Knowledge Systems and Rural Livelihoods: Incorporating Climate Forecasts into Farm Management in Niger, West Africa

By

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Table of Contents

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List of Tables and Figures

Baray, i si a day, i si a kumna, zumandi no.

Knowledge, one doesn't buy it, one doesn't gather it, it is a gift from the sky.

--Zarma proverb

Introduction

Researchers in environmental and social sciences have become interested in the relations of indigenous and scientific knowledge. Though many researchers had believed that the latter were superior to the former, others have begun to explore the multiple dimensions of these two kinds of knowledge and their relations. Niger, West Africa, located in the heart of the Sahel region, provides an appropriate environment in which to consider some of these interactions. Despite poverty and limited rainfall,

subsistence farming is the way of life for the majority of the population. Because farming is their livelihood, Nigeriens are in tune with the weather, especially leading up to and during the rainy season. In addition, farmers monitor variability from year to year in regards to the onset and amount of rainfall. Where and how do they receive their information about the current year? The research examines how indigenous and scientific knowledge intersect and their respective impact on the behavior of farmers in Niger. Traditional and scientific forecasting can be examined in order to show the interplay between the two.

It is in this rural agricultural setting that I sought to explore the nature and value of knowledge. What constitutes knowledge? How is it conveyed, communicated and utilized? In this semi-arid climate what impacts farming most is rain. Knowing when the rain is coming is crucial to the success of the millet crop. Thus, looking at the methods and knowledge about the prediction of rain in both the traditional (village) and scientific settings provided the mechanism for examining different types of knowledge. By extension, access to weather forecasting exemplifies how the intersection of scientific and traditional knowledge impacts farmers and service providers both.

The coming together of two worlds is at the core of what I am examining—the meeting of the traditional and the scientific. I look at bridging different knowledges and languages: in this case, the indigenous knowledge and oral tradition of Zarma and the scientific knowledge

primarily conveyed in French and in writing. For the most part these "worlds" are separate due to the structure of life: you don't find many scientists living out in a rural village. However, development projects aimed at bringing some technology or knowledge to the village is one mechanism for how these two types of knowledge intersect. For example, Peace Corps projects often bring the scientific knowledge behind a particular agricultural practice and try to incorporate this with the lifelong experiential farming of villagers. Some amount of coercion and consent on both sides occurs in both of these realms. Thus, in some sense, I myself represent the intersection of these knowledge bases, especially in this research where I was at times villager and at times UC Davis scientist.

Setting

Niger, located in the heart of the Sahel region of West Africa, provided the setting for my research. Niger is a landlocked country bordered by seven nations: Libya and Algeria to the north, Benin and Nigeria to the south, Chad to the east, and Mali and Burkina Faso to the west. Niger's land area is approximately 1.3 million km^2, yet only 3% of the total country's area is able to be farmed (www.fao.org). Vegetation is mostly scrub brush and trees dot the landscape. Ranked 173rd out of 174 countries on the UNDP's Human Development Index, Niger is one of the poorest countries in the world and sixty three percent of Niger's population lives on less than a dollar a day (World Bank, 2002). The

majority of the population lives in rural areas where they are farmers and pastoralists.

Niger is a former French colony and remnants of its colonial history are evident. The French educational system is still used in Niger and instruction is in French. Not all children attend primary school, and, of the ones who do, only a small percentage continue on in the system. At each level they must pass an exam to advance to the next level. Formal education is not a high priority and thus the majority of the population is illiterate. It is not uncommon for there to only be one or two literate people in a small village. Therefore, Nigeriens who speak French are treated with great respect, for it is a sign of their education.

Climate and Seasons

Niger experiences a hot and dry climate for most of the year. Temperatures can be over 115 degrees Fahrenheit. There are three main seasons in Niger: rainy, cold, and hot. The rainy season (*kaddiya, korsalo*), which begins in May or June and lasts until September, is the most important season for Nigeriens. During this time, storms come and go quickly and are often preceded by a dust storm. A typical rainstorm comes from the east during the night and brings about 10-20mm of rain. The Sahelian zone receives between 250-500mm of rain during the rainy season, depending on the latitude . The majority of the population "lives south of the 300-350mm isohyets, which are regarded as the limit for rainfed agriculture based on pearl millet". The rainy season is a busy time

of year, as it is the farming season and the millet production depends on the rains. After the harvest and the cessation of the rains, the cold weather begins. The cold season (*jaw, hargu*) lasts from three to four months. The harmattan winds blow and a layer of dust seems to always be in the air. Nighttime temperatures can be in the 30s Fahrenheit. During this time many villagers participate in gardening activities, especially if the village has a high water table. The hot season (*haini*) starts in March and lasts until May. Both days and nights are oppressively hot. During this time men who have left in search of work begin to return as field preparation begins.

Agricultural cycle and system

Subsistence farming is the primary livelihood for the majority of the population. The predominant crops are millet *(Pennisetum glaucum*), sorghum *(Sorghum bicolor*), and cowpea *(Vigna unguiculata*) (Gandah et al., 2003) which are all hand cultivated and harvested. In this gender-segregated society, the farming of these staple crops is done primarily by men. Constraints to this rainfed agriculture include poor sandy soils, unpredictable rainfall patterns and access to capital to purchase inputs. Precipitation “can vary considerably even within a few kilometers distance and on different time scales which means that crop yields are very unpredictable”. Citing Goutorbe et al. 1997, Graef and Haigis (2001) state that “The erratic rainfall dispersion is caused by irregular movements of weather systems, by sudden southward retreats of the ITCZ{Intertropical Convergence Zone}, which are common even after the rainy seasons have

become well established, and by the randomness of the convective cells prevailing in that area, which range over distances of 1-30km."

May to October constitutes the growing season. Farmers typically begin preparing their fields in May, predominantly using slash and burn methods. Once the land is cleared, they will wait for the rain to fall—usually in early June— to plant. Farmers measure the depth to which the rain has penetrated to decide if it is enough to plant. If the moisture measures from the fingertips to the wrist, they declare it is enough. However, "the dates of onset and ending of the rains as well as the growing season length has become more erratic, so the timing of cropping has become more risky". Some farmers choose to dry plant some of their seed, taking a risk that the rain will fall soon. However, this practice is becoming less common as the rains become more unpredictable. Often farmers will have to plant multiple times, as the millet may not be able to survive in the sometimes long periods between rains.

Most farmers have multiple fields in different locations as well as a field close to the village. By having fields in multiple locations, farmers reduce their risk of crop loss. Some farmers' fields may be as far away as 2.5 hour each way by foot. Because the rainfall in these areas may be very different from what it is near the village, farmers rely on each other to convey the local conditions. Farmers passing through villages on their way to local markets help convey this information. Reiterating the importance of weather and local communication, Graef and Haigis (2001) state that

“making their own weather and site observations and exchanging local information are a must for the farmer.”

Declining soil fertility is a major problem for the farmers, however, most cannot afford even small investments in soil fertility. Of the ones who can, some farmers will contract with a Fulani herder to keep their animals on the field over the dry season. Usually the Fulanis receive some measure of millet for this service. However, often there are not enough herders in the region for everyone who wants to exercise this option. Other options include buying small quantities of fertilizer at the local market and planting this with the seed. Much rarer, some farmers bring loads of manure out to their fields via a donkey cart. At the very least, some farmers will bring small amounts of household debris to their nearby field. Recognizing the importance of soil fertility, farmers use fallow periods used to help regenerate the soil. However, now due to population pressures and declining land fertility, fallow periods, if they exist at all, usually average only two years.

Because all of the farms are planted and weeded by hand, a good deal of labor is required. Millet requires two weedings: the initial and the follow up. Farmers use a tool called a *kumbu* , a long wooden stick with a metal blade on one end and a handle on the other. Male children as young as seven years old start accompanying fathers, brothers and cousins to the field to participate in the work. Fathers and sons work side by side on the same parcel of land methodically farming until it is complete. If a farmer

finds he has more work to do than he and his family can accomplish, he holds a work party (*bogu*). Many of the young men participate in these *bogus* as the norms of reciprocity prevail.

According to farmers, lack of millet is a somewhat recent phenomenon. Older farmers recall a time when fields produced abundantly. Families had enough millet to even sell some of it. However, this has not been the case in the last thirty years. Farmers note decreasing rains, declining soil fertility and increased population as factors contributing to this change. When asked about their main problems, lack of food (millet) and water (rain) are echoed time and time again.

Millet farming affects and influences most aspects of life. This traditional farming itself is based on knowledge: learning from past experiences and continuing to do things that have worked in the past. In Niger, farmers start learning how to farm from a young age—around age seven. This information and knowledge is passed down from father to son. The majority of farmers said that they learned everything they know from their fathers and their practices reflect this traditional knowledge. As farmers get older, they continue to learn via trial and error; they do what has worked in the past. Most farmers interviewed said they do not make changes from year to year, but rather do exactly as they have in previous years. Planting of crops, types of seeds, and other farming practices show little variation from year to year. However, dry planting has been reduced because with the variability in rains, it is less reliable. Thus, “To induce

large behavioral change, the information must disrupt farmers' expectation so much that the outcome of their normal choices appear not simply sub-optimal but inadequate to meet their basic requirements". That being said, large-scale changes to the way that farmers make agricultural decisions runs counter to their long-standing traditions.

Scientists do not have the same connection to and knowledge of millet as do the Nigerien farmers. Whether it is a UC Davis scientist or a climatologist making a forecast, the concepts of millet, farming and rain are just that—concepts. Examining the data or simply making forecasts without regard to how they might be applicable makes their knowledge markedly different from that of a farmer. They have the luxury of this disconnect, of thinking of them in the abstract; a successful millet harvest is not crucial to their livelihood in the same way as it is for the traditional farmer.

Social/Political System

My research took place in the Balleyara region, which is approximately 100 kilometers northeast from the capital city of Niamey. The majority of the population belongs to the Zarma ethnic group, however, the Bellas, the former slave class of the Tuareg, for whom the area is named (Balleyara means "market of the Bellas") also have many villages in the area. The second area of study, the Fakara region, is also predominantly Zarma and is located 100 kilometers southeast of Niamey. The Zarmas comprise 22% of Niger's population and are primarily settled

around Niamey (World Bank, 2002). Over ninety percent of the ethnically diverse population of Niger is Muslim. In addition to the Zarma, ethnic groups include Tuareg, Hausa and Fulani. The Balleyara region includes representation from all of these groups and relations between the ethnic groups in this area are amicable. Each village has a village chief and a women's leader who are generally well respected and serve to monitor disputes and provide counsel. The role of chief is usually passed from father to oldest son. The traditional canton, or province, is also overseen by a chief of the area who is generally very respected. The political districts have elected officials who are somewhat less respected, though still seen as influential.

