Water Management and Conservation in Rural Morocco

A Follow-up Study to AUI Pilot Implementation of Drip Irrigation

Completed at AL Akhawayn University

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Abstract

In the largely agricultural country of Morocco, climate change and increasing drought are depleting water resources and have severely damaged the livelihoods of farmers and the general population. Attempting to address these issues, Al Akhawayn University began a pilot project, through funding from the Canadian IDRC. Our project weighed the success of the AUI project in spreading the implementation of drip irrigation systems in the Ain Cheggag area, as well as improving the application process for government funding. In addition, we made recommendations for further extension.

Executive Summary

Much of Africa, including Morocco, is experiencing diminished water supplies due to climate change and growing population. Al Akhawayn University (AUI) completed a pilot project starting in early 2011 focusing on reducing the effects of these inevitable changes. AUI's project concentrated on reducing demand on water supplies through the use of drip irrigation for farming. Two farms in the Saiss Basin near the university had drip irrigation systems installed in order to demonstrate to others in the area its benefits and efficiency. In addition, a Technology Center was set up to aid farmers in getting government assistance for installing drip irrigation. The goal of our project was to assess the impact of the work done by AUI, and determine successes and failures of their efforts.

Background

Morocco is a nation heavily dependent on agriculture, which is responsible for 19% of the country's GDP. This is exemplified in the Sebou River Basin. The Basin is responsible for half of Morocco's sugar production, as well as the majority of the country's olive and leather production. The most fertile part of the Sebou River Basin is the Saiss Basin. It holds about a quarter of Morocco's arable land but only has a little more than a tenth of the country's water, and this water is being overexploited and poorly managed. As a result, the water table in the Saiss Basin has plummeted, falling 70 meters over the past 27 years, leading to ever deeper wells and less available water. The collective output from springs in the region has similarly fallen, from 24 cubic meters per second in 1970 to 15 cubic meters per second in 2007. Despite this shortage of supply, the demand for water has only continued to rise, and farmers must compete with cities and industry for the water they need. Exasperating the problem, the Sebou Basin is

home to approximately 6.5 million Moroccans, but by 2030 the population is expected to rise to 9 million.

Several government agencies manage Morocco's water usage. The country is divided into nine water basins, each with their own Water Basin Agency, or ABH, which were created following the Water Law of 1995 to regulate water flow and usage. The ABH manage water resources by controlling pollution, constructing dams and setting rules for usage. The Saiss Basin is included in the Sebou Basin Agency, or *Agence du Bassin Hydraulique du Sebou* (ABHS). The *Direction Provinciale d'Agriculture de Sefrou*, or the Sefrou DPA is another government regulatory body within the area.

In an effort to protect the region from severe shortages, AUI completed a project relating to Demand Side Management (DSM) of water which is the controlling water demand by reducing the amount of water used instead of supplying more water. DSM is more easily implemented on a small scale and can demonstrate its effectiveness without sourcing more water.

Drip irrigation is a very effective example of demand side management in farming. Through the project "Using Demand Side Management to Adapt to Water Scarcity and Climate Change in the Saïss Basin, Morocco," AUI installed drip irrigation systems and opened a Technology Center. Funding for the project was provided by the Canadian International Development Research Centre (IDRC). The pilot sites were pre-existing family farms run by two men with positive and trustworthy reputations within the community. The Technology Center in Ain Cheggag, near the two pilot farms was designed to provide farmers with information regarding farming techniques and assist in the application process for reimbursement for drip irrigation installation. The Center became the responsibility of the Sefrou DPA.

Methodology

To gather the information needed to evaluate the AUI Demand Side Management Project, we visited the farms, the Technology Center, and the ABHS. While in the field we conducted interviews and observed interactions between government officials and farmers, as well as their interactions with us. We then analyzed the sometimes contradictory information we collected using triangulation and evaluated of the dependability of our sources. Triangulation is a method of analysis where potentially opposing results from different sources are compared to find valid data.

We met with and interviewed farmers from the pilot farms of the AUI project who provided us with valuable information about both the installation of drip irrigation, and how it benefitted them. They also shared information concerning the process of applying for loans from the government after installing the drip irrigation systems. The second group of people we interviewed was the Technology Center officials, as well as other government officials in the ABHS. They were able to inform us about certain parts of the loan application process, as well as provide additional information about the Saiss Basin. The last group of people we interviewed was the professors from AUI, who originally completed the project. They were able to provide us with their opinion on how the project went, and how certain aspects of it could be improved.

We went on three field visits to the Technology Center, and Toufahi farm as well as two visits to the Ezzayani Farm, and one visit to the office ABHS in Fes. The team also made observations on the site visits about the interactions between farmers, officials, and researchers, including their reactions to us and our research.

Our visits with farmers proved to be the most beneficial to us as they had firsthand experience with the government refund processes, as well as with the installation of drip

irrigation systems on their farms. The ABHS supplied us with facts and figures about the water supplies within the Sebou Basin, future approximations of water quantities, proposed solutions for current and future water problems, and the building of dams.

Results

The interviews and observations conducted by our team provided an abundance of evidence regarding the successes of the AUI DSM project, as well as the difficulties that they encountered. To ensure accuracy, comparisons of all collected responses were made, to identify any glaring differences.

Our team found that farmers are aware of the benefits of drip irrigation and interest is very high; however the actual implementation of drip irrigation is not very common in the area among small scale farmers. The reason for this disconnect is the high upfront cost of installing the systems, along with difficulties that arise from customary practices among Amazigh peoples concerning land holding that makes it difficult to obtain mortgages. Following installation, farmers can apply for government reimbursement. The process of applying for reimbursement is complicated and lengthy, which serves to discourage farmers from implementing drip irrigation systems. Through the creation of the Technology Center in Ain Cheggag, the AUI Demand Side Management Project has slightly eased this process by having all reimbursement forms available in one location. Despite this, much inefficiency still exist, as the paperwork must go through several officials multiple times before being approved. Farmers also report having to check on the progress of their applications daily in order to keep them moving.

We also found after several visits to the Technology Center in Ain Cheggag that it is not being used very often. Center officials told us that the attendance at the center was low and

inconsistent. Limited publicity exists for the center and as a result, few people outside of the area know about it.

Conclusions and Recommendations

After reviewing all the information gathered from interviews and observations, our team decided that the main objectives of the AUI pilot study that are most important to the community were not yet fully satisfied. Although neighbors of the pilot farmers did recognize the advantages of drip irrigation, they did not have enough support to implement the systems in their own farms. Numerous obstacles stand in the way of the successful completion of other objectives set forth by the AUI study. Complex governmental practices, unwritten tribal laws, and long ingrained cultural behavior all had a negative impact on the success of "Using Demand Side Management." Furthermore, the Technology Center is not being used to its full potential, and publicity is needed in order to make it better known among nearby farms.

We suggest the following recommendations to address some of the obstacles mentioned above.

- Better Publicity for the Technology Center

  The main reason why the Technology Center is not functioning as proposed is due to the lack of knowledge about the center by farmers outside of Ain Cheggag. Advertising at the souk is an optimal location for spreading word about the Technology Center because farmers go to the souk regularly to buy or sell produce. Individuals currently get their information and news about where to get forms for reimbursement in the larger cities.

- Alternate location for Center

  We recommend that the DPA open a similar Technology Center like the one in Ain Cheggag in another more prominent agricultural area. Having a new center centrally located near a larger group of farmers will add convenience and thus, its usefulness and traffic will greatly increase.

- Collection of Forms

  Currently farmers may pick up forms for reimbursement at the Technology Center; however they must then be submitted elsewhere. By allowing for the collection of forms at the center, the application process for reimbursement would be greatly simplified. In addition, if forms were faxed from the center, the process would be further improved by saving time and money.

- Online Application

  Our final recommendation is to implement a web-based submission service for reimbursement, thus reducing recirculation of paperwork and increasing efficiency of processing. Some potential obstacles to this would be the setup and maintenance required for a web-based service, as well as the resistance to technological change exhibited by both the famers and the government.

The people of Morocco are facing rapidly depleting water tables and must make an effort to reduce their demand on this shrinking water supply. Al Akhawayn University's study demonstrated the benefits of drip irrigation but has not yet affected the spread of conservation techniques to other small scale farmers. Minimal change was made regarding government attitudes, and the reimbursement process is still very difficult. Several propositions

have been made in order to ease and streamline this process for the farmers to allow for more widespread water conservation.

