](#) (Accessed 11-8-2024).

⁴⁷ Examples are [Pilot project for solar irrigation in Niger | CAPOSOL : Innovative off-grid power systems](#); [NIGER: Startup company launches solar-powered remote irrigation system | Afrik 21](#); and [Food Security and Women Empowerment Through Solar-Powered Irrigation in Niger - Water and Energy for Food Grand Challenge](#) (all accessed 11-03-2024).

(2020). Adisa (2020) is a case study of a “Dimitra community listeners’ club” (DC) in Niger. This is a strategy used by FAO and others to promote communication and amplify women’s voices through dialogues among women and men. The purpose of DCs is to bring people together to discuss shared challenges and collective solutions to help improve their livelihoods. Based on a literature review and personal experience, Adisa (2020) suggests that DCs could increase women’s participation in developing modern solar irrigated systems, among other things.

Several pilot projects focus specifically on providing women with access to solar irrigation. For example, a Water and Energy for Food project is working with a cooperative of 180 women with access to two hectares to develop a solar-powered irrigation system. This project is ongoing; the irrigation system has yet to be installed⁴⁸. The Niger Irrigation Program, discussed in section 7.3, is another example (IFC 2023).

7.5 Synthesis of key lessons

Most Nigeriens depend on rainfed agriculture or raising livestock for their livelihoods. But even where the average annual rainfall seems sufficient, its unreliability makes agriculture a highly risky enterprise. This discourages investments to enhance productivity, resulting in more poverty, food insecurity, and malnutrition. Improving agricultural water management is a necessary though not sufficient requirement to enable rural people to prosper. Niger is pursuing several pathways to improving water availability and use in agriculture.

7.5.1 Large-scale irrigation

Historically, the largest investments have been made in *large-scale irrigation schemes*, built and managed by the government through ONAHA. Since the mid-1980s, there has been a strong emphasis on implementing management and marketing reforms to increase the productivity of these schemes. Despite these efforts, large-scale schemes still face critical challenges, including financing operations and maintenance and enhancing farmers’ profitability. Many interventions intended to improve scheme performance fail because they focus on one or two specific symptoms and fail to understand that irrigation is a complex system and requires a systems approach to be successful (Pittock et al. 2018; Smith et al. 2024). There is a need for in-depth interdisciplinary research to identify ways to achieve the full potential of these schemes. Programs to support the government to achieve such improvements require long-term, patient engagement: there are no quick solutions.

7.5.2 Climate-smart agriculture

Based on the studies reviewed, the experience with *CSA/SLWM/FMNR interventions* has been very positive. These interventions are relatively low-cost. Successful cases are driven by local communities. The available evidence suggests positive results such as increased productivity, improved nutrition and food security, and the sustainability of the interventions. However, it is notable that some of the proponents make extravagant claims, and many of the impact studies have been done by the proponents. As discussed in section 4.1, there is also good evidence that growing conflict-induced insecurity is undermining progress in some areas. For example, in northern Niger, a major surge in

⁴⁸ [Food Security and Women Empowerment Through Solar-Powered Irrigation in Niger - Water and Energy for Food Grand Challenge](#) (accessed 11-03-2024).

insecurity has reversed gains made in land restoration under the [Regreening Africa program](#) (Singbo et al. 2020).

There is a need for more detailed well-designed assessments of their overall impacts, equity outcomes, and sustainability, accompanied by in-depth analyses of the most effective technologies and implementation strategies. A note of caution is also in order: these interventions, by themselves, may not provide effective protection against increasingly severe heat and droughts.

7.5.3 Small-scale irrigation

Over the past 15 years, the government, NGOs, and donors have invested significantly *in small-scale irrigation*. These programs have included subsidized access to technologies such as pumps and drip irrigation kits, attempts to support the development of a competitive market to make irrigation technologies available at more affordable costs, and providing training to both service providers and farmers. Somewhat separate from these initiatives, farmers themselves have invested in various small-scale irrigation technologies for market gardens and other crops. Much of this private irrigation depends on groundwater, which is abundant in many parts of southern Niger. The availability of solar-powered pumps is growing, and costs are declining, but they are still out of reach for most farmers. Solar irrigation holds considerable promise for the future. Despite all this investment, there are very few quality research studies analyzing their costs, benefits, and impacts, identifying how the irrigation technology market works, and how to support poor farmers to gain access to and benefit from SSI.