The most famous president of Niger (and arguably the most well-liked) was Seyni Kountché. Kountché ruled the country from 1974- 1987 . During his governance, Niger experienced prosperity. However, one of the reasons for this prosperity was due to Niger's uranium reserves. Uranium was a major export during this time and most of Niger's Gross Domestic Product (GDP) was derived from this. With declining demand on the world market for uranium Niger's GDP has declined. The Kountché family remains powerful in Niger to this day. His influence is especially acute in the Balleyara region, as Kountché was from this area. His home village was Fandou, located five kilometers from Maourey, one of the villages selected for research. Hamidou Kountché, the older brother of Seyni, owns three large fields in this area. The largest one is over 100 hectares and many

local villagers assist in the farming of this land—either as wage labor or by participating in the fieldwork parties. Kountché currently holds the position as Chef du Canton in the area and thus exerts his influence over the local villagers. One example of this is that he declared that no one in his canton, Tondi Kandia, would farm on the Balleyara market day and all of the villages abide.

In real terms, the average Nigerien villager does not expect much from the government. There is very little interaction between villagers and the government on a day- to- day basis, except around election time when various candidates bring millet or other desirables to villages in hopes of winning support. The Chef du Poste collects taxes from village chiefs and only in instances of non- payment is there much discussion. The Chef du Poste in this area is based in Balleyara and oversees a cadre of government agents, including agricultural extension agents. These agents are typically from other areas of Niger, as government agents do not get to choose where they work. All agents have motorcycles, but due to limited resources they often have no funds to purchase gas. Hence, they do not venture out to villages as often as one might think, especially villages that are far away and on difficult roads. Often agents will choose a few close by villages where they concentrate their efforts.

Village life

The household compound, or concession, forms the basic social unit among the Zarma. Families live in grass huts constructed with local

materials. Typically a fence built out of millet stalk separates one compound from another. A Neem tree (*Azadirachta indica*) is usually present in a concession, as it grows quickly and provides much needed shade. When a son marries he builds another hut in the same compound for his wife. Thus, the number of huts in a compound can vary. If a man has two wives, each woman has her own hut and the husband alternates each day where he stays. Within the concession, each woman has her own area where she cooks and pounds millet, although these tasks are usually performed together with other women in the concession.

Meal preparation and cooking are time consuming processes that occupy much of the women's day. Women pound millet into flour using a large mortar and pestle two times per day: for the midday meal and for the evening meal. The pounding process can take hours, depending on how much millet they are pounding and how many women are involved. The midday meal is a millet porridge and the evening meal is usually cooked millet flour served with a green leaf sauce. Meals are eaten from a communal pot. Men eat together while children eat with the women. If a special meal is prepared then small offerings will be sent to friends and relatives in the village.

Concessions are close to each other and thus there is a lot of interaction between individuals on a daily basis. As well, most of the heads of households are related to one another so there are many family connections to be maintained. It is not uncommon for people to pass

through concessions on their way to the well or out of the village or just to bring their greetings.

Most villages have at least one cement well from which the women draw water. It is a very social time in addition to being a chore: the stories of the day and laughter dominate. Women pull water from the well—which may be anywhere from three to over thirty meters deep— using a rope with a rubber bowl attached to the end. Usually two women will work together to fill up their buckets to make the work easier. Very few villages in this area have water pumps or, if they do, they are non- functional.

Daily activities vary according to the time of year. In the farming season everyone is up at dawn. Men walk to their fields to embark on a long day of farming in the hot sun. At midday the wives/daughters bring the meal out to the field. This entails having to get up even earlier than usual in order to ensure that the pounding is done and leaving enough time to prepare and transport the meal. On the way back from the field women will stop to gather firewood or leaves for sauce for the evening meal. After getting water from the well, and taking care of the children, they will begin the process again for the evening meal. In the non- farming season both men and women have a bit more leisure time. The men who do not go on exode gather in a central place—usually outside the village mosque— to share conversation, weave rope or listen to the radio. The women's main free time is mid- afternoon. During this time they usually

gather under a tree to weave grass mats while socializing and braiding each other's hair.

Seasonal migration: the Exode

Seasonal migration is an important issue in Niger. Each year following the harvest most men ages 18- 55 leave their home village in search of work. This phenomenon is referred to as "exode". The majority of these men will stay away for the entire year and only return home for the farming season. However, this varies according to the individual: some stay away for years at a time while others only stay a short time. Popular destinations vary by village, as most men tend to go where others they know are. Some of the most common are Cote D'Ivoire, Ghana, Togo, Benin and to a lesser extent, Burkina Faso and Libya. Some individuals also travel only as far as Niamey in search of work. For instance, an assessment of the exode in the village of Maourey completed by Peace Corps in 1994 estimated that one half of the men and one quarter of the women leave the village in search of work. However, observations and interviews show that the trend is increasing: the majority of men leave to seek work. While they are away, the men send money and other items back to the village to help support their families. For young men who are not yet married, they work to earn enough money to pay the bride price when they return.

It is also becoming more and more common for young women to leave during the non- farming season. However, the young women only

travel to Niamey where they find work as a cook or house servant for the Nigerien middle class and ex-patriate community. In past generations women would not leave the village in search of work and wages. Yet, now most families in the area find they do not have enough food to support themselves throughout the year. This predicament necessitates more young girls leaving the village: both so there is one less mouth to feed but also so they can work and send money back to the village.

Literature Review

The research explores farmers' exposure to forecasts and their comprehension and application of them. Orlove's (2000, 2002) research on ethnoclimatology informs the practice of looking at how farmers use traditional knowledge in order to make crucial decisions. In this instance, I explore how farmers bridge different knowledges and languages: indigenous knowledge and oral tradition of Zarma and the scientific knowledge primarily conveyed in French and in writing. The traditional forecasting methods may exist to varying degrees, depending on the village and the individual farmer. The timing of scientific forecasts, the dissemination of information, and constraints based on socio-economic characteristics of farmers and villages are variables that all have an effect on how useful and appropriate they may be to the end users. Related to this, the method of their dissemination will also have an impact on the credibility and value assigned to the information. The socio-economic

characteristics of the farmers and the villages include their level of education and exposure to life outside the village.

Links to theory and concepts

Where and how do indigenous knowledge and scientific knowledge intersect? Are they inevitably opposed, or can they complement each other? The intersection of these two seemingly incompatible approaches has been documented (Thrupp, 1989; Agrawal, 1995; Nader 1996a, b;). Indigenous knowledge is typically place- based, anecdotal, and oral, while scientific knowledge is universal, principle- based, and written. However, these two approaches can be integrated to analyze various aspects of life, including farming. Such integration is applied in the health field where understanding the community's beliefs and perceptions about disease can influence the use of modern medical treatment (Liefooghe et al., 1997). An approach to incorporating more indigenous knowledge into community planning is Participatory Rural Appraisal (Chambers, 1994) which provides a forum for using farmers' knowledge to help improve their lives. Recent scientific studies have capitalized on the extensive knowledge of villagers about their environment. For instance, Nigeriens were asked to note plant species and perceived increases or decreases in species in order to study vegetation changes due to climate and human impact (Wezel and Haigis, 2000). Additionally, a survey to address farmers' perceptions of wind erosion in Niger shows that they are well aware their environment . These results are not surprising, considering that observing the environment is

so intrinsic to their livelihoods. Graef and Haigis (2001) report that "farmers assiduously observe the weather and check the nearby fields for soil moisture". They continue on to say that "the availability of this information is often limited to a range of a few kilometers. Therefore, farmers ask other farmers who cultivate fields further away from the village about rainfall events they have observed or traveling people like herders. Finally, if no news is available about remote fields, they visit the fields concerned regularly around sowing time".

As knowledge relates to climate and forecast, Carla Roncoli's work on indigenous knowledge in Burkina Faso concludes that farmers draw on some combination of generalized local forecasts of natural phenomena, specialized local forecasts by spiritualists and scientific forecasts to make decisions (Roncoli and Ingram, 2002). As well, Eakin (1998) examines how farmers in Tlaxcala, Mexico manage climatic risk through traditional methods of climate prediction and ritual and illustrates the relevance of local climate knowledge and seasonal forecasting.

Therefore, an analysis of the intersection of indigenous and scientific knowledge in this context could potentially provide a framework for improving potential success of limited farming opportunities. If scientific forecasts can be presented in such a way that is most useful and understandable to the farmer, they will be much more applicable in the villages. Improving the communication between these seemingly separate

worlds has the potential to impact the beneficiaries of the knowledge by allowing them to shape the way that information is presented to them.

Materials and Methods

Utilizing a combination of descriptive, ethnographic and survey methods, I sought to explore the following hypothesis: The extent to which farmers rely on local and modern forecasts depends on two sets of variables: 1) farmers' characteristics and 2) the format of the information presented. Farmer characteristics include aspects such as knowledge of French, level of education, and religious beliefs, age and gender. One would expect that these factors, among others, would affect farmers' understanding and reaction to various forecasts. Secondly, the format the information is received in will have an effect as well. Scientific forecasts for Niger are made in global centers and Nigerien meteorological services. These forecasts are spread from the capital city of Niamey to farmers through radio, and agricultural extension.

In addition, two institutions, RANET and ACMAD are currently involved with climate forecasting in Africa. RANET uses radio as its medium while ACMAD monitors climate variability (http://www.ranetproject.net/ ; http://www.acmad.net). RANET is a collaboration of local and international organizations whose aim is to make climate and weather forecasting information available to the rural communities by disseminating the information via radio and otherwise improving access to information. ACMAD (African Center for

Meteorological Applications for Development) represents fifty-three member states in Africa and has its regional base in Niamey, Niger. ACMAD is co-sponsored by the Economic Commission for Africa (ECA) and the World Meteorological Organization (WMO). The goal of ACMAD is to "provide climate and environmental data and products for sustainable social and economic development in Africa" (www.acmad.net).

What might be the comparison between a RANET forecast and another mode of agricultural extension such as an agent visiting the village? Whether or not the information is accepted may depend on its source and how much the farmer trusts that source. For instance, in a very traditional village, farmers may only trust a forecast made by an elder and not one from the unknown "technology". In addition, inter-community as well as inter-individual variability may be present. For the latter, although the communities are comprised of the same ethnic group and are located in the same general area, each village has a particular resource endowment, a particular history and a particular location in wider networks, which will impact the farmers' perceptions and actions.

In order to conduct this research, I spent the rainy season (June-September 2003) in Niger in the Balleyara region. Balleyara is a mid size town located 100 kilometers Northeast of the capital of Niamey. Balleyara is known for having a good market, especially the animal market, and Nigeriens and ex-patriates alike travel there for this purpose. I had been a Peace Corps volunteer in this region and was therefore familiar with the

area. I chose four villages with whom I had previously worked as my research base. Because I had previously worked with these villages, I had already established a rapport with them. However, re-entering the villages as a researcher and not as a volunteer was a different experience. Peace Corps was no longer actively working in these villages. Since my last interaction with these villages had been as a team coordinator who was responsible for bringing volunteers to villages, the villages kept insisting that I should bring them another volunteer. Despite attempts to clarify the situation, I think they still expect another volunteer to show up someday soon.