Acknowledgements

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1 Introduction

Water is scarce in North Africa as well as parts of Southern and Eastern Africa and in the Middle East. North Africa is very dry, with an average annual precipitation in Morocco of 45 cm (Varangis et al., 2001). As a comparison Worcester Massachusetts' annual rainfall is about 124.6 cm, nearly three times the amount in Morocco (Worcester, 2012). In recent years the occurrence of droughts in Morocco has increased and water tables have been depleted. Adding to this, the rising water consumption in the area is being poorly managed and much of the water is going to waste. Water scarcity in North Africa is having a variety of impacts including desertification, drying out of the land, inability to irrigate farms and a decreased crop yield (Legrouri et al., 2012). In addition, social issues concerning water distribution and consumption among villages are not resolved and are causing instability and conflict in the region (Haddadin, 2001). The insufficient amount of water is also having a progressively greater impact on current and future generations of farmers by limiting the variety of crops they are able to grow in certain regions as well as forcing them to learn how to conserve the water they do have (Legrouri et al., 2012). Humans, however, do have control on how they manage water, but unfortunately have chosen to grow crops that require heavy irrigation in areas that are not able to keep up with the water use. The limited supply of water in North Africa is no longer being prioritized for farming but rather for domestic and industrial use, drastically affecting the farming industry (Rosegrant and Ringler, 1999). This means that there is a great increase in industrial water usage that is gradually requiring the transfer of water out of agriculture.

Morocco is particularly affected by scarcity of water. Population growth along with the shrinking water supply is beginning to cause shortages. The increasing population in Morocco

has made obtaining and conserving water a pressing issue in poorer rural communities. On the water supply side, drought in Morocco has become more prevalent in the past ten years and it is predicted that the total precipitation will decrease an additional 4% over the next 20 years (Rochdane et al., 2012). In recent decades the occurrence of drought conditions has increased notably to 1 year for every 2-year period. In the past half century, the growing season has decreased from 150 days per year to 110-130 days as a consequence. A substantial portion of Moroccans are subsistence farmers and grow only what is needed to live, and as a result precipitation levels are a key factor in the survival of these individuals and their families (Aldosari, Ali 2006). Therefore, the magnitude of this issue is great inasmuch as a wide span of Morocco is being affected by this problem.

To help alleviate the growing water scarcity in the area the Moroccan government has begun several water conservation initiatives in addition to those started by several Non-Government Organizations, such as USAID and the International Development Resource Centre, foreign governments and Al Akhawayn University. In the past, focus has often centered on issues regarding the supply of water whereas newer projects focus on the demand side of conservation (Baroudy, Ellysar 2005). Conservation on the demand side puts emphasis on resource management and their efficient use. The local water basin agencies have been working for years to promote water conservation, and a series of practices that improve efficiency of water use.

A particularly hard hit section of Morocco is the Saïss Basin. A subset of the larger Sebou River basin, the Saïss basin is home to approximately a quarter of Morocco's arable land and 11% of the country's water endowment (Legrouri et al., 2011). The Saïss Basin's water supply is being severely and unsustainably overexploited, and there are no additional sources of

water to augment what is there. In this situation, demand side management is the most practical way to control the growing water problem (Legrouri et al., 2012).

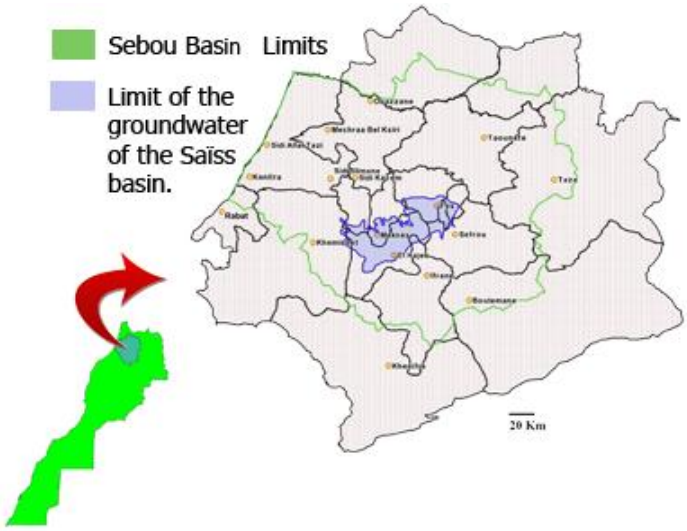

Figure 1: Map of the Sebou Basin Area

One very effective method of demand side management is the replacement of traditional methods of irrigation with drip irrigation. In order to demonstrate the practicality and efficiency of drip irrigation on smaller farms, Dr. Ahmed Legrouri of Al Akhawayn University initiated a program to install drip irrigation systems on two farms located in the Saïss Basin. The two farms were that of Mr. Said Ezzayani, and Mr. Driss Toufahi, both of whom were willing to try out the new system to prove to other farmers that drip irrigation has positive effects on their farms. The study, called "Using Demand Side Management to Adapt to Water Scarcity and Climate Change in the Saïss Basin, Morocco," referred to herein as "Using DSM," also set up a Technology Center to aid farmers in receiving government assistance in installing drip irrigation. The goal of the project was to increase awareness of the practicality of drip irrigation on small farms and to

facilitate better communication between the farmers and the various government agencies tasked with water management and farming.

Figure 2: Traditional irrigation near Ain Cheggag (left) and Tofahi's pilot farm using drip irrigation (right)

The two pilot farms in the project were chosen based on the farmers' reputation in the communities, as they were considered to be leaders in the community as well as reliable, so that other farmers would take heed of the results produced. When the drip irrigation systems were installed on each farm, a presentation was held by the university with government officials from the Technology Center and *Agence du Bassin Hydraulique du Sebou* (ABHS), the Sebou Basin Agency, for other local farmers to show them how the system worked and how it could save water, reduce labor, and produce better crops (Legrouri et al., 2012).

After the AUI Demand Side Management Project was completed, the Technology Center was left under the control of the *Direction Provinciale d'Agriculture de Sefrou*, or the Sefrou DPA, without any further supervision or input from the university. The pilot farms were also left with their new irrigation systems in the hope that other farmers would take interest in this alternative irrigation. This project assessed the actual success of "Using DSM" and determined whether the project could succeed without additional oversight from the university.

After reviewing the stated goals of the project, we selected the three that had the greatest focus within the AUI study. Of the project's five initial objectives, two were discovered to have been accomplished externally from AUI's Demand Side Management Project. From the remaining objectives we derived our research questions. Our first question was finding out what effects the seminars and pilot farms had made on local attitudes and actions regarding drip irrigation. We wanted to find out whether the pilot study had an actual role in encouraging other farmers in the area to adapt drip irrigation, changing their traditional farming techniques and methods of farming. The second question we had to explore was what local and ministry policy changes occurred as a result of the Al Akhawayn project. One of the goals of the AUI project was to strengthen local authorities and ministries, improving the enforcement of water management. We planned to determine if there had been any progress after the study towards these goals, and if that progress had been maintained after the completion of the study. The final part of our research was assessing if the beneficial interactions between the farmers and the government, as well as with each other, about water policy improved or not.

The goal of our project is to assess the outcome of the AUI pilot study, which aims to address local over-consumption of water through the installation of drip irrigation systems on two farms to serve as examples of demand side management. In addition, the AUI Demand Side Management Project set up a Technology Center in order to provide farmers with assistance in receiving government funds for the installation of drip irrigation, and our research investigated the current effectiveness of this center. The research in this project allowed us to provide recommendations to further the original goals of the AUI pilot project.

2 Background

Water is an incredibly valuable resource, often unappreciated in societies where it is easy to acquire; however the entire world needs to be aware of its immense value. There are freshwater supply concerns throughout the world, most commonly caused by the changing climate. In Africa in particular, drought resulting from climate change is a growing fear. The Sebou Basin within Morocco is the focus of our project and is experiencing a rising demand for freshwater in addition to its decreasing supply. Extensive coastlines along Morocco provide access to salt water; however this water cannot be used in traditional irrigation and desalination technology is not cost effective (Beltran, J. M., & Koo-Oshima, S., 2006). Conservation and regulation practices have already been put in place by both government and independent organizations; however there are gaps in finding a successful solution to water shortages in Morocco.

2.1 Water Supply Issues in Morocco

Over the course of the past few decades it has become increasingly apparent that North Africa will suffer from a severe water shortage in the near future. The shortage has already begun to manifest itself in the form of increased drought and through the drying up of wells, and if current trends continue the effects promise to cripple agriculture in the region. Despite humidity along the northern shore from the Mediterranean Sea and from the Atlantic Ocean on the west, the region also experiences the threatening advances of the Sahara desert's dry air. Morocco is largely agricultural with 19% of the GDP coming from agriculture and depends vastly on its fresh water supply ("Investment", 2012). Additionally, 40% of the population is dependent on agriculture (USDA, 2009). The depletion of this resource may prove to be nothing less than devastating for the farmers reliant on it, and as a result to the country as a whole.