7.5.4 Social equality and inclusion

A major issue on which there is too little research is the impact of all these interventions on *social and economic equality and inclusion*. There is evidence that some interventions are leading to greater inequality and exclusion of poorer people, minority ethnic groups, pastoralists, and women. In some cases, this is driven by increasing pressure on land resources, leading to women losing access to land they previously used to support themselves. Some land improvement projects may exclude women and others such as pastoralists, exacerbating inequality. This is an area that needs a lot more attention from researchers.

7.5.5 Wastewater reuse for irrigation

I found only one study of *wastewater reuse for irrigation* outside Niamey, focused on risk factors of microbial contamination of vegetables grown in market gardens (Alio et al. 2024). This type of irrigation is expanding in other parts of Africa and Asia, where there are programs to make it safer and more sustainable (Drechsel et al. 2022). Rapid appraisal studies to document the status of this form of irrigation, the challenges it faces, and the potential opportunities for intervention would be useful.

8. Priority Agricultural Water Management Research Questions and Potential Partners

The previous sections of this report provide a basis for answering the questions guiding this study. These questions are:

1. What are the most pressing research questions as they relate to irrigation and mechanization in Niger, and which international partners could be engaged meaningfully?
2. What are the most promising directions for the sector, particularly regarding the intersection between small-scale irrigating farmers and the larger irrigation command areas?
3. What institutions in Niger could be possible research partners?
4. What important factors outside these terms of reference should still be considered when refining a research strategy?

This section is organized around these four questions. I have not tried to prioritize the research topics or make specific recommendations; much will depend on collaborators' interests.

8.1 Agricultural water management research questions

Given its critical importance, agricultural water management including irrigation is relatively understudied in Niger. Strengthening research capacity and producing quality, targeted research results could lay the foundation for more effective agricultural development. This section offers options to consider as research and development organizations develop strategies for Niger.

8.1.1 Large-scale irrigation

The performance of large-scale irrigation schemes in Niger raises many questions for research. USAID and MCC may wish to build on the investments already made in the Konni irrigation scheme, discussed in sections 6.2 and 7.1. It faces serious challenges such as water scarcity, infrastructure sustainability, watershed degradation, and farmer profitability. The papers by Abdoukarimou & Mahamadou (2023a, 2023b, 2024) raise many questions about the design of the scheme, its sustainability, and whether farmers with such tiny holdings can prosper based on irrigated agriculture. The problem for research institutions and other bilateral donors is that large schemes such as Konni are heavily dominated by state agencies. Working with them may involve some risks and potential restrictions; but they could consider collaborating with Nigerien partners to implement an interdisciplinary agnostic analysis of the issues affecting large schemes and use the results to propose a strategy for addressing them, supported by further in-depth research.

8.1.2 Climate-smart agriculture

Most of the work on climate-smart agriculture (CSA), sustainable land and water management (SLWM), and farmer-managed natural regeneration (FMNR) reports positive, sometimes even dramatic, results. However, Francis et al. (2015) note significant research gaps: the lack of formal impact evaluations, standardized measurements of impacts, and systematic research strategies to support or strengthen programs. Two studies (Turner et al. 2021; Singbo et al. 2023) raised questions about who benefits from these programs. Too little attention is paid to the needs of the poorest and most vulnerable people including women. There is also insufficient information on which interventions are most appropriate for specific eco-agricultural systems. Section 4.1 suggested reliable weather predictions could encourage profit-maximizing inputs (Wouterse & Odjo 2021). Making such predictions available on time could be explored with AGRHYMET and the SERVIR Project. In 2023, there were 14.6 million cell phones in Niger; internet penetration was around 22%⁴⁹. Most of these people are likely living in urban areas. Therefore, reaching rural people with timely weather reports would be a challenge; but a start could be made.