These four villages—Deyguindé, Maourey, Sorgo Koira and Haini Si Moru-- are similar in size, ethnic background and language. They have strong village leaders and attend the same weekly market. However, they vary in terms of the percentage of the population who leave the area seeking work, their political connections outside the village, interactions with the local agricultural agent, and supplemental economic activities.

I conducted semi- structured surveys and key informant interviews. Semi- structured surveys were conducted with fifteen farmers per village who were randomly selected from list of names of heads of household provided by village chief. Because I was focusing on millet farmers and the head of household, all of the farmers interviewed were men. As will be discussed later, women's perspectives were elicited in the focus groups. In most cases, the surveys were conducted at the farmer's field. As it is a

predominantly illiterate population, interviews were conducted orally in Zarma and were primarily open-ended questions. In order to get a sense of the fields, I walked to all of the fields to conduct the interviews. Some fields were nearby the village while others were a 1-2 hour walk (the furthest was 2.5 hours each way!).

Most interviews were one-on-one but for some interviews others were present. I found that the interviews with just the farmer alone went better because then others were not distracting. I asked each farmer a series of questions, but tried to keep it as informal as possible. I took notes—in a mix of Zarma and English—while they were talking. This proved to be a bit of a curiosity, as Nigeriens in the village are not accustomed to people writing things down. Additional information was gathered via participant observation and conversations with key figures such as the village chief and the women's leader, who are respected and knowledgeable members of the village.

The observed and measured variables are the characteristics of farmers, which encompass age, gender, village of residence, level of education, travel outside village. Next, farmers' perceptions of climate forecasts and their applicability—both long and short term was queried. Additionally, I looked at whether farmers receive the forecasts, how often and when, and if they perceive them to be useful and trustworthy. As well, traditional forecasting methods were discussed. Questions which were considered included: What methods are used? What are the indicators of

when it is time to plant? Does everyone agree? Does it vary year by year? Finally, I examined perceptions of climate variability. How does this year compare to previous years in terms of precipitation and temperature? And, if variability is present, how has this affected harvest? The full interview schedule can be found in Appendix A.

In order to gain a broader understanding of the farming system as a whole, various additional questions were asked. As part of both the interviews and the focus groups, participants were asked about the main problems they faced in farming their fields. Similarly, farmers were asked to note changes in their fields in their lifetimes. They were allowed as many answers as they wished. Each interview lasted approximately 30 to 45 minutes, depending on the farmer. Because I was cognizant of the fact that they were losing valuable farming time to talk with me, I tried to keep the interviews as short, but as thorough as possible.

As an additional component to this research, I interviewed 43 farmers in the Fakara region of Niger. While this region is not very far from the Balleyara region, the villages in general have greater access to resources than the Balleyara region. This portion of the research was performed in service to the Institute for Crop Research in the Semi-Arid Tropics (ICRISAT) based in Niamey and Sadoré. Because I had not previously worked in this area, none of the villages knew me or of my past association with Peace Corps. Three villages from each of the three sub-regions were chosen. Therefore, a total of nine villages were selected. In

each of the nine villages, five individuals were randomly selected from a list of names from the ILRI (International Livestock Research Institute) database. Alternates were also chosen to be interviewed in the event that the originally selected individual was not present.

These interviews were conducted over a short time frame. The researcher was based in the mid size village of Diantiandou where ICRISAT maintains a location base. Participating villages were driven to and farmers were interviewed at their home or at some other village location, such as outside the mosque.

Thus, in total, I interviewed 103 farmers in 13 villages. The scientific aspect of climate forecasting was addressed by interviews with the forecasting agency, ACMAD, and the Nigerien Meteorological Services, both of which are located in the capital city of Niamey, as well as the local agriculture extension agents.

Because of the nature of the project, I collected both quantitative and qualitative data. I conducted similar focus groups of farmers in the four Balleyara villages in order to discover their perceptions about climate forecasts and their applicability —both traditional and scientific. Due to lack of time, focus groups were not conducted in the Fakara region. In each of the villages, I conducted both a men's and women's focus group. As this is a gender- segregated society, women and men's focus groups were separate. All men and women of the respective villages were invited to participate. For the focus groups, topics covered included names and

lengths of seasons, definitions of a “good” rainy season, indications of when the rainy season is beginning and ending, and the differences in rainy seasons over time. Numbers in attendance ranged from ten to forty individuals, depending on the village. Due to the busy nature of the rainy season, meetings were held at night. The one exception was the village of Sorgo Koira, where the meeting was held on their one day off from farming.

The meetings were conducted in Zarma by myself. Facilitating the meeting, taking notes and being engaged in the conversation all at the same time was indeed a challenge. Because the meetings were at night, I was taking notes either by lantern or with a flashlight. For many of the meetings the men or women’s president would take on some of the facilitation role. In focus groups, a young man from Maourey commented after the fact that the younger men would not speak up but would generally defer to the older men out of respect. This dynamic is not present in the women’s focus groups which were very lively with women competing to contribute.

Data Summary and Results

The following table summarizes the village data from the research. As noted above, focus groups were held in the evenings (with the exception of Sorgo Koira) in a location of the village’s choosing.

Table 1: Village data

Village	Distance from Balleyara	# Surveys	Men's Focus Group (#attending)	Women's Focus Group (# attending)
Balleyara: Deyguindé	15km	14	20	30
Maourey	20km	16	30	40
Haini Si Moru	16km	15	40	20
Sorgo Koira	15km	15	21	25
		N= 60	N=111	N=115
Fakara: Katanga		 5	n/a	n/a
Ko Dey		5		
Koma Guinde		4		
Falanga		5		
Gorou Yena		5		
Tigui Tegi		5		
Bani Zoumbou		5		
Youloua		5		
Koma Koukou		4		
		N=43		
		Total N=103		

In talking about the rainy season, both the current one and in general, farmers were asked about indicators of the arrival of the season. As men's and women's focus groups were separate, their responses are also separated. The vast majority referred to counting the number of months since the rain had stopped as their best indicator of when the rains would start. However, as we shall see, they also noted that the onset of the rains is getting later. On the whole, the focus groups stated more indicators than the individual farmers. As for scientific forecasts, some farmers were aware of them being broadcast on the radio, but due to the timing (in the middle of the day when they were working in their fields)

and the language (French) of the broadcast, many did not access them. Yet, they did express a desire to know what was being said and had varying levels of trust in these forecasts.

As for the scientific forecasts, the National Meteorological Services and ACMAD access satellite images which are then broadcast in a daily forecast on television. The daily forecast is also broadcast on radio in the afternoon in French. Because of these factors, they are of limited use currently for the average Nigerien farmer. However, although most farmers did not receive the forecasts, they did express an interest in them and feel they could be useful and trustworthy. They said that forecasts would be useful, even if only so *"lakkal ma kani"*—they can relax because they would know that rain was coming. For now, they rely on themselves and their family for information. As "good" years become less frequent (average of five years since the last good year) and the rains continue to arrive later and with less force, traditional forecasts may be less reliable indicators. Thus, the opportunity exists for making scientific forecasts more appropriate for the users and may be able to alleviate, in some small way, a few of the main problems expressed with their agricultural system.

In the Fakara region villages, farmers were more likely to know of the existence of forecasts and to listen to them. These villagers are much more accustomed to scientific information, mostly due to its exposure to ICRISAT's work.

Table 2: Traditional indicators

Indicator	Survey respondents	Deyguindé Focus Group Men/Women	Maourey Focus Group Men/Women	Haini Si Moru Focus Group Men/Women	Sorgo Koira Focus group Men/Women
Count months	**22**	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
Winds from east	**6**	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
Humidity	**2**		Yes/Yes		
Clouds	**14**	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
Village elders	**8**				
Trees still	**2**				
Heat *(Konni)* Or Cold *(Yeeni)*	**1**	Yes/Yes		/Yes	
Prayer *(Fatiya)*	**4**				
Trees flowering/leaves	**1**			/Yes	Yes/Yes
Allah *(Irikoy)*	**4**				
Storks arrival (*Walliya)*	**1**	Yes/Yes	Yes/Yes	/Yes	/Yes
Lightning	**2**				
Snake/animal arrival or movement	**3**		No/Yes		Yes/Yes
Health		/Yes	/Yes		Yes/Yes
Food availability			/Yes	/Yes	
Dust		Yes/Yes	/Yes	Yes	
Small rains *(mimsi)*		Yes/Yes		Yes	

In order to gain a broader understanding of the farming system as a whole, various questions were asked. The following chart shows the variety of crops that farmers plant. This diversity of crops, especially in the crops traditionally planted by women (groundnut, peanut, sesame,okra) shows the diversification strategy farmers employ.

Table 3: Crops planted by farmers

Zarma name	English name
Haini	Millet
Haamo	Sorghum
Dunguri	Beans

Zarma name	English name
Gisima	Hibiscus- red
Damsi	Groundnut
Kolansey	Peanut
La foy	Okra
Lampti	Sesame
Gasu	Calabash
Waraw	Hibiscus- white
Kolkoti	Corn
Haini Ciray	Fast Millet
Haini Sumna	Traditional Millet

As part of both the interviews and the focus groups, participants were asked about the main problems they faced in farming their fields. The most common responses are listed below; the ones in bold were the most frequently mentioned of these.

Table 4: Main agricultural problems

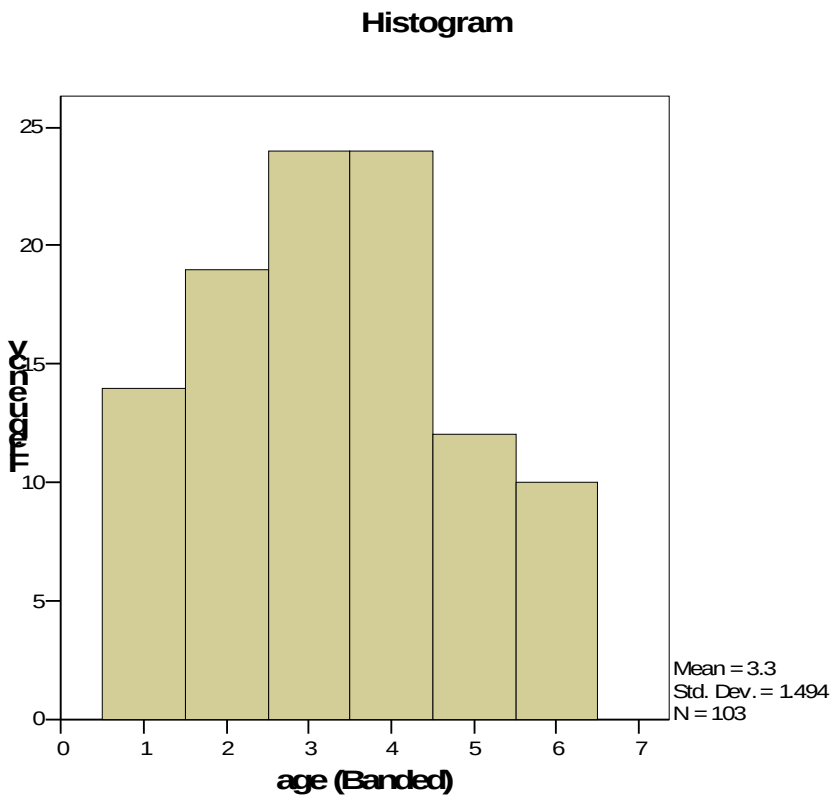
Stated problem
1. Lack of water to drink, no well near field
2. Not being healthy enough to work
3. Not having enough food to eat to allow working
4. Fields far, no transportation to field
5. Working alone on farm, not enough help
6. Rains have decreased and not enough water for crop
7. Good soil gone, *goro* (erosion) taking field
8. Lack of good tools to farm
9. Lack of ability to procure fertilizer
10. Lack of manure
11. Increased pests infecting crops

Similarly, farmers were asked to note changes in their fields in their lifetimes. They were allowed as many answers as they wished. Many of the changes were quite similar to the perceived problems from Table 4. Again, the most common answers are in bold. Numbers 12 and 13 are Zarma proverbs that were repeated time and again.