2.1.1 The Saïss River Basin

The Saïss Basin is a highly relevant example of the water supply concerns seen in North Africa, and specifically within Morocco. The Saïss Basin is the central part of the larger Sebou River Basin, which drains to the Sebou River. The Sebou Basin is pictured below, along with the other water basins of Morocco.

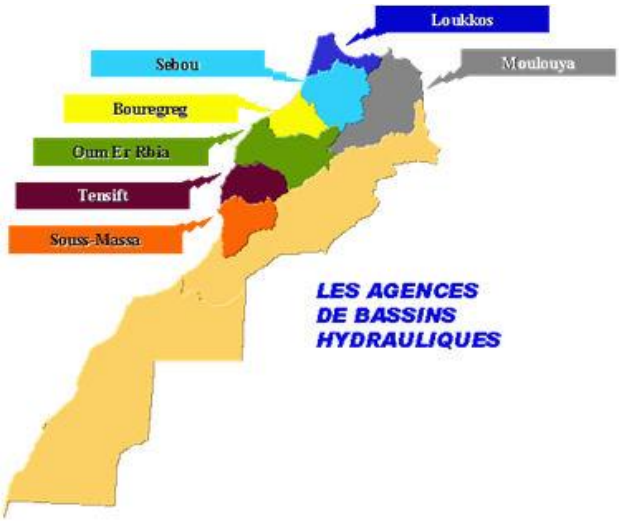

Figure 3: Seven water basins of Morocco

Figure 4: Map of the Sebou Basin

The Sebou River flows northward through the major city of Fez, and then eastward to the Atlantic Ocean.

The Saïss Basin's supply is used to its fullest extent. It is responsible for 11% of Morocco's annual water endowment, providing water for 1.8 million Moroccans, and possesses a quarter of the country's arable land. Over 82% of the water supply from the Saïss basin is used for agriculture, irrigating 37,000 hectares, or over 140 square miles. Of this vast area irrigated by this supply, only 22% of it is irrigated using drip irrigation techniques (Legrouri et al., 2012).

2.1.2 Decreased Water Supply

One of the largest factors in the changing water situation in North Africa is climate change, and this is no different in the Saïss basin. Over the past 40 years, from about 1967-2007, precipitation in the region has been decreasing significantly, coupled with a 1°C increase in temperature. This temperature change, measured in Ifrane, corresponded with an approximately 33% decrease in precipitation over the same interval. The rate of decrease has slowed over the past several years however. This decreased rainfall, along with the significant increases in water usage, has led to a significant drop in the water table, with immediate and severe effects. As of 2007 total output from all the springs in the basin has decreased from 24 cubic meters per second to 15 meters per second since 1970, resulting in a severe decrease in surface water flow. Additionally, at a monitoring station at Hajj Kaddour in the basin, the water table has dropped by 70 meters over the past 27 years (Legrouri et al., 2012). This decline is by no means an isolated incident. Another example of a lost water supply is the Ain Amer spring, which went from a flow of over 90 liters per second in the early 1980s to less than five liters per second in 1997 (Benaabidate & Cholli, 2011).

Water scarcity is a product not only of the decreasing supply due to climate change, but also increasing demand. The increase in population and non-native crops has resulted in a rising demand for water which will be examined in the following section.

2.1.3 Rising Demand

Despite its growing unavailability, the demand for water in Morocco has been steadily increasing. One of the greatest causes of additional water usage has been the cultivation of crops that require heavy irrigation. These tend to be crops that are not native to the region, but sell well: examples include apples and peaches. As a result, farmers can turn a higher profit, and they tend to ignore the effects of the crops on the water in the region. In the Saïss region, over 11,000 acres are being used as apple orchards.

On top of the rising agricultural usage, the growing population of the country poses a water demand problem. Over the past fifty years the population of Morocco has quadrupled, and by 2030 the population is expected to grow by another 5 million (Legrouri et al., 2012).

2.1.4 Impacts of the Imbalance between Water Use and Supply

The growing demand for water and shrinking supplies are leading to severe water scarcity. As a result of the scarcity, people have had to take more and more drastic measures. For example, in response to dropping water tables, farmers have drilled more and deeper wells in order to maintain the water supply needed for their crops. Since the 1980s the number of wells in the region has shot up from "a handful" to over 9,000 (Legrouri et al., 2012). These wells have only been compounding the problem by leading to increased water drawdown, and causing the water table to drop further. As wells are drilled deeper, they pull more water from deeper in the water table. As a result, farmers drill more wells, and the cycle continues. For example, Mr. Toufahi at the Ain Cheggag Pilot Project had a supplementary 146 meter well that he dug because the water from the canal was simply not enough (Toufahi, Personal Communication, September 3, 2012).

2.2 Water Conservation and Regulation

Water scarcity within these regions requires attention before the severity increases. Several agencies have begun to promote practices that conserve and regulate water, so that these water scarcity problems can be alleviated. There are several different governmental agencies involved with water management in Morocco.

2.2.1 Water Basin Agencies (ABH)

There are several governmental agencies in Morocco tasked with the conservation and preservation of water resources in the country. Many have worked within the Sebou Basin specifically, whereas others focused on similar locations. The Water Basin Agencies were created after the Water Law of 1995 in Morocco and are the more prominent organizations in the regulation of water flow and usage. The Water Law was put in place in order to protect and preserve water resources, monitor wastewater discharge and to encourage re-use of treated wastewater (METAP). The water basin agencies play a very important role in ensuring that laws are followed, and the agencies are responsible for the maintenance and care of their designated water basin area. Seven water basin agencies were created as a result of this law. The Saïss Basin Agency includes the cities of Ifrane and Meknes, as well as the surrounding villages that are the focus of this project.

2.2.2 International Development Research Centre

The International Development Research Centre (IDRC) provided funding for the project conducted by Al Akhawayn University in 2011. The IDRC was established by an act of Parliament in 1970 as a Canadian aid corporation. Through the use of technology and science, the IDRC is able to assist individuals and groups in developing countries to find solutions to the everyday problems they face. Aside from financial assistance, they also provide advice and

training in order to make the most use of their scientific and technical knowledge by spreading it to those who could benefit most from it. The goals of the organization are to aid in the progress within developing countries, which will in turn "lead to healthier people, higher incomes, cleaner environments, and responsible governments" (Supporting local research, finding lasting solutions).

2.2.3 Water Demand Management

Water Demand Management (WDM) is a system of methods designed to reduce the burden on freshwater supplies and preserve its quality. The aim of these efforts is to motivate people and to have people be more aware of water conservation in their actions. By doing so, the amount of water accessed, manner in which it is accessed, and the price paid for it can all be reduced through proper water management. The need for WDM is increasing as the supply of freshwater and its quality continue to drop. Conservation and more efficient use are both crucial. The methods used in demand management are varied, but tend to include the use of technology, incentives, regulations and market systems (Baroudy, 2005).

For decades, Morocco focused on managing supply through efforts such as building dams, however, the amount of water the country currently has available is declining and as such supply side methods are proving ineffective (Patel, 2010). In order to more successfully control water problems, the demand-based management system was promoted and mandated through local water basin agencies and efforts to implement water saving practices such as drip irrigation.

2.3 Drip Irrigation

Drip irrigation can be a very efficient method of irrigation, depending on the application, often more so than typical overhead sprinkler irrigation used in the developed world. Sprinkler systems that spray water into the air above the plants in linear or rotary fashions are often used

for irrigation but are less effective in arid climates like in Morocco. It is also significantly more efficient than the traditional form of irrigation used in Morocco, using as little as a third as much water (Legrouri et al., 2012). Drip irrigation runs hoses with drip nozzles through fields, delivering water directly to the plants' root zones. Water flows through a polyethylene tubing with distributed punctures or nozzles that allows for an increased crop growth while reducing the water use. Since the water is delivered directly to the ground, there is less risk of evaporation and run off during irrigation making it ideal for locations looking to conserve water resources (Information of the types of irrigation systems). In addition to using less water, drip irrigation also limits the growth of weeds, and produces better quality crops, yielding as much as twice as much produce per field, while requiring less labor (S. Ezzayani, personal communication, September 3, 2012).

2.3.1 Implementation of Drip Irrigation in Pilot Farms

Drip irrigation systems were set up on two pre-existing farms in the Saïss Basin for the pilot study by Al Akhawayn University and were funded by Canada's International Development Research Center (IDRC) and the UK's Department for International Development (DFID). The study was conducted by Dr. Ahmed Legrouri, Dr. Jack Kalpakian, and Dr. Driss Kettani from AUI. The methods used for data collection in the project were participatory observation, a KAP (Knowledge, Attitude and Practice) survey, and observation of the two drip irrigation pilot farms. The KAP survey proved that the farmers within the region were aware of the negative effects of climate change and the existence of drip irrigation. It was also concluded that the main reason for not implementing drip irrigation systems was the lack of capital of the farmers.