Research questions could include:

⁴⁹ [Digital 2023: Niger — DataReportal – Global Digital Insights](#) (Accessed 11-8-2024).

1. Using with and without interventions, and before and after interventions analysis, what are the social, economic, and environmental impacts of CSA/SLWM/FMNR interventions, and how sustainable are they?
2. What circumstances increase the likelihood of sustainability of the interventions?
3. What impacts do land tenure practices have on the outcomes of these interventions? How can impediments be reduced?
4. What types of programs, e.g. large donor- or government-funded projects versus small NGO projects, are most effective and sustainable?
5. How have women, pastoralists, and minority communities benefited and what actions could increase their benefits?
6. Which packages of CSA interventions are most effective in specific zones?
7. How can affordable, timely, reliable weather forecasts be made available to farmers? If they are available, will farmers use this information to adapt their strategies?
8. What further research is needed to strengthen and improve these interventions?
9. On the assumption that cellphone use and internet access will grow over time, what kinds of options can be considered for providing timely weather reports and agronomic advice, as is being implemented in other African countries (see Rose et al. 2023; CIMMYT 2024)?

8.1.3 Small-scale irrigation

Promoting small-scale irrigation (SSI) is a potentially transformative strategy to increase food production, reduce food insecurity and malnutrition, promote economic growth, and enable farmers to adapt effectively to the ravages of climate change. However, there are many questions regarding implementation strategies, including those related to targeting women and poor people, market development, social and economic impacts, and environmental impacts. Examples of research questions include:

1. Which implementation strategies most effectively promote affordable, sustainable SSI? Are donor- and government-supported programs using subsidies and technical support most cost-effective? Or would focusing on developing value chains based on private firms be more effective and sustainable?
2. How can affordable crop insurance, credit systems, and measures to spread capital cost payments (such as rent-to-purchase) be developed and scaled out?
3. How can the costs of SSI technologies, including drilling wells, pumps, and water distribution and application technologies be minimized while maintaining quality?
4. What are the most effective ways to target access to SSI technologies to women and relatively poor farmers? How does the land tenure system affect women's ability to obtain and use SSI technologies and how can impediments be overcome?
5. What are the longer-term impacts of SSI technologies on household income and food security, economic growth, employment, social, including gender, equality within and between households, and the environment (e.g., groundwater levels)?

6. How will the expansion of solar-powered irrigation pumps affect the productivity, profitability, and sustainability of irrigated agriculture? What are the most effective ways to scale out solar irrigation and what will be the benefits and costs?
7. How profitable and effective are irrigated market gardens? How can they be made more productive and sustainable? Where wastewater is used for irrigation, how can it be done safely while controlling costs? Has the African Market Garden (including using solar pumps) model been replicated? If not, why not?

8.1.4 Groundwater sustainability

Related to SSI, there are still some questions about the sustainable use of groundwater. Aquifers vary considerably from place to place, but MCC's and other studies suggest groundwater is abundant in southern Niger and can be sustainably tapped. Groundwater is used for multiple purposes, not only agriculture. We understand that IWMI is about to implement the "Agroeconomic/Groundwater Optimization Study and Recommendations for the Sustainable Use of Aquifers for the Republic of the Niger" study. Possible questions include:

1. How can research institutions or others collaborate to address research questions not directly included in that study?
2. In areas with less productive aquifers, how can communities be assisted to use them productively and sustainably?

8.1.5 Gender and social inclusion

This report has frequently raised questions related to gender and, more broadly, social equity. Although addressing this topic can be integrated with other topics discussed above, it is important to raise the profile of this issue. There are signs that inequality and disempowerment are increasing along multiple dimensions: gender, large versus small farmers, cultivators versus pastoralists, urban versus rural, and among various ethnic groups. Possible research questions not fully specified above include:

1. How do land tenure customs and practices affect the role and status of women in households and communities, including their access to productive assets like irrigation and markets? How do these vary among ethnic groups?
2. What impacts on women are resulting from the introduction of SSI and CSA practices? For example, are women's labor burdens increasing or decreasing? How can introducing these technologies strengthen rather than undermine women's status?
3. Are there lessons and frameworks from other contexts that can be used to improve the targeting of SSI and CSA technologies for women?