Table 5: Changes in agricultural fields in farmers' lifetimes

Changes
1. Land is old, not producing
2. Smaller millet
3. Not getting as much harvest
4. Land does not produce without fertilizer
5. Desertification
6. Good soil leaving, *goros* taking fields
7. No more trees
8. No more small animals
9. Increased pests
10. Decreasing rain, droughts in middle of season
11. Temporary pond didn't use to be there
12. Jiri fo ga te, jiri fo si te **(One year is good, the next is bad)**
13. Jiri kulu inga ce diraw **(Every year is different)**
14. Gangani (hardpan)
15. Population growth
16. Land scarcity

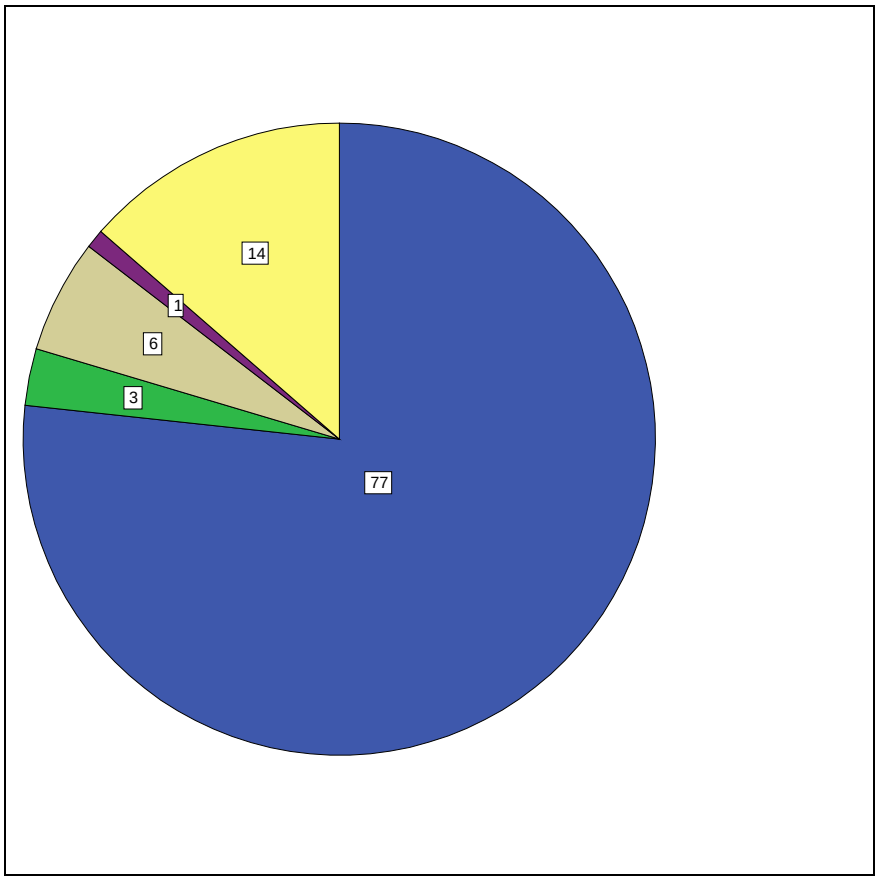
Table 6: Age category quantifications of participants

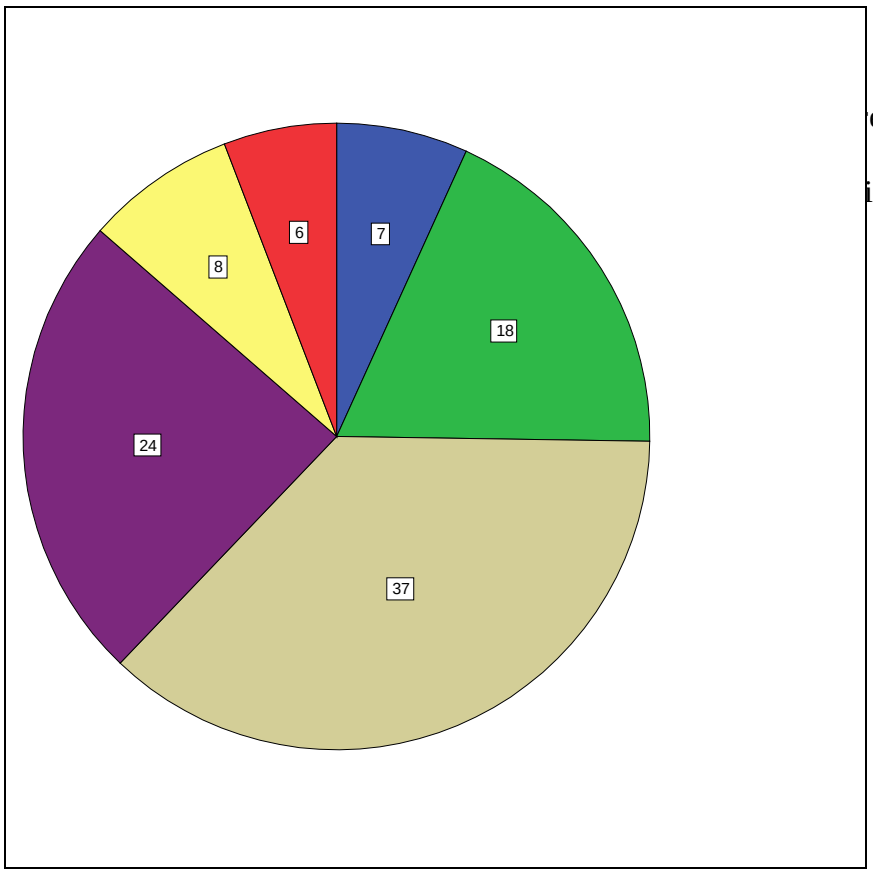


age (Banded)

	Frequency	Percent	Cumulative Percent
Under 30 years old	14	13.6	13.6
30- 39 years old	19	18.4	32.0
40- 49 years old	24	23.3	55.3
50- 59 years old	24	23.3	78.6
60- 69 years old	12	11.7	90.3
70+	10	9.7	100.0
Total	103	100.0	

Figure 1: Education Level of participants





espondents had

inally, fourteen

The above graph shows that thirty seven percent of farmers responded that they farmed three fields. Four fields was the next most common response, with twenty four percent reporting they had three fields.

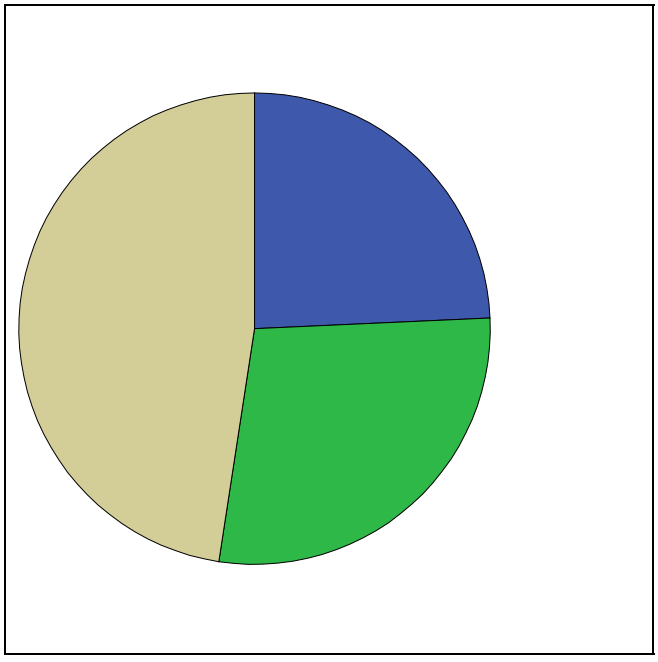


Figure 3, at left, shows whether or not farmers accessed scientific forecasts. Just under half of the farmers said they did.

Table 7: Exode and forecasts Crosstabulation

		forecasts?			Total
		no	sometimes	yes	
exode	No	9	4	6	19
	Yes	16	25	43	84
Total		25	29	49	103

An individual farmer going on exode does not appear to have an impact on whether or not they access forecasts. The majority of farmers do go on exode.

Table 8: Outside advice and forecast crosstabulation by region

		forecasts?			Total
		Yes	7	8	5 2
		no	sometimes	yes	
Balleyara	outside advice? No	15	17	8	40

	Total		22	25	13	60
Fakara	outside advice?	No	2	1	22	25
		Yes	1	3	14	18
	Total		3	4	36	43

Receiving outside advice about agriculture either from a project or the government was more common in the Fakara region than in the Balleyara region. And in the Fakara region farmers were more likely to access forecasts. Only five farmers out of 60 in the Balleyara region responded that they both received forecasts and had access to outside advice.