One reason for the inability of farmers to raise capital is that they cannot mortgage their land. The country of Morocco is heavily influenced by former tribal practices of Amazigh

peoples, especially in rural areas such as the mountainous terrain of the High and Middle Atlas. There are long standing laws among those in these tribes regarding land and water rights. Due to the scarcity of water throughout many parts of Morocco, farmers and families are given certain allotments of water. Often, land rights are directly correlated to water rights and when land is sold, the water rights are sold with it. However, poorer individuals may sell part of their water rights separately to a wealthier neighbor which in turn reduces the overall value of the land (Hart, 2000). Collective forms of landholding make it difficult for farmers living in tribal areas to mortgage their land or use it as collateral, and as a result it is more difficult for them to acquire principal to use for the installation of drip irrigation systems. (J. Kalpakian, personal communication, September 3, 2012)

The pilot farms in the region are Mr. Said Ezzayani's farm in Bitit and Mr. Driss Tofahi's farm near Ain Cheggag. Both of these farms are currently using the drip irrigation technology that was set up about a year and a half ago in early 2011. The purpose of these sites was to physically demonstrate to other farmers in the area the benefits of drip irrigation (Legrouri et al., 2011, IDRC Short Report). Both of the farms had drip irrigation systems installed in their main fields after ensuring they would support of other farmers by sharing their experiences in workshops. As a direct result of this project, the Zoubiya Cooperative, a group of small household farms, joined their efforts and built a reservoir as well as implemented a drip irrigation system across their land. The Zoubiya collective is an example of the intended result expected the project, and the fact that such a collective began while the project was still running was encouraging.

Figure 5: Filter and pump on Toufahi farm (top) and reservoir on Ezzayani farm (lower)

2.3.2 Water Canals

Current methods of supplying water for irrigation in the Sebou Basin region primarily consist of open air canals. Large canals run from the source of the water down to smaller branches of canals or directly to local farms. These canals are incredibly inefficient, losing water to ground seepage and evaporation (Bisson et al., 2008). In some cases, including the pilot farm in Bitit, even when sufficient water supplies arrive from a canal, it may not be clean enough to use. As the water flows to the farms, children and animals can get into the canal. Children can be

seen playing and washing in the canals upstream, which results in water contaminated with soaps and other residues arriving at the farms further downstream.

Figure 6: Children playing in a small branch of the canal near Ain Cheggag.

According to a conversation with Said Ezzayani, one of the pilot farmers, the canals cannot be covered due to the growth of algae and other organisms, causing clogs and potentially harming crops. The problems resulting from the use of uncovered canals and reservoirs are larger than just contamination. Water loss due to evaporation is also a concern due to the high resting temperature of the water. Furthermore, plants growing on the sides of the canals siphon off more water resulting in additional water losses (J. Kalpakian, S. Ezzayani, personal communication, September 3, 2012)

2.4 Summary

Worldwide climate change has led to water supply issues across the globe, many of which are increasing in severity each year. Drought is a common occurrence throughout Africa and is negatively affecting the livelihood of rural farmers. The dwindling supplies of water and

traditional, high water usage farming practices have had a great impact upon the Saïss Basin in Morocco. Water conservation and regulation are not new concepts to the region and many agencies and programs have addressed possible solutions, including the project conducted in 2011 by Al Akhawayn University. This project will gauge the results of the AUI Demand Side Management pilot project based on interviews with the farmers and government officials originally involved.

3 Methodology

In order to acquire the necessary information to address our research questions, the group made several trips to several different sites involved with the AUI pilot study in order to interview relevant individuals and observe the interactions between these individuals, their interactions with us and the state and usage of facilities. The interviews were prewritten sets of questions in the appropriate language for the interviewee, along with a set of follow up questions determined on site based on the data received. The observations conducted focused on the behavior of the interviewees, as well as observations of the condition of facilities and equipment. Data gathered from interviews was combined with these observations.

3.1 Data Sources

Our two sources of information were interviews conducted with individuals related to the project and observations we made on several trips to the field. The interviews were conducted with farmers, government officials, and researchers who worked on the project. In order to conduct interviews with the farmers, we visited them on their farms several times, to address different questions that arose as the project proceeded. Interviews with government officials consisted of with meetings with the Sebou Basin Agency and the DPA staff at the Technology Center in Ain Cheggag. The meetings were held at the agencies' respective offices with either our WPI advisor Bland Addison or one of the researchers who participated in the original research. Interviews were conducted either in Arabic or French, and the team was assisted in such interviews by Arabic or French speaking students or professors at AUI or WPI. In addition, the team included a member who spoke Modern Standard Arabic. Our contact with the professors at AUI involved meetings them in their offices and discussing related issues in English, as AUI is an English-speaking institution.

All of the different groups of people we talked to had separate views on the matter at hand, adding different perspectives to the information we gathered. To reconcile this sometimes contradictory data, triangulation was used, weighting different answers based on the frequency of their occurrence and the reliability of the sources.

To complete our data, the team made observations on several site visits in order to more fully understand the interaction between farmers, officials, and researchers including their reactions to us and our questions. For these observations, we were specifically looking for aversions to answering specific questions, any sign of overstated results, or behavior that would indicate an attempt to misrepresent the results of the AUI study for better or worse. In addition, we looked at the state of relevant spaces and equipment to see if data from the interviews matched with the physical state of affairs.

Figure 7: Officials from the Technology Center followed us to Toufahi's farm on our second visit

3.2 Study Group

All of the people interviewed were directly involved with the project and were therefore familiar with the intended outcome of the pilot project as well as familiar with each other. Due to our limited time and resources we were unable to bring in any participants from outside the original "Using DSM" project.

The farmers had achieved levels of education ranging from graduates with college degrees to basically no schooling, and could be considered illiterate. Both farmers are males and the heads of their households, and both have additional family in the household, from siblings to sons. They are linguistically Amazigh, or Berber, and were fluent in additional languages from Darija to Modern Standard Arabic and French. They own between one and three and a half hectares, of which drip irrigation was installed on between 0.8 and one hectare. Their water is either solely obtained from the canal or supplemented by an illegal well. The primary crops grown range from vegetables such as onions, potatoes and green beans to olive trees.

The government officials at the Technology Center were all males, while one of the officials at the ABHS was a woman. We did not gather any further information about the officials.

The AUI professors were all males with Doctorate degrees ranging from computer science to international studies.

3.3 Measures

The interviews were conducted with several different groups of people, and despite the differing nature of these groups many of the questions asked were formulated to determine the same data. The IQP group designed the questions based on the information that was needed to

answer our research questions, and were specifically tailored to each group of interviewees. For example, questions regarding changes in the processing of paperwork were addressed to government officials and not farmers.

The farmers were asked about their experiences with the actual drip irrigation system itself, such as differences in water usage patterns and changes in profits. They were also asked about changes in their interaction with other farmers and government officials, as well what they thought were the lasting changes due to the project. The first questions that were asked were simple questions about the success of the drip irrigation installation and the effects it had on their farming practices and crop yield and quality. Once the conversation had been opened, we moved to questions involving the results of the AUI Demand Side Management Project, whether they thought that other farmers would be more willing to adopt drip irrigation after seeing its use on the pilot farms.

The employees at the Technology Center were asked about their involvement with the government reimbursement program for drip irrigation, as well as their beliefs on the effects of the project. Once again we opened with simple questions involving the expected use of the center and moved to questions regarding their observed results of the AUI Demand Side Management Project and their thought on it. For this interview, we had Dr. Kettani acting as a mediator and translator, as the DPA employees responded well to his authority.

Finally, the employees at the ABHS in Fes were asked about what they knew of the "Using DSM" project, what they thought its effects were, and their role in helping in the reimbursement of farmers for drip irrigation installation. As with the other two interview groups, we began with questions regarding the function and goals of the agency and moved to more pertinent questions.

We did not have any specific questions prepared for the AUI professors, but instead went to them for advice on several different parts of the project and received a large amount of important background material, such as information about landholding practices, problems they ran into while conducting the study, and which groups of people were reliable and why.

For the complete transcript of all the questions asked to farmers, DPA and ABHS officials, see Appendices D, I and L.

3.4 Data Analysis

Our analysis of the data gathered consisted of comparing the perspectives expressed to us by our different sources. As so much of the data was potentially contradictory, we employed triangulation in order to determine what was actually happening. Triangulation involves using multiple sources to double or triple check information. In our case, with several sources of sometimes conflicting information, this involved determining which answers occurred the most frequently and from the most reliable sources. The reliability of sources was determined based on evidence we gathered through observation and through different sources giving us the same answer. Unfortunately, due to our short time in Morocco we were not able to build up long term relationships with the people involved in the study in order to better evaluate their trustworthiness. Instead, we drew upon the knowledge that the AUI professors had gathered during the course of their study, as they had been involved with these groups of people for several months and their assessments coincided with our observations.