8.1.6 Wastewater irrigation and mechanization

There has been little research on wastewater irrigation and mechanization of agriculture in Niger. Irrigation technologies such as pumps and drip kits are examples of mechanization. However, only a moderate portion of land is cultivated with plows, and using planters and harvesting equipment is even rarer. The result is relatively low labor productivity. As noted above, there seem to be almost no studies of the use of wastewater for irrigation, though it is likely to be as widespread as in other countries. Possible research questions include:

1. What is the extent of urban and household wastewater used to irrigate market gardens, where are they located, who are the farmers, what are their water sources, and what are the risks and benefits?
2. How can the use of wastewater for irrigation be made safe for farmers and consumers in a way that is also affordable?
3. What is the potential to enhance the productivity of irrigated agriculture by introducing low-cost mechanization for land preparation, planting, and harvesting of crops? Are there ways to mechanize the construction of planting pits, half-moons, and contour bunds to increase the pace of SLWM development?

8.1.7 National agricultural water management research capacity

Finally, we have noted the paucity of in-depth quality research on agricultural water management in Niger. This suggests a need to strengthen the research capacity of both public and private universities and other agricultural research institutions (see sections 5.2.3 and 8.3). One option could be to offer financial support directly to students to carry out graduate research on topics of interest and provide technical and mentorship support.

8.2 Promising directions for the sector, especially between small- and large-scale irrigation

With the support of international finance institutions, Niger will continue to reform and upgrade existing large-scale irrigation schemes, and in the Niger River Valley, the Kandadji Dam is eventually expected to create some 45,000 additional hectares of irrigation. Bjornlund et al. (2020) persuasively argue that the physical design, institutional arrangements, and lending and financing policies need to be overhauled to recognize that farmers are capable producers and partners in government schemes. Therefore, I suggest that the Government and its supporters should consider more radical interventions than those currently being pursued. For example, the Government should consider creating a market in irrigated land to encourage consolidation and investments by farmers to improve productivity. Also, in designing new systems, and, where feasible, redesigning existing systems, it should consider alternative designs that would enable real decentralization of water control to local user groups and communities. For example, using large supply canals to bring water to decentralized water reservoirs or even farm ponds – “melon-on-the-vine” design—is one option worth exploring (see Cai et al. 2012). In essence, this can combine the advantages of large-scale water works with those of SSI. Finally, the high operating cost of pumps is a major problem in government schemes. Switching to solar pumps could dramatically reduce these costs.

Developing and achieving high productivity levels on large-scale schemes is expensive and takes a lot of time – sometimes decades. SSI has far higher economic returns than large-scale irrigation in Africa (African Union 2020). Encouraging SSI is less costly, implemented more quickly, and has more potential for targeting women or other disadvantaged people. Encouraging and supporting farmers’ initiatives – farmer-led irrigation development – can respond to demand quickly and mobilize considerable local investment. Further, it is a practical way to take advantage of the abundant groundwater available in many areas of the country. However, success requires creating a policy and institutional context that encourages farmers to invest. Minh et al. (2024) synthesize the lessons IWMI, and its partners have learned regarding what is required to encourage productive, sustainable farmer-led irrigation.

Making solar-powered pumps of various sizes easily available and affordable can transform Niger’s agricultural system. Minh & Ofosu (2022) describe a “solar-based irrigation bundle” being implemented

in Ghana. The model combines offering solar-powered irrigation pumps and pay-as-you-go and pay-as-you-own (PAYGO/PAYOWN) financing services to smallholder farmers. This is combined with tailoring their business models to different client segments (ability to pay, frequency, amount) to lower the barrier for upfront investment cost, enabling solar irrigation adoption and enhancing productivity and income throughout the year. Such a program would also need to explore ways to improve the market value chain for the products produced by small farmers.