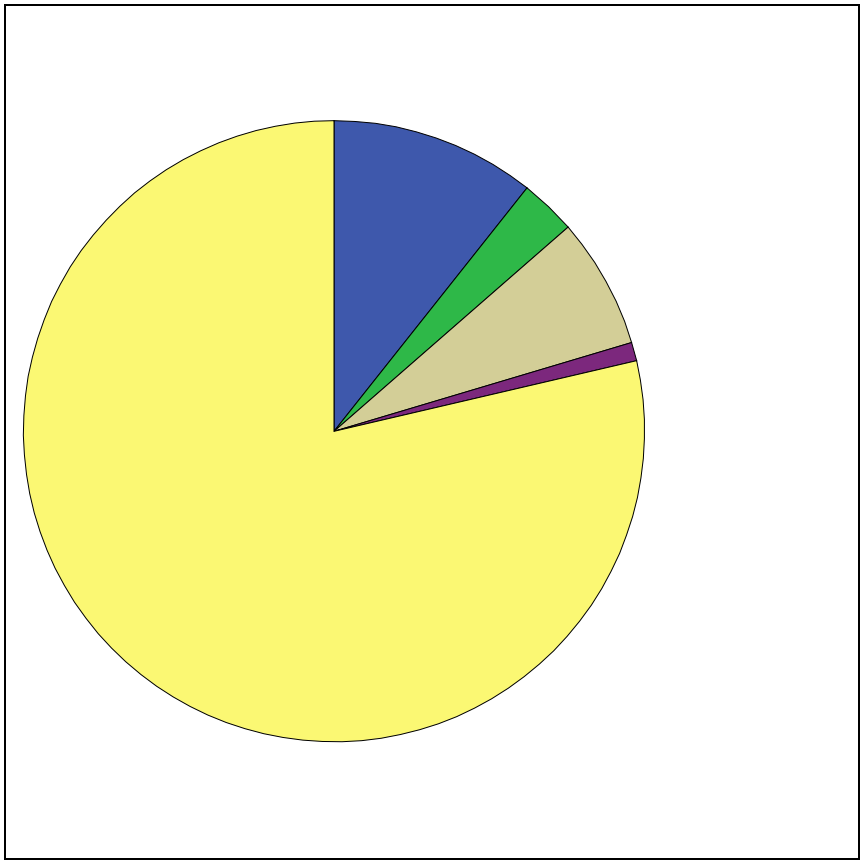


Figure 4 shows the percentages of farmers who said that scientific forecasts were useful. Overwhelmingly, farmers said that they were useful. Some farmers specified that they were not useful because the forecasts were issued in French. Whether the farmers accessed the forecasts or not, they still found them to be useful information that would help inform their farming practices.

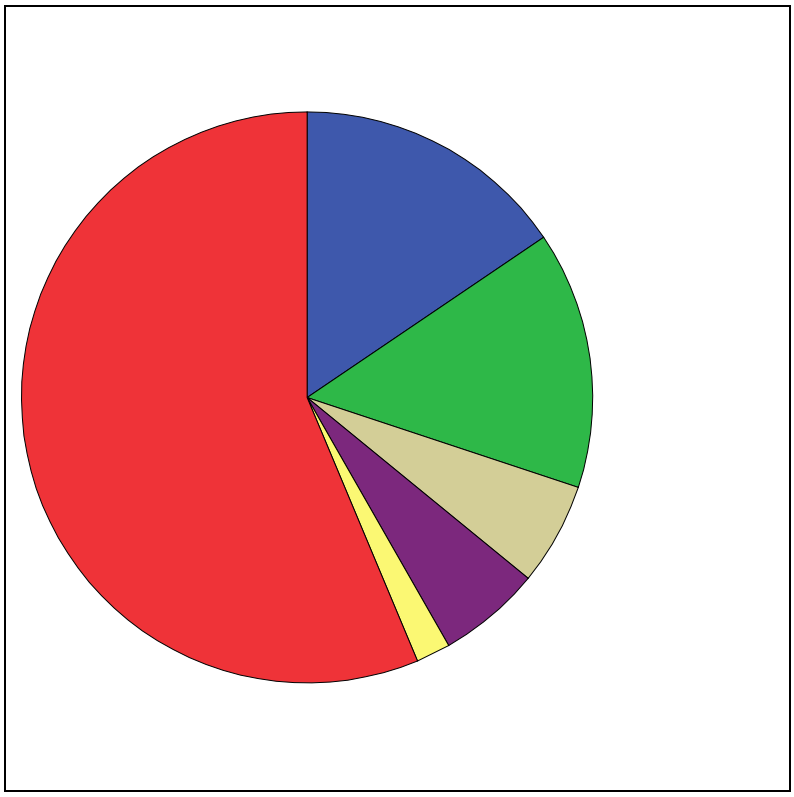


Figure 5 shows the trustworthiness in scientific forecasts. Over half of the farmers said that the scientific forecasts were trustworthy. Of those who said that

they were only somewhat trustworthy or not trustworthy, some specified that their reasoning was that only Allah (Irikoy) can know such things. Answering that the forecasts were trustworthy may have been an attempt to please the researcher.

Table 8: Region and trustworthy Crosstabulation

		trustworthy?						
		n/a	no	no, Irikoy	some	some, Irikoy	yes	
	Balleyara	14	15	1	0	0	30	60
	Fakara	2	0	5	6	2	28	43
Total		16	15	6	6	2	58	103

Comparing trustworthiness of forecasts in the two regions, we can see that the Fakara farmers expressed more trust than the Balleyara farmers. Since more of the Balleyara farmers did not access forecasts, fewer of them had trust in them. With the presence of ICRISAT, the Fakara region is more exposed to outside knowledge than are the other farmers.

Table 9:Traditional and forecasts by region Crosstabulation

region			forecasts?			Total
			no	sometimes	yes	
Balleyara	Traditional?	No	7	10	7	24
		Yes	15	15	6	36
	Total		22	25	13	60

Fakara	traditional?	Yes	3	4	36	43
	Total		3	4	36	43

Principal components analysis

Using principal components analysis in SPSS 12.0, we can look at some of the relationships between variables. “Principal components analysis enables us to represent the points graphically after a series of iterations in which we attempt to find a reduced number of dimensions that provides a good fit for the observations and the variables so that the distances between the points in the subspaces provide an accurate representation of the distances in the original data matrix” . Aiding in the understanding of these visual representations is the following:
“…it is legitimate to interpret distances among the elements of one set of points”…and also “It is legitimate to interpret the relative positions of one point of one set with respect to all the points of the other set”.

“The closer the points representing two or more categories, the more likely it is that they contain the same objects, and the further the points representing the categories of a particular variable are from the intersection between the two dimensions, the better this variable discriminates the objects” . The total variance is accounted for by the principal axes.

The Figure 6 represents the exposure to outside knowledge. In this instance, thirty two percent of the variance is accounted for by dimension 1 and twenty six percent by dimension 2. Being in the older age class is associated with not having education or access to forecasts. Outside advice

egion.

Figure 6: Outside knowledge

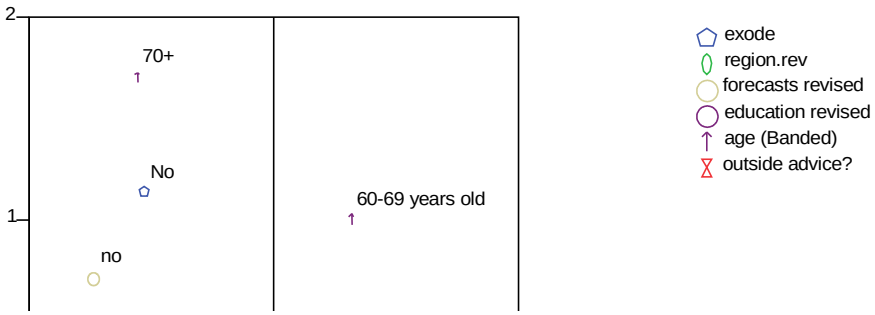


Figure 7: Trust and Usefulness of scientific forecasts

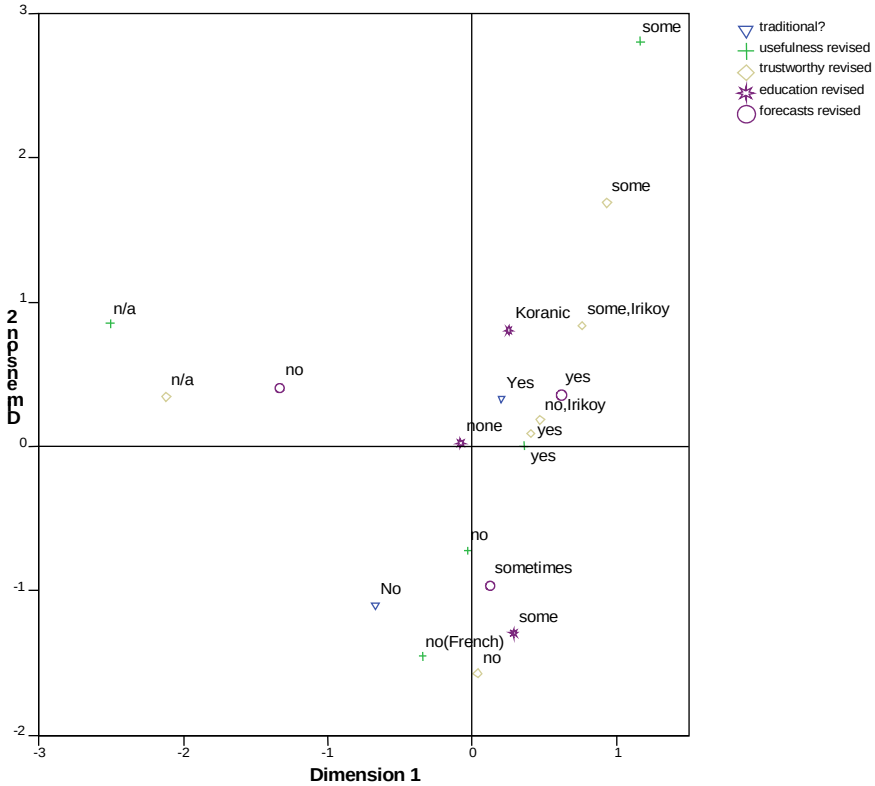


Figure 7 shows the trust and usefulness responses. Dimension 2 separates those who use forecasts and who do not. Hence, those who do not access them are associated with not finding them useful or trustworthy. Dimension 1 also contributes to this separation with those finding them trustworthy and useful also indicating that they use traditional indicators. Having some education seems to be related to not finding the forecasts useful or trustworthy.