These contradictions in information from separate sources were a marker of subjects that could potentially be very important as different people wanted us to believe different things about them. Some of the people involved in the study may have been attempting to use us to further their own objectives, as we are foreigners and were associated with AUI throughout the

course of our work. In this region, AUI holds a lot of importance as it is a very prestigious institution. In addition, as foreigners, people may have wanted to put their best foot forward, sometimes to the point of obscuring facts. Aside from this, some people may have seen our interviews as a chance to discuss their frustration with the current lack of progress in extending drip irrigation.

Additionally, we looked for the opposite evidence, where the same theme occurred in answers we were getting from many different sources. This was another marker of an important point, one that everyone agreed on, indicating that it was a well-established idea.

3.5 Summary

Overall, our method for information gathering consisted of a series of interviews with several different groups as well as observations. The interviews were conducted with interviewees of widely ranging backgrounds and perspectives, and were prepared to fit specifically with our knowledge of each group of interviewees in order to obtain the best information possible. The information that was gathered was often contradictory and was therefore subjected to triangulation. The team also paid special attention to data that was the same from several different sources. In addition to interviews, the team also made observations in order to look for behavior that might indicate that the interviewee may be concealing information or attempting to obscure facts. Through these methods, the IQP team was able to gather and analyze sufficient data to answer the posed research questions.

4 Results

Interviews and observations produced enough information to draw certain conclusions about the success and remaining problems of the "Using DSM" pilot study. To arrive at these conclusions the team had to reconcile contradictory information from different interviewees. Various methods of analysis were used to eliminate the responses with the highest level of bias and conflicting information as well as to eliminate responses from unreliable sources. Through this analysis the group was able to develop a more reliable assessment of the true conditions in the village and in the community.

We performed an evaluation on the pilot project based on the goals they initially set out for themselves. The AUI Demand Side Management Project had a distinct set of objectives to achieve, including:

- Demonstrate through pilot projects and the development of a Technology Center the value of DSM and the economic use of water with small-scale farmers.
- Strengthen local authorities and ministries so that enforcement, policy, and management of water throughout the region could be improved.
- Facilitate greater communication and interaction between the farmers and the government as well as promote greater communication among neighboring farmers about the benefits and techniques of drip irrigation

From these objectives we were able to determine the successes of the AUI Demand Side Management Project, as well as where there was room for future improvement.

4.1 Local Attitudes and Actions

The first objective of the project conducted by AUI was to improve awareness and usage of drip irrigation through the creation of pilot farms and a Technology Center. In this study we addressed the effects of the pilot farms and seminars on local attitudes and actions regarding drip irrigation and farming. Through our observations, we have found that while knowledge and interest in drip irrigation has increased the barrier to entry remains unattainably high for small farmers. As evidence of this problem, one of our interviewees, Mr. Driss Toufahi, told us that installations are encouraged; however the means to start such a project require the farmer to have prohibitive amounts of capital. The bureaucratic process necessary to achieve funding for installation of a drip system is too complicated for the farmers to deal with, and they would rather keep inefficient customary systems of irrigation to grow traditional crops. Those are the main reasons why many of the farmers in the area are not installing drip irrigation systems.

The AUI Demand Side Management Project resulted in some changes in local attitudes and actions that were of great impact on the farms and community; however there are many desired changes that did not occur. Interest in drip irrigation is high as a result of the implementation of the pilot farms. In our visit to Mr. Said Ezzayani's Farm, he told us that most of his neighbors knew about drip irrigation after the installation on his farm. He also told us that 90% of his neighbors do not have drip irrigation because of the paperwork and documentation needed to receive funding, not because of a lack of desire on their part to acquire such systems. The seminars held through the Technology Center at the start of the project regarding fertilizers and seeds have been very informative and well attended according to Dr. Jack Kalpakian, who was among the people to initiate the project. Despite these seminars, it does not appear that the Technology Center is used much otherwise now. We interviewed two officials in the center on

October 3, 2012, and they told us that the center is not being used anymore. The people in the village are not making use of it in the way that it is supposed to help them. This is not due to any fault on the part of the villagers; rather, the Technology Center has not performed any advertising or other programs to improve public knowledge of its existence, such as sending out flyers showing the village the capability and purpose of the center. On two separate unannounced visits to the center performed by the IQP group, the doors to the center were locked and looked unused, as shown below.

Figure 8 - The Technology Center, closed on one of the team's visits

When the group conducted an announced visit to the center on October 3, 2012, in order to conduct interviews with center employees, the officials opened up the room where help sessions were held, as well as where the computer is stored. We observed that most of the surfaces in the room, including chairs and tables, were very dusty, possibly indicating that the room had not been used in several weeks. These observations were backed by statements from

the DPA officials that the room received very little use, and that even attendance to the seminars that were held had dropped off after AUI's presence was removed from the project.

4.2 Changing Relationship between Farmers and Government

Another important research question that we posed in the evaluation of the AUI pilot project was to find out if the farmers' interactions with the government and with each other changed after the project, and if they had, in what manner. Our research indicates that the government has only minimally improved the process of applying for loans and grants for irrigation. Farmers, as well as professors at AUI, gave us examples as to how the government could do a lot more to ease the process of the applications, and other issues that go along with the installation of drip irrigation systems.

Farmers' interactions with the government consist of the application processes, the guidance the farmers get from government officials, and ultimately receiving financial support for installing drip irrigation. Farmers go to the DPA in Sefrou to get the forms needed for the application process that will give them the grants to pay for their drip irrigation systems. After completing the necessary paperwork farmers have to wait a period of 2 to 4 weeks to receive the grants or loans and can be covered for up to 100% of the cost of installing the system, depending on certain criteria the government establishes such as farm size and equipment quality. Our investigations suggest that these paperwork interactions were not made easier by the pilot project. However, communication among farmers concerning agricultural techniques and improvements has definitely changed for the better after the implementation of the project as we found reports they are exchanging ideas about the new systems they have, discussing the prospects of actually installing drip irrigation systems if they can.

We met with Mr. Abderrahman Haddourha, who is a communication manager in the ABHS, who gave us valuable information and data about the application process and how much the government grants farmers depending on the quality of equipment they have, and on the actual crop yield they are obtaining. Unfortunately, despite what the officials at the ABHS said to us, applying for these loans and getting all the necessary paperwork in order to install the system is a lengthy and difficult process. In a conversation with Dr. Driss Kettani, a professor at AUI and an integral participant in the original project, we learned of his personal experiences in applying for government assistance for installing drip irrigation. He purchased a piece of land for himself and then went through the process of applying for funding for drip irrigation on his land to test out the system the government was running. He went through the process as though he was a farmer and he said that it took him almost 3 years to finish paperwork that is complex and lengthy (D. Kettani, personal communication, September 27, 2012).

Bureaucracy within the state and sheer amount of paperwork required in applying appears to discourage individuals from applying themselves. Mr. Said Ezzayani, our main farmer interviewee, told us that the reason his neighbors are not all installing the drip irrigation system is because they have to pay all the money upfront and then after all that is set up they can apply for loans and grants. This evidence suggests that that the goal that Al Akhawayn had set out to achieve, which was to strengthen local authorities that are related to the processes in the applications, was not fully achieved. We found evidence that proved that the process is in fact quite long and discouraging to the farmer, and that is the reason why many farmers are not going ahead and applying.

It should not go without mentioning however that the governmental reasoning behind the excessive paperwork processing is to prevent opportunities for corruption. By having a

systematic approach to the process, involving checking paperwork, the government is attempting to control corruption. Unfortunately, if this process is not done in an efficient manner, it can lead to unnecessary delays and hold-ups in an otherwise appropriate effort to fairly distribute government funding.

Farmers' interactions with each other have changed since the project began. The pilot project sought to enhance communication among farmers so that ideas of drip irrigation might spread and build stronger collective relationships aimed at agricultural improvements, and this seems to have been the outcome, at least to some extent. Many farmers seem to be interested in the drip irrigation systems, and we received word that the pilot farmers had received several inquiries about their experience. There is no doubt about the interest in drip irrigation systems; however the process of acquiring government funds has proved to be a serious complication in extending the use of drip irrigation.

4.3 Changing Government Procedure

One of the most important goals of the Al Akhawayn project was to change the way that the government acted in regards to water management policies on local and regional levels. From our research and observations, we have concluded that there were no lasting changes in the actions or policies of the Sebou Basin Agency. The Sefrou DPA, who runs the Technology Center, did however experience change as a direct result of the project, most obviously the installation of the Technology Center with all of the forms available to the farmers in Ain Cheggag. In addition, farmers expressed some trust of the DPA as they are seen as more local and dependable (S. Ezzayani, personal communication, September 19, 2012), however we have no way of knowing whether or not this was as a result of AUI's "Using DSM" Project.