8.3 Potential partners in Niger

Section 5.2 presents information that I was able to gather from internet searches on possible research and development partners in Niger. An important constraint is that there are currently limits on bilateral funding being used to support government institutions, and most universities and agricultural research institutions fall under this category. Some universities seem to be private; if this is confirmed, they are possible partners. Many NGOs are working in Niger; some of these are also potential partners. There is little information online regarding private Nigerien consulting firms, but they undoubtedly exist; there are also companies involved in the agricultural water management value chain that may be potential partners for work on markets. For example, NETAFIM works with [Agrimex](#), Talibus Engineering, and [Nirritech](#) to support the marketing of solar irrigation pumps. The Network of Agricultural Chambers of Niger ([Reseau National des Chambres d'Agriculture du Niger](#)) may be a source of more information on possible partners. Its website has a lot of useful information including documents on Nigerien agriculture including irrigation.

Possible *university partners* are listed in Table 2. It may also be possible to engage individually with faculty from public universities.

OIREN is an organization representing 45 INGOs in Niger (List is at: <https://www.oiren.org/membres/>). Similarly, NGO Base is an organization representing 45 INGOs in Niger (List is at: <https://www.oiren.org/membres/>).

Possible NGO partners include Save the Children-Niger, World Vision International, Plan International-Niger, CARE International, and N-DEV. Table 3 has more details. A possible strategy could be to collaborate with NGOs supported by USAID's Bureau of Humanitarian Assistance to complement interventions aimed at alleviating hunger and malnutrition with interventions aimed at enhancing people's longer-term adaptive capacity⁵⁰.

I have identified three *international or regional institutions* which are potential partners (see section 5.2.3 for more details). They are:

The [ICRISAT Sahelian Center](#) (ISC) has a campus outside Niamey. It is an international organization.

[CILSS](#) is a regional institution that invests in research for food and nutritional security and to fight the effects of climate change in the Sahel and West Africa. It is a technical arm of ECOWAS, it also operates a regional training center in Niamey for agronomists and weather specialists, [AGRHYMET](#). It is an arm of ECOWAS, from which Niger plans to withdraw; however, it may be an appropriate partner.

⁵⁰ A CGIAR Initiative on Fragility, Conflict and Migration has demonstrated the potential of this approach; see [CGIAR Initiative: Fragility, Conflict and Migration - International Water Management Institute \(IWMI\)](#) (Accessed 11-10-2024).

[CORAF/WECARD](#) is a sub-regional organization whose mandate is to coordinate and facilitate innovative and cutting-edge agricultural research.

This list can be refined and finalized through in-country consultations.

8.4 Other factors to be considered

Two factors will have a significant impact on the kind of work research and other international institutions can do in Niger. One is security: Niger struggles with jihadist violence and other threats, including IS Sahel and the al-Qaeda-affiliated groups in the west and south of the country, bandits, and organized crime networks. The Green Wall, for example, is being affected badly⁵¹. The US State Department advises “Reconsider travel to Niger due to risk of **crime, civil unrest, terrorism, and kidnapping**”⁵². At a minimum, security threats will limit the locations where researchers can do fieldwork.

The other factor is politics. The current rift between the US and other Western governments and the Government of Niger including restrictions on funding and collaboration with government entities may limit the selection of partners. This could also affect non-government institutions’ willingness to collaborate. Delays in getting visas and other clearances can be anticipated.

Nevertheless, the need is great, and the potential for agricultural water and land management and mechanization applied research and capacity development programs to achieve substantial impacts on food security and livelihoods is clear.

⁵¹ [A year after Niger’s coup: corruption, violence and human insecurity. What now? - Transparency International Defence & Security](#) (Accessed 11-6-2024).

⁵² [Niger Travel Advisory](#) (Accessed 11-7-2024).