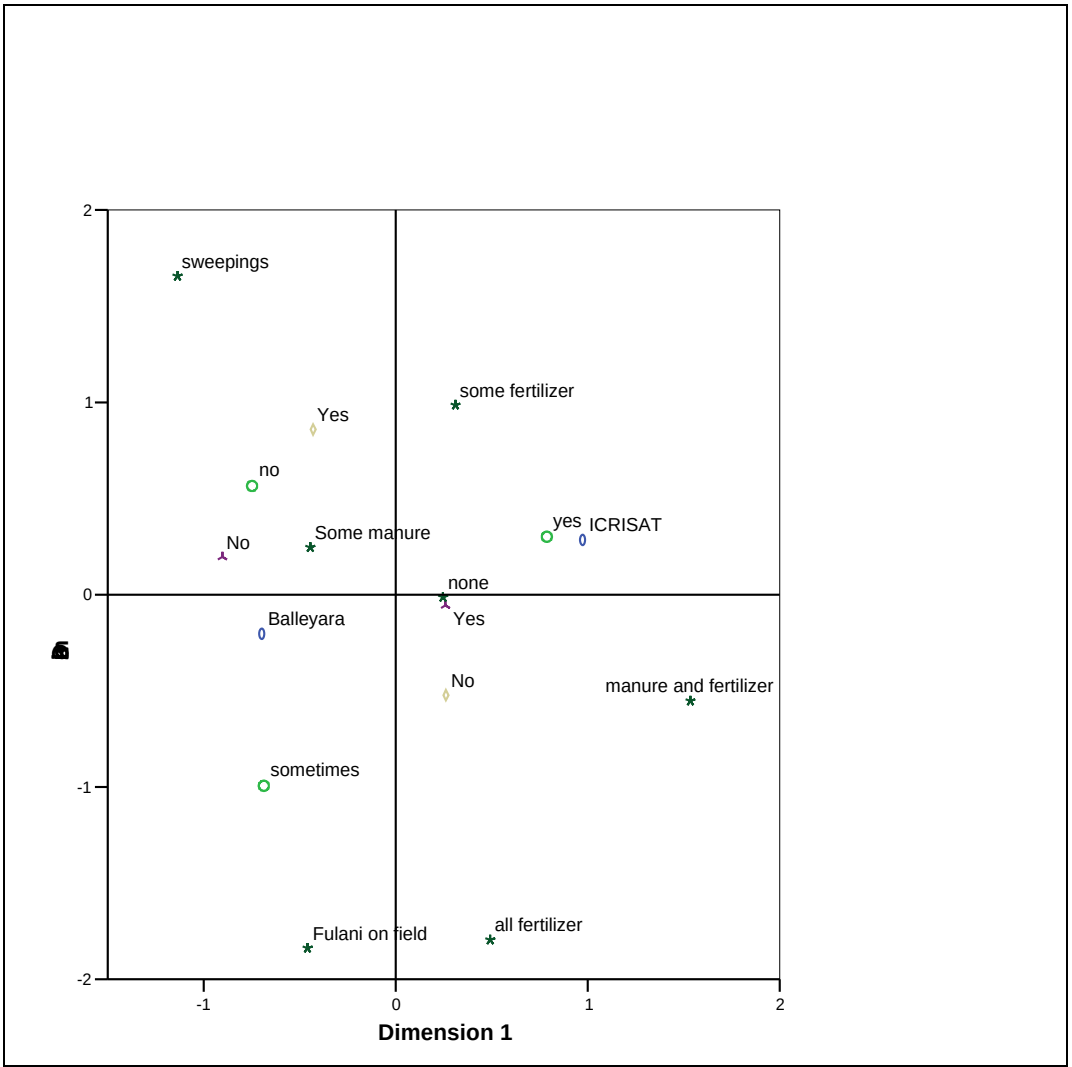


Figure4: Agronomic variables

Many farmers had a common response when asked to comment on the rains from year to year: *Jiri fo ga te, jiri fo si te* (one year is good, the next one isn't). Farmers have noted that the rains are becoming less regular, and therefore less predictable. The most common way for predicting when the rains would come was counting the months since the rain fell last. By this method, farmers generally expected the rains to start in the seventh month

Climate forecasting: Traditional and Scientific

Thus, we can see that weather forecasting can be a powerful form of knowledge. Among other things, the quality and quantity of the millet harvest is highly dependent on the rain. Farmers have a small window of opportunity for planting in order that all the necessary criteria are met: there has to be enough rain for the soil to allow the millet to grow (one hand deep for the first planting) and the millet needs at minimum one hundred days to grow. Because of these constraints, farmers have developed ways of maximizing their chances of success. The traditional practices and indicators most commonly cited by farmers were: counting the months since the rain had ended in order to prepare for the onset of the rains. The seventh month was the most common answer but farmers acknowledged that rains are starting later and may be in the eighth or sometimes even ninth month. The change in wind direction and clouds beginning to appear on the skies were common atmospheric indicators. Botanically, farmers noted a wide range of tree species whose flowering or new leaves marked the onset of the rains. The arrival of the *walliya* (stork) is also a very common indicator. Most of this knowledge is passed on from generation to generation orally. As their livelihoods are tied to the land, it is no surprise that the type of knowledge valued and circulated by farmers involves ecological and environmental factors.

Education is a salient variable in this endeavor. The vast majority of farmers I interviewed had no formal education. Thus, the approach to disseminating forecast knowledge to them needs to take this into account.

Currently, forecasts are broadcast in French and are therefore not reaching many of the farmers who might otherwise find them useful and trustworthy.

When discussing their trust of this outside information, some farmers elaborated.

"I trust them because what they say comes true—if they say there will be wind, there is wind, or that rain will come at a certain time and then it does." Discussing the timing of the forecasts, the same farmer continued " anytime is useful—in the beginning of the season would be able to get ready to plant, useful in the middle because if I am far away (in the field) I can come back to village." In this instance he was referring to the practice of some farmers who stay in their furthest fields rather than having to "commute" each day.

In contrast, another farmer expressed his lack of trust in the forecasts. "Yes, but I don't know if the rains will reach us or not. Sometimes they are trustworthy and other times not—what is not in your control you can't trust. *Kala Irikoy* (only Allah knows)." He further explained that as a Muslim, one cannot know when the rains will come but rather that everything is at *Irikoy's* discretion.

Another farmer exemplifies some of the issues at hand. He said, "I used to hear the forecast but now my radio is not working so I don't. So, I only hear it if from someone else has a radio. There is a student in the village so he can translate the French… No, I don't trust them because

Irikoy didn't give them (the forecasters) special knowledge. Sometimes they will say it will rain and it doesn't and vice versa. When clouds form and it does rain, some say, "see the Met services said it would" but at other times it doesn't. … But it is still useful to hear because it benefits us all." This response encapsulates many of the issues: forecasts being in French, lack of resources, the role of outside knowledge, and the camaraderie of farmers.

Another farmer illustrated the point of the spatial heterogeneity of precipitation mentioned earlier. He said that he trusts forecasts but not completely because rain does not fall everywhere. "You don't know if it will reach you or not, but if somewhere gets rain that is good." His sentiment was echoed by numerous others who agreed that if others received rainfall even if they did not then that was o.k.

The attitude of farmers towards choice and living with uncertainty is also expressed by another farmer. When discussing if they had used fertilizer in their field, one farmer commented: "If you have the choice between buying fertilizer and buying food, you buy food." Whatever *Irikoy* gives is what you will get—that is what you do. This was stated very matter- of -factly and highlights the farmer's tough decisions and self-reliance. Interestingly, although the villagers in Maourey have more resources in terms of cash and animals than the villagers of Deyguindé, they did not purchase any inputs for their fields whereas Deyguindé villagers did.

Implications of results

Scientific forecasts could serve to augment the traditional forecasting currently in use by farmers in Niger, provided that certain issues are taken into account. First, let's look at a few ways in which receiving forecast information could impact the behavior of farmers. Most farmers have three fields on average and, though millet is the staple, they plant a variety of crops. Therefore, they may be able to diversify field locations and crops based on a forecast. If a good (or bad) year was predicted, they could plant more or less of their secondary crops, such as hibiscus, peanuts and groundnuts. Farmers may be able to modify the planting dates, as potato farmers in the Andes do based on Pleiades (Orlove et al., 2000). Additionally, drought forecasting can help both institutions such as Famine Early Warning System and individuals be prepared. Depending on the prognosis for the year, farmers could put more or less effort into the field, such as labor and inputs. Because so many Nigeriens are in other places—as far away as Cote D'Ivoire and other coastal countries- - working for most of the rest of the year, a forecast for the rains would let them know to return from exode and prepare the field (or conversely, stay longer and work until the rains come). Knowing the onset of the rains is the most crucial time, as getting a harvest may depend on planting at the right time. Overall, forecasting the duration and

distribution of rainfall over space and time on a localized scale is the most valuable (Ingram et al., 2002) and the most challenging.

Challenges and Barriers to Success

"It was pointed out that in Niger there are few resources for forecast information that is useful on the level of farmers"(ACMAD, 2002).

As research shows, " Knowledge helps people feel in control and connected with the world, even when it is not useful in any objectively identifiable sense".Thus, knowledge is powerful, or can be if access exists. Who controls the access to knowledge? Niger is a hierarchical society with power concentrated on both the local and national scale. Both the formal governmental society and the traditional village leaders garner a great amount of respect that accompanies their power.

Dissemination is key to the usefulness of the forecasts. The following from ACMAD, the regional forecasting agency, sums up the main issue: "The group highlighted that it is important to get climate information to people beyond just institutions, i.e. to people "on the ground" and at the same time there is need to think of more cost- effective way of distributing climate information to such users as small- scale farmers directly in a language understandable and useful for them. It was argued that it is not easy to bring information to grassroots, however, the Met services distribute information through the radio as small- scale farmers listen to radio and that way have access to the information"(ACMAD, 2002). The method, language and timing are critical.

Whether it is radio, television, or agricultural extension that is employed, the forecasting agency needs to ensure that the information is actually reaching farmers. Word of mouth from a trusted source seems to work the best. Secondly, the forecasts need to be in Zarma or other local languages to accommodate the vast majority of the population—and thereby farmers —who do not understand French. As an FAO report notes, "If the benefits of new technologies are to reach rural areas in developing countries it is essential not only to increase rural populations' access to these technologies, but also to disseminate information in local languages and ensure that it is relevant to local development needs" . Thirdly, timing of the dissemination is important, as they would be most useful at beginning of season before farmers have planted.

ACMAD acknowledges that better communication is needed. "Traditional means of communicating climate information should also be given a chance, e.g. churches, mosques, in comfortable environments that people are used to and markets. Regional institutions can help nations use those means of climate information distribution. Word of mouth can also be used through those that command respect in their societies. In agricultural extension, we learned that people listen to authorities or people who are seen to be successful. There is need for capacity building in climate and applications and communication at ACMAD and the other regional institutions in Africa." (ACMAD, 2002) As Wells (1991) comments, "farmers' frequent interactions with their own ethnic groups help build up

useful social networks and institutions. These social structures themselves help determine the acquisition, evaluation, use and even generation of farming information." This equally applies in Niger, where social structures play a crucial role in the farming system. Adams and Mortimore (1997) also address this point "Decisions about 'intensification' are not made in isolation from other social and economic decisions and may not be solely economic judgments of costs and benefit. Intensification is a social process, one that requires extensive and focused social organization at either the household or community level (or both). Decisions about intensification are not made in isolation from wider issues of who does what and for whom within the household."

Additionally the needs of farmers have to be considered. Lemos et al. (2002) argues that forecasts need to take into account farmers needs and decision making to be effective. As such, scale is a critical variable. In Niger, as in other places, precipitation is so variable locally that it is difficult to make forecasts applicable to the farmer's field (Lemos et al., 2002). Within a few kilometers, the rainfall may be considerably higher or lower.