Before the project, getting government assistance for the installation of drip irrigation was a challenging process, requiring large quantities of time. We heard frequent complaints of corruption and favoritism that undermined a governmental process designed to help famers save money and conserve water. While we ourselves cannot establish that corruption exists, there is no doubt that there is a widespread popular perception that the application process is plagued by irregularities. There is still distrust of the Basin Authority among farmers, and the Basin Authority is still reluctant to work on the social side of any of the problems, instead preferring technical solutions (J. Kalpakian, personal communication, September 3, 2012).

At the meeting we had with ABHS representative Mr. Abderrahman Haddourha, he told us that dams are being built and research is being done to do something about the water table levels dropping. However, none of this matters if there is no effort to change social practices and customs that will make technological changes effective. Additional evidence from the DPA officials at the Technology Center contributed to this conclusion; the farmers were aware of the water problem but they did not know what they could do about it, even when the ability to install drip irrigation was within their reach.

Although the actual change was limited, the officials at the DPA did have an attitude that could be receptive to change. They expressed frustration with the current practices conducted by upper levels of government, and condemned the reported corruption. Additionally, they identified the pilot project as a step forward. Once again, it is difficult to be sure how much of their positive attitude toward change was as a result of the AUI Demand Side Management Project, however it definitely had an impact (E. Abdallah, personal communication, October 3, 2012).

4.4 Summary

The evidence collected suggested mixed results as a result of the AUI Demand Side Management Project. There is an increased local interest in drip irrigation. Interactions between farmers and the local branches of government were increased, and several positive seminars were held. Farmers increased communication between themselves about drip irrigation and its implementation. The most serious complication remains opening up the application process for reimbursement through the government. There is a large local interest in acquiring the benefits of drip irrigation, further increased by this project, but farmers are held back by the application process. Although none of the objectives were completely accomplished, there was positive progress made on many fronts.

5 Conclusion and Recommendations

After reviewing all the information gathered from interviews and observations, our team decided that the main objectives of "Using DSM" that are most important to the community and the farmers were not fully satisfied. The AUI Demand Side Management Project was a success in many aspects, particularly in the process of further introducing the idea of drip irrigation to the community. However, many unanticipated problems have subsequently emerged and remain unsolved, such as facilitating the ease with which neighboring farms might adopt drip irrigation technology. These original successes and shortcomings of the project were initially identified by the project authors in AUI's final technical report "Using DSM" delivered to the IDRC, and our evidence supports their conclusions. Complex governmental practices, tribal laws, unwritten customs, and long ingrained cultural behavior all had a negative impact on the success of "Using Demand Side Management." Despite these challenges, the project was successful on many fronts and provides a strong starting point for future projects.

The implementation of drip irrigation in the pilot farms and their use in proving the benefits and efficiency of drip irrigation was successful. In our interviews with the pilot farmers, we were told that their neighbors knew about drip irrigation and had spoken to the pilot farmers about their interest in using it on their own farms. The creation of these pilot farms was effective in expanding knowledge of the technology and demonstrating that drip irrigation is an efficient and desirable system. After AUI's Demand Side Management Project's completion, the number of small farms that implemented drip irrigation increased in the region. It is difficult to conclusively prove that the pilot project was directly responsible for this and although drip irrigation systems have become more common, the number of farms with the systems installed remains relatively low. An official from the Technology Center said that the spread of the drip

irrigation was also due to general knowledge that farmers had about different types of irrigation (E. Abdallah, personal communication, October 3, 2012).

The project was definitely very beneficial to the individual pilot farmers, as the final technical report for "Using DSM" documented. We verified this with the farmers when we conducted interviews with them and found that they in fact benefited greatly from the installation. However, the actual goal of spreading the use of the system around to the nearby farms has not been as successful to date due to several factors. Other farmers know that the system uses less fuel, uses less water, requires less labor, and increases crop output and quality; however they are not yet able to install it on their farms due to their financial limitations and the complexities of the application process.

The goals of the project concerning the Technology Center have also not yet been accomplished as satisfactorily as the project intended. The center is a local branch of the Sefrou DPA and successfully trained farmers in the usage of new fertilizers and seeds in initially well attended information sessions. The staff is very competent and has been able to overcome obstacles such as a poor literacy rate among local farmers (J. Kalpakian, personal communication, August 29, 2012). Although this function of the center is successful, its primary goal was to make the application process easier by providing the forms for receiving government subsidies for drip irrigation installations for the farmers in Ain Cheggag. The intent was to save interested individuals in the community time and money that would have been necessary for them to travel to Fes and other cities to collect the forms. The farmers however were not well informed about the existence and purpose of the center, therefore most of the people still traveled farther than was necessary. This was a good idea that could be better implemented now that the usage patterns are better known. There was no advertising about the center or any publications

about it that stated its purpose and how it could provide help and guidance for farmers and villagers. Those were not the only factors, however, that have led to its current lack of use. The location of the center is also another aspect, inasmuch as Ain Cheggag is not a centrally located farming town. There are many other towns in the area that have a larger base of farmers and situating the center in one of them would have led to better utilization.

Despite these limitations, some people in Ain Cheggag are making use of the Technology Center. It has all the forms for applying for reimbursement from the government for drip irrigation systems in one place, as opposed to being spread out among diverse agencies in the region. Having the forms easily accessible for the farmers within their town is of great convenience as it provides a connection between them and the Sefrou DPA. (D. Kettani, E. Abdallah, personal communication, October 3, 2012)

The goal of improving relations with the government was also not completely achieved by AUI's "Using DSM" project. The process of applying for reimbursement for the irrigation system is still highly difficult. It is a very long process that can take up to 3 years in some cases. Frequently following up on the status of an application is also a necessity. There are reports that officials will put off applications until their attention is drawn to them again (D. Kettani, personal communication, September 27, 2012). There were several reports of corruption in the system, with people paying to have forms processed more quickly. Otherwise, the applications will often be left to languish, leaving the farmer to shoulder the cost of the installation. The ABHS claims that it should take 2-4 weeks to get the money back after applying, but more often it can take a year or longer (A. Haddourha, personal communication, October 2, 2012). There are several different agencies that need information from one another to approve the forms and they do not communicate well with each other (D. Kettani, E. Abdallah, personal communication,

October 3, 2012). The farmer must also be qualified to get money back depending on the approval of the DPA, after they assess the quality of the drip irrigation system. The better the quality of the equipment is, the larger percentage of the money spent will be reimbursed (A. Haddourha, personal communication, October 2, 2012). Because of the ambiguities in interpreting the quality of equipment, a farmer may not receive what they anticipated. After the application is accepted, the money is sent to the bank and then the bank can hold it for an additional week before giving it to the farmer. (E. Abdallah, personal communication, October 3, 2012)

As a result of our findings, we have developed recommendations that would allow the positive effects of the project to be extended thus meeting objectives originally set forth by AUI. The success of the Technology Center is completely reliant on farmers' knowledge of its existence and what it can offer them. In order to maximize the potential of the center, advertisement is necessary. Many farmers in the area visit the souk or local markets to either sell their crops or buy from other farmers and merchants. Advertising at the souk is an optimal location for spreading information about the Technology Center for this reason. Individuals get their information and news about where to get the forms for reimbursement in the larger cities from talking to others at the market. As a result, an effective method of advertisement would be to set up a table at the souk to inform farmers about the assistance available. Banners or flyers on the streets written in Berber and Darija, or Moroccan Arabic, are also another suggestion to be taken into consideration. These written advertisements can get farmers talking to each other and provide them with facts about all of the center's capabilities. A potential challenge to this is that some farmers are illiterate, so word of mouth would be another important avenue of spreading the information about the Technology Center.

The process for applying for reimbursement is in obvious need of simplification. Currently, forms can be picked up in the Technology Center however once completed, they must be turned in to the ABHS in Fes and the DPA in Sefrou. If the farmers were able to turn in their forms to the Technology Center instead, the process would be greatly simplified for them. Another recommendation would be to relocate the center, or set up another center in a town that is more centrally located. This might simplify travel for the farmers, which is the point of the center in the first place.

The main problems encountered in achieving the objectives of the "Using DSM" project were the inability to change the government structure and organization involved in the application process, actually having farmers adapt to drip irrigation, and changing local attitudes about government cooperation. Of these, the most severe appear to be bureaucratic delays in the application process and the widespread perception that the system is corrupt; both charges were raised against all levels of government. Despite the well-meaning intentions of many officials at the government agencies involved in the project, there is a crippling lack of cooperation and willingness to find ways to expedite the application process. The government has allotted funds for the installation of drip irrigation on small farms, but the application process for what is essentially a guaranteed grant is still very difficult for a farmer from a small town. Fixing this is beyond the scope of "Using DSM," and remains a challenge for any further projects that would attempt to work along these lines.