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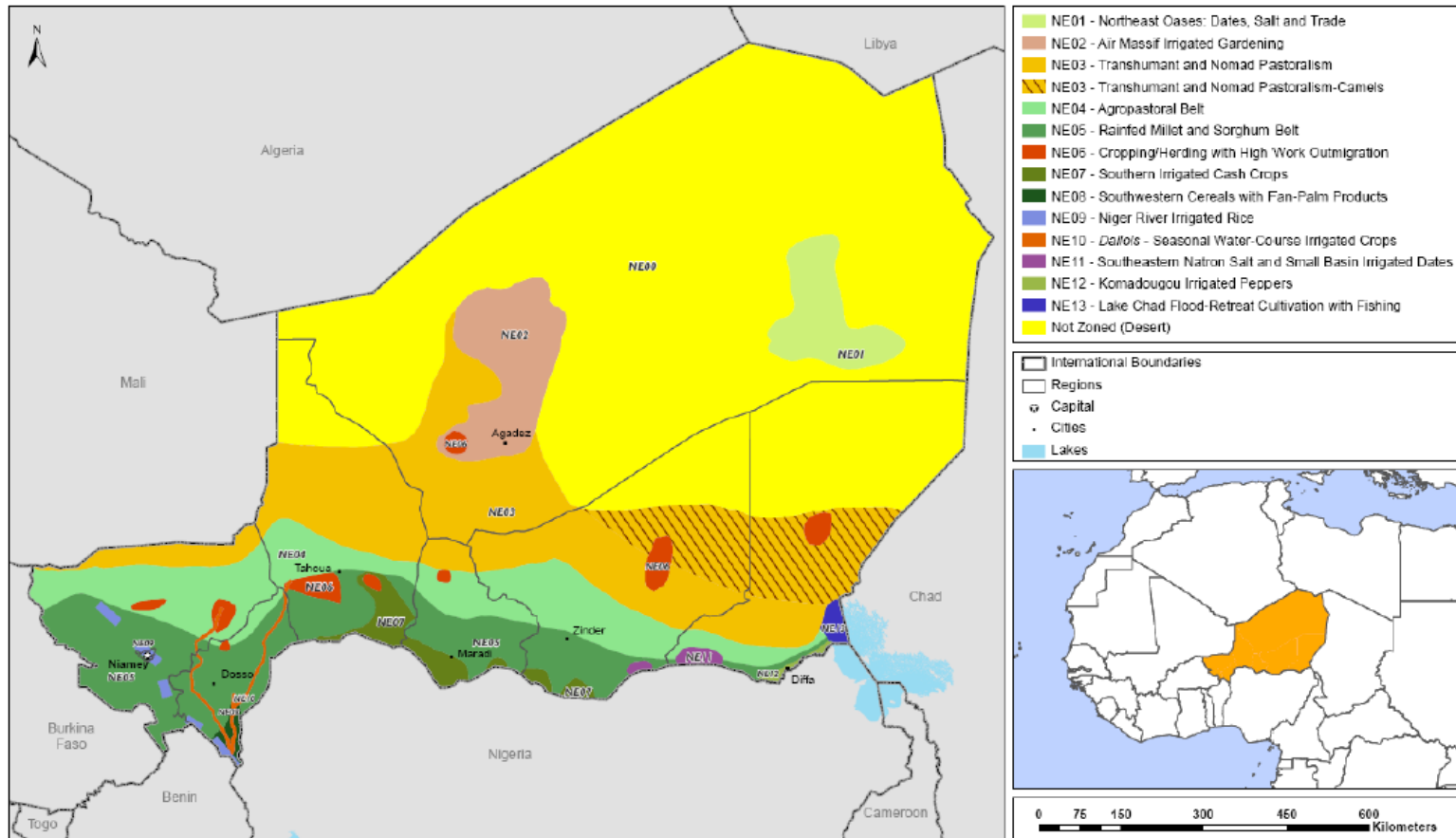
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Annex: National Livelihood Zones in Niger



Source: FEWS NET 2011