"It is through repetitive communication that forecasters and farmers learn about each other's methods, such as who makes decisions, what decisions they make and through what channels information arrives" . Yet this repetition and communication does not take place. Time, money and effort are all required to make sure forecasts would actually be useful and

appropriate for farmers' needs and concerns. "Farmers may be suspicious of the forecast if they do not understand the scientific methods used to develop it, especially if they see the forecast as conflicting with local traditional climate indicators". Finally, state that "communicating a forecast effectively requires not only sound science to support the information, but also a great deal of thought as to how, when and by whom that information can and will be used in the context of daily life." Yet, forecasting agencies do not attempt to meet this challenge, and in many cases they are limited by resources themselves.

Scientific forecasts will have a limited impact unless farmers have access to different seeds or other flexibility measures. "Droughts have been recurrent in the Sahel during the last 90 years. The aim should therefore be to make the present agricultural systems sufficiently flexible to cope with these climate risks within the farmers' traditional setting". Thus, "flexibility is an indigenous response to environmental risk, and it offers the freedom of manoeuvre that can be lost in the process of intensification. Loss of flexibility is, therefore, one of the costs of intensification" (Adams and Mortimore, 1997:152). Adams and Mortimore (1997) argue that flexibility is essential in agricultural intensification in the Sahel. They identify the following six types of flexibility ":1. use of farm labor in response to rainfall and the growth cycles of crops; 2. use of diversity of cultivars; 3. use of economic plants; 4. shifting of field locations; 5. use of grazing resources and 6. use of diverse livelihood

strategies."(p.158). I would argue that all of these types of flexibility could be impacted or altered in some way based on an appropriate and useful forecast. Villagers in general are good at identifying problems and potential solutions, but are not able to implement them due to lack of funds or lack of time (in the case of their fields, where they are gone on exode).

Educating farmers about how forecasts work is also essential. In a similar situation in Burkina Faso, Roncoli et al. (2002) states "the notion of uncertainty is not new to farmers, although whether they can or do quantify probabilities remains to be established. Uncertainty is a defining feature of farmers' environment and experience as well as a building block of local systems of thought, which stress that human knowledge is inherently partial and provisional as a 'work in progress'which unfolds through time. This perspective enables them to appreciate that science as well as local knowledge can at best provide incomplete information, and that actual outcomes may always differ from those expected and may always be altered by divine intervention. No attempt is made to reconcile pieces of information derived from the plurality of knowledge systems that are at work locally into a unified coherent picture. Full knowledge is considered to be God's exclusive domain in which humans cannot, and should not, venture." As many of the Muslim farmers expressed this supreme faith in Allah and therefore did not believe fully in the ability to predict what only God can know, Islamic beliefs and practices should be

incorporated into the educational component. Because of the potential serious ramifications if farmers were to rely too much on forecasts and they are “incorrect”, the education component is critical.

As more and more young men and women leave the village and then return, the diffusion of new ideas and ways of knowing is somewhat inevitable. Most are now exposed to television from their time in other places such as Niamey. They know more about the world outside of Niger than past generations. Thus, the new generation of farmers will be equipped with more ways of interpreting knowledge from outsiders. And it is this generation that will face the challenges: working with a traditional father while potentially wanting to try new things. There is a “growing willingness to consider new information for decision making. In a region of high climate variability, simply expecting each year to be like the previous year is a poor heuristic. To the extent that farmers learn to evaluate and consider scientific information about farming practices, rather than simply accepting on faith or rejecting on intuition, they will only benefit” .

All of the younger farmers that I talked to expressed greater openness to new ideas. They have seen more of the world than their fathers and grandfathers. They do not have the same view of outsiders and outside knowledge that is traditionally one of resistance—at least beneath the surface.

Conclusion

The findings from this research show that farmers rely primarily on traditional methods for forecasting, but that they are open to the possibility of using scientific forecasts. Most likely, the younger farmers and those who have traveled more will be more open to receiving information in this way. If the agricultural agent is delivering the forecast, farmers may be more likely to utilize it because it is from a trusted source. However, this appears to rarely be the case. Therefore, villages which have more interactions with the agricultural agent in the area will be more likely to use scientific forecasts. Because, traditionally, the male head of household makes decisions about when to plant, women farmers do not make use of the scientific forecasts. Overall, the timing and the format will play the most crucial role in the usage of the scientific forecasts and they will supplement farmers' experiential knowledge.

In arguing against normative economics for analyzing farmer decision making, Cancian (1980) concludes: "We seem to believe that people generally act on knowledge—that they use this knowledge to calculate, and having calculated, act. The fact of the matter is that they are very often called on to act before they can know." To take it one step further, sometimes farmers wait until they see the evidence (the rain!) to act, in which case they are in an even more precarious situation. Nigerien farmers current behavior exemplifies this point and highlights the need to improve access to credible, understandable information.

Thus, information and knowledge is essential. Commenting on community based natural resource management systems, Getz et al. state that “western- trained scientists often do not appreciate the extent to which solutions depend on the expertise and power of local people”. The authors continue with their recommendation that “partnerships between academic scientists and villagers require that scientists solicit and heed the knowledge and opinions of local men and women. The role of the scientist is to provide knowledge and political leverage to enable communities to implement their own decisions and affect decision- making at higher levels. The goal is policies and institutions that enable local people to have sustainable livelihoods where they live and an effective voice at higher socio- political levels”. This recommendation can apply as well to the weather forecasting realm. And as with introducing management practices of any sort, “participation of all stakeholders will be the crucial element for the development and adoption of new techniques”. However, in the end, “the agricultural development of West Africa will not be achieved by the artificial application of foreign techniques, but by the application of African formulas, inspired no doubt by more evolved techniques, but thought out by Africans, adapted to the needs, the means and the aspirations of African people”.

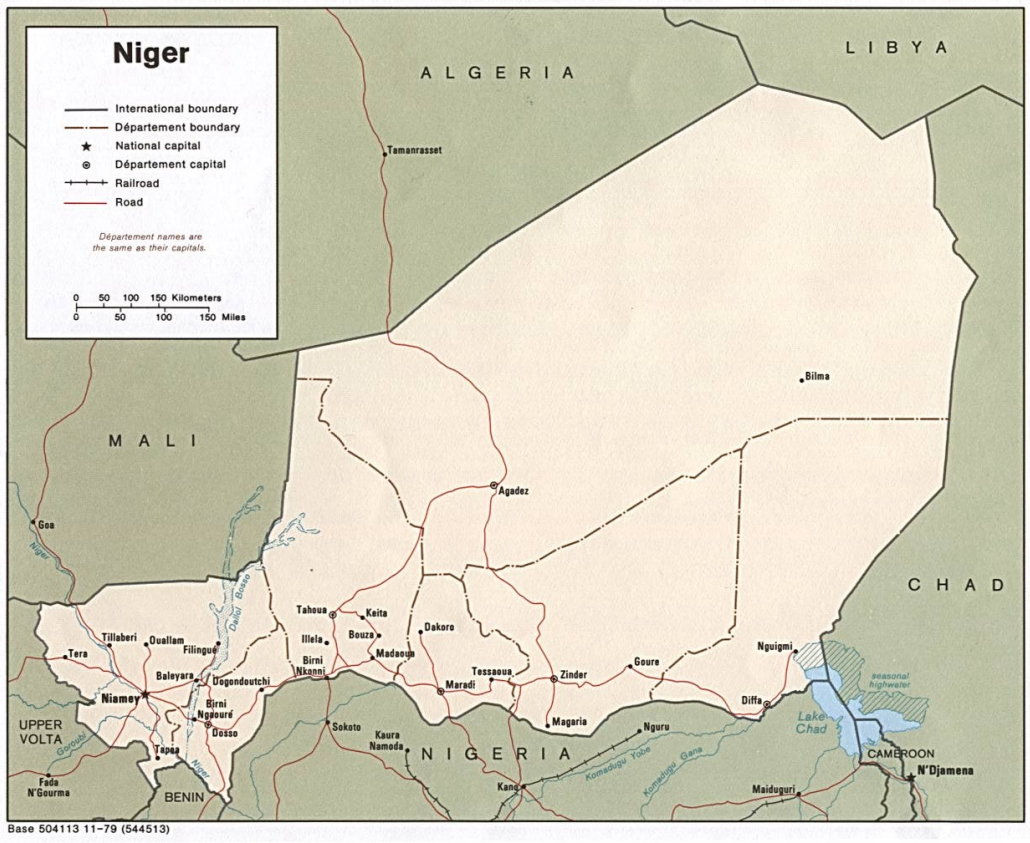


Figure 9:Map of Niger

Afterword

And so I fell into the same trap to some extent. When choosing farmers to interview, I chose men. I chose men because they make the millet planting decisions. And if there is a radio to be had they are the ones who have it. They are more likely to leave the village (though this is changing)

and have access to outside information. But in the end, the women are farmers too. In addition to helping with the millet farm, they do plant their own crops and most farm them themselves. These crops are not insignificant. They can provide both money and some food items to the household. However, in looking at access to forecasts I decided that if anyone had access it would be the men. I did hold focus groups with women and had many informal conversations with them (I spent most of my time with women). But in the end, I did not give women equal chance to be part of my interviews. As Jacques Diouf, the Director General of FAO stated: "A common challenge, for men and women alike, is to exploit the power of communication processes as a means of realizing their potential as well as achieving equitable and sustainable development" .

Postscript

Snapshot: Seasons and Time

"Thus, even while striving to assume a native perspective, the ethnographer will not see exactly the same world that insiders see and will not write an account that says exactly what an insider would say".

There is nothing quite like seeing the wall of red dust roll in over the mesa: a sight that means rain is imminent. Or the first taste of the new millet: a taste that means the hungry season is almost over. Or the sound

of girls clapping, dancing and singing at the full moon: a sound that means the day's work is done. I welcomed the seasons of Niger—in all their glory and annoyance—because each one showed me a different facet of life. My knowledge and understanding of Niger is inextricably linked to the seasons. Experiencing one rainy season you can know a lot. But, in the end, every thought and opinion can be revised over time. For "When human behavior is the data, a tolerance for ambiguity, multiplicity, contradiction and instability is essential".

Millet is so much more than an agricultural crop. And Nigeriens are so much more than poor millet farmers in some Third World country in Africa. When I think of Niger the words that come to mind are laughter,

patience, humor, acceptance. Through my description and analysis I have attempted to make the reality more vivid than a National Geographic picture. As they have time and again, Nigeriens will persevere in the face of challenges. *Irikoy ma boriandi.*

Appendix A: Interview Questions

1. What is your name?

2. What is your age?
3. What is your village of residence?
4. How many wives do you have (living)? How many children (living)?
5. How many and what types of animals do you currently own?
6. How many and what types of animals did you own during the cold season?
7. Have you left the village in search of work? Where and how many times?
8. Did you attend school? For how long?
9. Is the farm far? How many fields do you farm?
10. Which trees are on your farm? Did you plant them?
11. When and how many times did you plant (millet)?
12. What did you plant?
13. What inputs, if any, did you use in your field this year?
14. Do you receive seasonal weather forecasts?
15. Are the forecasts useful? Are they trustworthy?
16. Do you have traditional forecasting methods? If so, what are they?
17. What is a “good year”? How long has it been since a “good year”?
18. *Describe the rains and harvests of the last four years.
19. *Describe rainy seasons now vs rainy seasons of past
20. What constraints/hardships do you face in farming?
21. Do you see soil differences among nearby fields?