A useful future project for a team from either AUI or WPI would be a better method of submitting reimbursement applications. We have suggested allowing the forms to be turned in at the Technology Center as a holdover, but a better long-term solution would be a web-based submission service. Although many rural households do not have internet access, the

Technology Center provides free access for the farmers. By switching to a web based submission service, much of the redundant circulation of paperwork and holdups could be avoided by removing the need for many people to physically handle the document. As a result the application process could be accomplished more quickly and more simply. Some potential obstacles to this would be the setup and maintenance required for the web-based service, as well as the resistance to technological change exhibited by both the famers and the government.

Overall, AUI's Demand Side Management Project was partially successful in its goals, despite several unanticipated sources of difficulty. Finding a solution to the water shortage in Morocco is a vitally important mission, and AUI has made significant progress in bringing to light what challenges lay in the way of a solution to the water problem in this region, as well as taking a first step to solving many of them. The pilot study showed the promise of drip irrigation on small farms, and brought this method of demand side management to the attention of farmers in the Saïss Basin. It made it easier for farmers in the region to acquire money from the government in order to install drip irrigation. Finally, the project has highlighted the problems that stand in the way of solving this serious environmental issue, particularly the bureaucratic inefficiencies and the persistence of traditional customs that use available water ineffectively. It is essential that these problems are solved rapidly, as a solution to the water crisis in the Saïss Basin is certainly needed.

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Appendix A

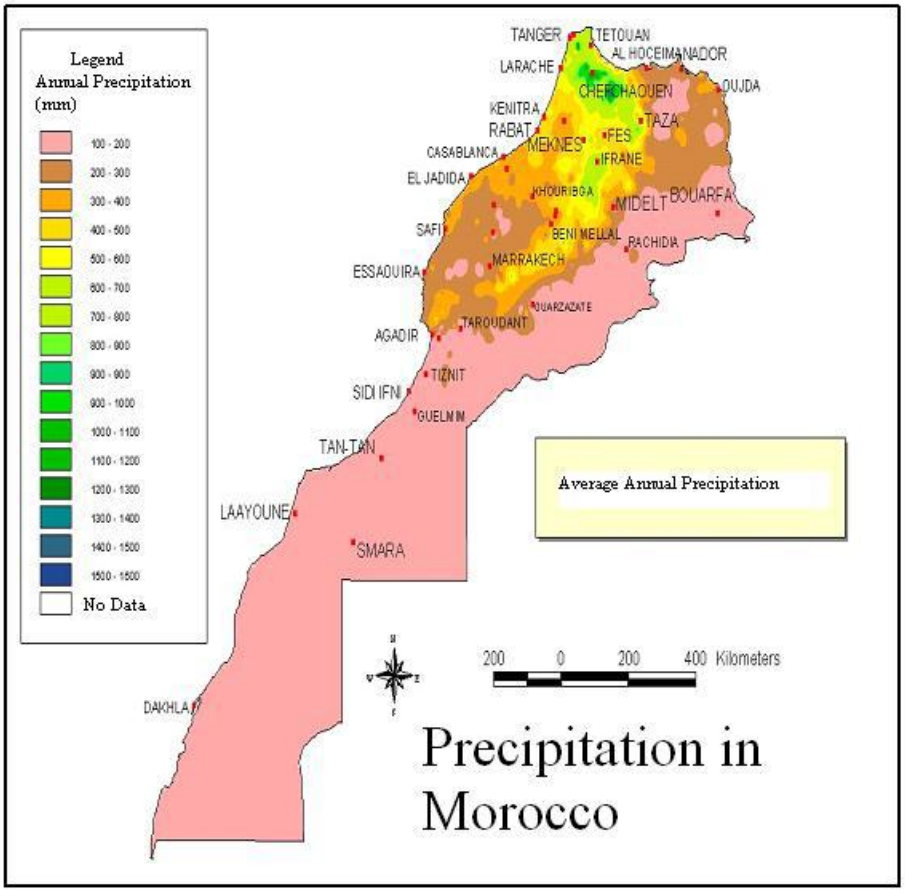


Figure 3: **Map of Average Annual Rainfall in Morocco**

Appendix B Timeline of Field Visits

Timeline of meetings and interviews, along with brief summaries:

8/29/12 – We had our first meeting with Dr. Kalpakian, who explained the AUI pilot project as well as its intentions, goals and known outcomes. In addition, he provided us with all the reports and presentation that had been produced as a part of the project.

9/3/12 – Dr. Kalpakian accompanied us on our first site visit, along with our advisor Bland Addison. On the taxi ride to Ain Cheggag, Dr. Kalpakian gave us more information regarding land holding and water usage. We first stopped at the Technology Center; however no one was there to answer questions, so we continued to the Toufahi farm, also in Ain Cheggag. We spoke with Mr. Driss Toufahi, and he explained his well and drip irrigation system. From there we continued on to the Ezzayani farm in Bitit. We met with Mr. Said Ezzayani, and he also showed us his drip irrigation system as well as his reservoir which he had recently expanded and planned on expanding again. We eat with Said and then departed.

9/19/12 – With Maha Laziri, an AUI student, as our translator, we traveled to each of the farms and the Technology Center again in order to ask our prepared questions. We were turned away from the Technology Center because we did not schedule an interview in advance. Two officials from the Technology Center then followed us to the Toufahi farm. We met with Mr. Tofahi's son; however he was prevented from answering any questions by the Technology Center officials. We left and lost the officials on the way to the Ezzayani farm in order to ensure an uninterrupted interview. Said was very welcoming again. He answered all of our questions and suggested several more that might improve on our data.

9/26/12 – We met with Dr. Kalpakian a second time and discussed our progress to date. He made some suggestions to assist in our data gathering and set up a meeting with Dr. Kettani in order for him to advise us further on our project.

9/27/2012 – We met with Dr. Kettani who explained his attempt to acquire government reimbursement for installing drip irrigation on a plot of land he bought as an experiment. After hearing about our trouble with the Technology Center officials turning us away, he offered to get in touch with them and set up a meeting that he could attend. We agreed, as we believed the Technology Center officials would respond well to authority. Additionally, we asked professor Kettani to set up a meeting between our group and officials at the ABHS so we could ask them the questions we had prepared.

10/2/2012 – We traveled to Fes to interview ABHS officials. They gave us two PowerPoint presentations about the purpose of the agency. Khalil asked questions in Arabic to one of the officials, Mr. Haddourha, and Professor Addison asked questions of the other official in French. Although we did not learn much about drip irrigation or the AUI project, the ABHS provided us with a wealth of information about the water problem in the Sebou Basin and Morocco as a whole.