22. What changes and differences in the field have you seen since you were a child?
23. Who taught you to farm? What did he teach you and do you do what he taught you? Do extension agents or projects provide agricultural advice?
24. Every year do the same thing in the farm or some changes?
25. What crops does your wife plant? Where does she plant them? Does she plant them every year?

In Zarma

1. *Mate ka ci ni mao?*
2. *Jiri marje no go ni se?*
3. *Kwara fo no ni go nda gorey?*
4. *Wande marje no go ni se? Zankey marje no go ni se?*
5. *Ni gonda alman? Marje no go ni se?*
6. Mannan jaw waate, I go ni se? I man zabu walla i man tonton?
7. *Ni bey ka koy yamma walla nango fo ka cece goy? Man no ni koy? Soro marje no ni koy? Ni gay walla ni man gay?*
8. *Ni bey ka furo lokkol? Jiri marje no ni te?*
9. *Fari wone, a ga moru walla a si moru? Fari marje no go ni se?*
10. *Turi wofo go fari ga? Ni n'I duma walla I fatta dey no?*
11. *Haran, ifo nda ifo no ni duma?*

12. *Watifo ni na haini duma? Soro marje no ni duma? Ni bisinay walla ni man bisinay?*
13. *Man no ni du dumiize (haini)? Jiri kulu nodin no ni ga du?*
14. *Ni dan birji walla engrais walla hayfo fari ga?*
15. *Ni go ga ma kaddiya sanni kan I go ga ci rajo ga?*
16. *Wo kan I ci, A gonda hinfani walla a sinda? A gonda nanay?*
17. *Aran kwara borey, I gonda fahamey ka bey hala hari ga kan walla a si kan?*
18. *Ifo ka ci jiri hanno? Aran gay ka fay nda jiri hanno?*
19. **Bene hari a ga tar ga ka walla a ga gongorom? To, mannan a te walla a man te? Mannan fo? Mannan fo kan dake wone ga? Nda wo kan dake a ga?*
20. **Watodin kaddiya nda sohon kaddiya, I kulu fo walla I ga fay?*
21. *Sandeyan nda taliyan kan aran go ga di fari goyo ga?*
22. *Ni fari, a gonda labu albarkante? Nangukulu walla nangufofo? Fari kan go ni wono jerga, ingey labu a kulu fo walla a ga fay?*
23. *Za ni go zanka hala ka sohon, Fayankayan kan no go ga di ni fari ga?*
24. *Ni baba ka ni dondonandi fari goy walla? Ifo nda ifo no a cabe ni se? Ni go ga te haykulu kan a ci ni se? Sohon, borey sanda gomnanti alfari walla projet borey, I go ga cabe aran se fari goy?*
25. *Jiri kulu ni go ga te a kulu for ni far ga walla a gonda barmeyan?*

26. *Ni wande, a go ga duma hayfo? Ifo nda ifo a duma? Jiri kulu a ga duma? Mey no ga haggoy nda? A gonda riba walla a sinda?*

* only asked in ICRISAT villages

Appendix B: Rain Log

Day	Date	Time	Location	Details
Sat/Sun	21/22 June	12:30AM	Balleyara	Pretty hard rain for about an hour
Sun/Mon	22/23 June	2AM	Deyguindé	Same as above. Villagers plant millet the following morning
Thurs	26 June	4-6PM	Deyguindé	Huge rain! Flowing water in the goro. Kids playing in it afterwards, some houses washed out. Hail (gari) also! Collect and eat hail like it is glace. Such excitement and entertainment. All the hargu waate clothes come out. Lots of thunder and lightning. Nobody can pound millet since it is all outside.
Thurs/Fri	26/27 June	5AM	Deyguindé	Mostly wind and dust, some mimsi rain, lots of thunder and lightning. People planting beans, damsi and

				okra (inside concession) the next day. Farmers start the first weeding.
Sat/Sun	28/29 June	5AM	Deyguindé	Lots of lightning at 4AM, storm finally hits at 5AM and lasts into morning and beyond. Slow steady rains all morning, gray skies with no sign of clearing (makes going/walking the 2 hours to the market difficult) Goro to Bangario flooded again and more flooding on the way to Balleyara.
Tues.	1July	9PM	Niamey	Lots of lightning and only a bit of rain
Wed.	2July	9PM	Niamey	30 minutes of hard rain with lots of lightning. Niamey streets can't handle the rain —all turns to muck and perilous to walk!
Thurs	3 July	8PM	Niamey	Dust and wind storm only— no rain
Mon	7July	8PM	Deyguindé	Dust and lightning rolling in —storm interrupts focus group meeting. Deyguindé didn't get any of the previous few days rain so this is the first rain on over a week. Dust and some rain all night. Yeeni in the morning.
Wed/Thurs	9/10July	2AM	Deyguindé	Thunder and lightning rain storm. Lots of rain, still cool and a little rain by 9AM—will be one of those totally gray and overcast days.
Sun	13 July	5AM	Deyguindé	Lots of lightning and koussa, seems like no rain will come but comes starting at 7AM or so and lasts til 10AM and even still some mimsi leaving Deyguindé to Balleyara (again put off by rain). Balleyara didn't receive much rain.

Wed.	16 July	11PM	Maourey	Looks like rain, wind etc but just a bit of mimsi and storm passes.
Tues.	22 July	12 noon	Balleyara	Slow build up, mostly just mimsi and a bit more.
Thurs	24 July		Balleyara	Balleyara got 24 mm of rain —Niamey didn't get rain.
Tues	29 July	midnight	HainisiMoru	Looked like a good rain, but wasn't really. Really needed it—millet getting dry.
Sat	2 Aug	9:30PM	Maourey	Slow steady rain that finishes with mimsi by 1PM. Long good rain. Definitely needed this one—people were starting to worry.
Sun	3 Aug	11PM	Niamey	Huge rain! Wish I were in the village for it rather than in Niamey muck. Good sign since it is on National Tree planting day (always supposed to rain on this day and marks the beginning of "aout"- the month of lots of rain). Power goes out briefly. Violent storm with lots of thunder and wind.
Mon/Tues	4/5 Aug	5AM	Niamey	Late Mon night rain and Tues til 9 AM. Slow steady rain.
Wed	6 Aug	6AM	Sorgo Koira	Rain all day! Starting at dawn til 2PM—pretty unusual. Heavy at times. Stays cold and overcast rest of day.
Thurs	7 Aug		Sorgo Koira	Totally overcast and clouds all day til 4PM, but no rain
Fri	8 Aug	9PM	Sorgo Koira	Pretty good rain but not as huge as day before.
Sun/Mon	10/11 Aug	12:30AM	Sorgo Koira	Rains into late morning. Full moon. Sky turns totally black. Straight line of clouds across sky. Storm comes from south. Lots of rain and lightning (in field notes).
Fri	15 Aug	7PM	Dogondoutchi	Huge rain at sunset. Preceded by great wind and dust! Coming back from

				rocks on moped—very exciting (description in 18 Aug field notes). Lots of umbrellas, ends about an hour later.
Sun	17 Aug	12- 3PM	Dogondoutchi	Short but heavy duration rain. Floods streets. Rains later as we hit Dosso and then all the way to Niamey (in Balleyara said it rained for 4 hours…again!)
Sat	23 Aug	8- 9:30AM	Deyguindé	Not a huge rain but a good build up to it—cool dark clouds like the 11 Aug SK rain. Not really a lot of rain though.
Wed	27 Aug	4PM	Niamey	Rain in late afternoon—lots of dust, not much rain. More rain at night too.
Fri	29 Aug	12N	Niamey	(but none in ICRISAT-Sadore)
Sun	31 Aug	4- 7PM	Balleyara	Huge rain storm en route to Niamey. interesting to be part of it and in it (sort of) in bush taxi driving…
Tues	2 Sept	6- 7PM	Diantiandou	Not much in Falanga, but all the way back to Diantiandou more rain fell (less than 10km away but a hug difference!) Best part is always watching the approach of the storm—that deep blue color.
Fri	5 Sept	7- 10PM	Diantiandou	Long huge rain—75- 80mm. Had been hot all day, clouds forming around 5 PM, took 2 hours to start raining. Great storm.
Sat	6 Sept	7- 8:30PM	Diantiandou	Market day. Wants to rain for awhile- clouds finally form to south at 5PM, rain at 7PM (sunset). Storm from south and merges with east. Rains but not very hard til about 8:30PM.

Appendix C: Focus Groups

Village	**Date**	Location*	# **M**	**#W**	**Season**	**Indicators**	**"good" rainy**	**Comments**
Deygindie	7Jul 03 11Jul03	Chef's concesssion	20	30	H, C1/C2, H1/H2, R1	O2,O1,Z, AG AT,H,B,Z AT AT,O1,H	R, M, P	Late PM meetings after working in fields all day; 1st meeting interrupted by rain
Maourey	16Jul03 17Jul03	**M**:Chef's concession **W**:Women's president's concession	30	40	R2, C1/C2, H1	AT, B **W:** Z, B, AT,AG AT, B AT **W:** AT, B, O1	R, M	Late PM Meetings; Men's first (one woman present) Women's the following day
Haini Si Moru	27Jul03 29Jul03	**M:**Outside the mosque **W:**Women's president's concession	40	20	R2, C1/C2, H1/H3	AT, H **W:**AG, B, AT B **W:** B, AT, O3 AT, B, O2 **W:** B, O2, AT	R, M	Late PM meetings, Men's first (one woman present) Women's 2 days later (one male present)
Sorgo Koira	10Aug03	**M:**Under a tree by the mosque **W:**Chef's concesssion	21	25	R2, H, C1/C2, H1	AT, B, Z, H, O1 AT, H, Z **W:** O1 AT, H W: B AT, B, Z	R, M	Afternoon meetings on a market day—men's first, followed by women's (one male present)

Key

Seasons+

Heemar (harvest)= H
Jaw (lit:dry)= C1 *Hargu* (lit:cold)=C2
Haini (lit:hot)=H1 *Weyno* (lit:sun)=H2
Dungay (lit:heat)=H3
Kaddiya (rainy)= R1 *Korsalo* (rainy)=R2
+ most villages use both names for the given season

Indicators
Agricultural=AG
Atmospheric=AT
Astrological=ST
Botanical =B
Hydrologic=H
Zoological=Z
Other=O1=Health
Other2=O2= Food available
Other3=O3=Sociocultural

"Good" rainy
Enough rain for crops=R
Good harvest of millet=M
If plant in 7th month=P

* Location chosen by villagers, usually the chef, with some input from key villagers. Location tends to be the place where they are accustomed to having meetings

nb where women's answers are different, the additions are noted.

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