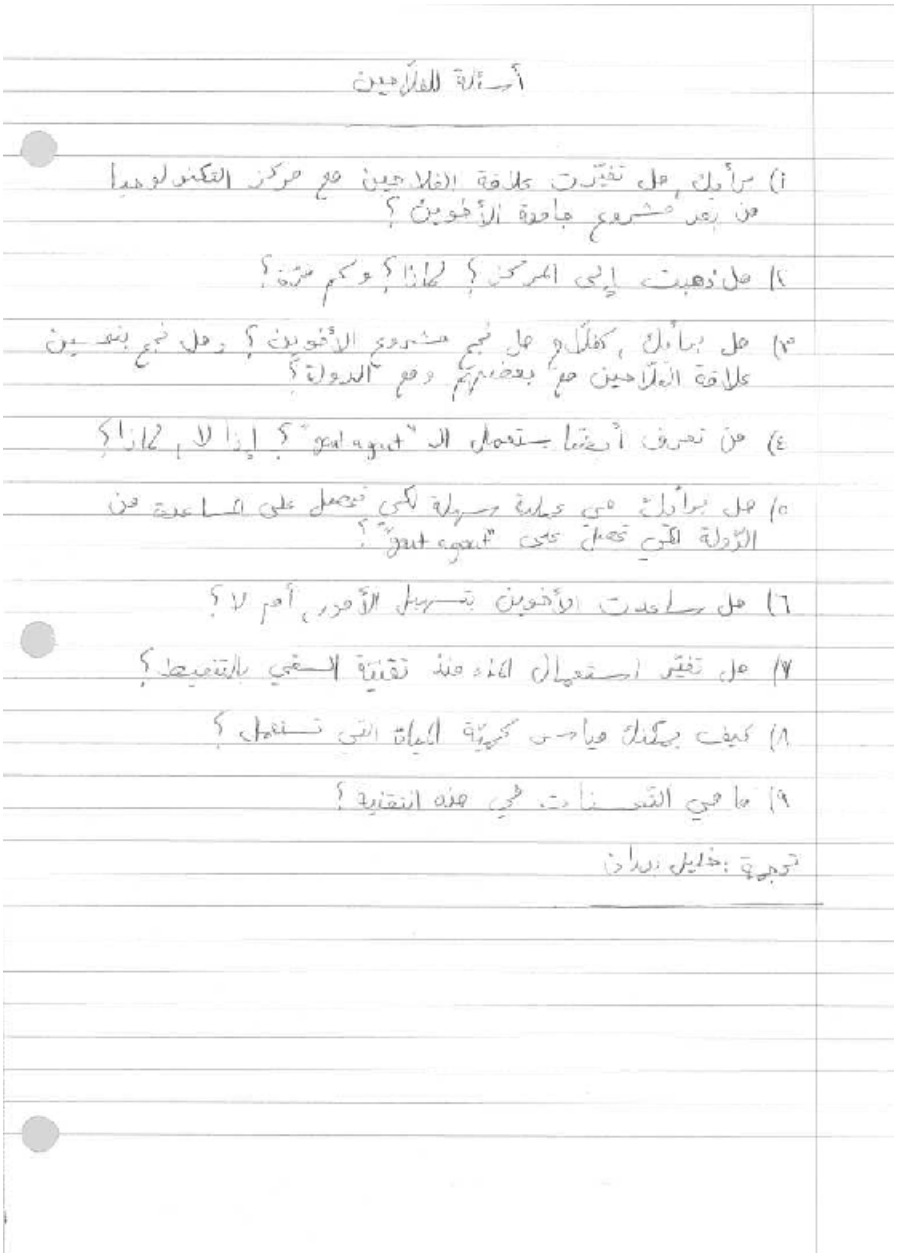
10/3/2012 – We met with Mr. Toufahi on his farm to ask him questions without the interference of the Technology Center officials. After this interview, we met Dr. Kettani at the Technology Center. We spoke with the director of the center, who was very helpful. He explained the state of the center and the drip irrigation reimbursement program. Dr. Kettani acted as a translator and helped direct our questions toward the results we were looking for.

After we had asked all of our prepared questions we had several follow up questions for the officials there based on what we had learned from the interview.

Appendix C - Questions for Farmers

1. Has your water usage increased or decreased since the installation of drip irrigation?
2. How do you measure water usage?
3. Have your water usage patterns changed?
4. How much fuel do your pumps use per day now? How much were they using in the past?
5. Do you manually control irrigation or do you use a timer?
6. How do you decide how long to water your crops for?
7. Do you know how much water your crops need?
8. Do you find the quality of your crops to have changed? Or remained the same? How do you assess their quality?
9. Has the amount of money you receive for your crops changed due to your usage of drip irrigation?
10. What crops do you grow on your farm and do you use drip irrigation on all of them?
11. Do other people who live near you use drip irrigation?
12. If not, have they expressed interest in installing drip irrigation?
13. If they do not have it, why have they not installed drip irrigation yet?
14. Have they attempted to get government assistance?
15. Does this include loans or grants?
16. What future plans do you have (if any) for your farm?

Appendix C – Question for Farmers (Arabic Translation)



أسئلة للفلاحين

1) برأيك، هل تغيّرت علاقة الفلاحين مع مركز التكنولوجيا من بعد مشروع جامعة الأخوين؟

2) هل ذهبت إلى المركز؟ لماذا؟ وكم مرة؟

3) هل برأيك، كفلّ، هل نجح مشروع الأخوين؟ وهل نجح بتحسين علاقة الفلاحين مع بعضهم ومع الدولة؟

4) من تعرف أيضًا يستعمل الـ "greenhouse"؟ إذا لا، لماذا؟

5) هل برأيك هي عبارة رسولة لكي تحصل على المساعدة من الدولة التي تحصل على "greenhouse"؟

6) هل ساعدت الأخوين بتسهيل الأمور، أم لا؟

7) هل تغيّر استعمال الماء منذ تقنية السقي بالتنقيط؟

8) كيف بيكفك مياه كتيرة الحيوانات التي تستعمل؟

9) ما هي التحسينات في هذه التقنية؟

ترجمة: خليل برادن

Appendix D – Interview Notes from Mr. Said Ezzayani

1. Has your water usage increased or decreased since the installation of drip irrigation?
    a. Farmers are using same amount of water for a better yield.
2. How do you measure water usage?
    a. We measure water usage by the amount of gasoline needed a day.
3. Have your water usage patterns changed?
    a. Before using the drip irrigation method, we used as much water but the yield was considerably less.
4. How much fuel do your pumps use per day now? How much were they using in the past?
    a. They are using about 12 liters/day, and it is about the same amount we used before, but the quality of the crop is a lot better.
5. Do you manually control irrigation or do you use a timer?
    a. We manually control our irrigation.
6. How do you decide how long to water your crops for?
    a. We just check with a piece of wood to see if there is enough water in the soil, and that is how we decide when the soil has gotten enough water.
7. Do you know how much water your crops need?
    a. Yes we use a piece of wood to decide when it is the right time to stop watering the crops.
8. Do you find the quality of your crops to have changed? Or remained the same? How do you assess their quality?
    a. The quality of the crops has gotten a lot better after using drip irrigation. We assess their quality by looking at sizes of certain crops, and changes in color. For example onions have a brighter red color which shows they have better quality.

9. Has the amount of money you receive for your crops changed due to your usage of drip irrigation?
    a. The price of crops that are drip irrigated is slightly more than normal crops, which makes us earn more.
10. What crops do you grow on your farm and do you use drip irrigation on all of them?
    a. I grow potatoes and onions to sell mostly, and grapes for myself. I am recently starting to grow peaches since I will earn more money.
11. Do other people who live near you use drip irrigation?
    a. 10% of the population nearby uses drip irrigation.
12. If not, have they expressed interest in installing drip irrigation?
    a. They have all expressed interest however there are reasons they are not able to install it.
13. If they do not have it, why have they not installed drip irrigation yet?
    a. They have not installed it because the process of applying for loans after you have already paid for all the expenses on your own is very complicated and lengthy.
14. Have they attempted to get government assistance?
    a. Yes they have but it takes a very long time to get your application processed.
15. Does this include loans or grants?
    a. Yes loans and grants.
16. What future plans do you have (if any) for your farm?
    a. I plan on expanding my water reservoir to make it double the size it is now.

Appendix E – Notes from Visits to Farms

First Visit:

On our first visit to the farms we were accompanied by Dr. Jack Kalpakian. We first went to the farm of Mr. Driss Toufahi. We introduced ourselves to him in standard Arabic, described our project to him and told him that we will be coming back for more visits to his farm. We asked basic questions about how his farm and equipment worked and what type of crops he grows using his drip irrigation system. We kept the first visit simple, as we had wanted to get as much information from him gradually.

After leaving Mr. Toufahi's farm, we headed towards Mr. Said Ezzayani's farm. We again introduced ourselves and described our project. He gave us a tour around his land and showed us his reservoir where he kept water for irrigation. He showed us the setup of his drip irrigation system, as well as the crops he was growing there. He later invited us into his house for a light lunch, where we discussed in French some of the problems they had with water in the area. The information was very general.

Second Visit:

Mr. Toufahi was not there to see us, however we met his son who was helpful in answering the questions that we had prepared along with the Al Akhawayn student Maha Laziri. Unfortunately, on our way to his farm, members of the Technology Center followed us. We believe that they were there to make sure everything sounded official and no flaws in the project

were pointed out. They took over most of the answers on behalf of Mr. Toufahi's son, which gave us mostly useless data.

Mr. Ezzayani's second visit was the most important visit, as he gave us all the information we needed. The information we got on this visit supplied us with great amounts of data to add to our paper, as it was the information coming first hand from people affected by the AUI project. We took another look around his farm and noted observations of what we saw and the way equipment worked.

Mr. Ezzayani also added that one of the key problems from the state farmers are facing now is the lack of its support by providing them with institutions that will help make farmers literate. He told us that the state should also help farmers look for new markets and create agricultural cooperatives. All of these would definitely help in improving the functioning of the system as a whole, benefitting the government and the farmers. Mr. Ezzayani added that he believed that before getting deeper into the research, it was important for us to understand where the water they use comes from and how it is shared. The source of water is from Ain Bitit. Access to water is regulated by an association named Khrichfa. Its speed is 26 Liters/second, and the water flow is divided into 3 fissures. The association regulates access to water and receives in return an amount of money as follows: 40 dirhams/ year for every hour, every farmer gets access to the water once a week for 24 hours. In case this water in not enough they can rent water to complete the parts left for irrigation and this complementary water costs 50 dirhams an hour. The complementary water is mostly used in dry summers especially in the months of June and July.

Third Visit:

Our third visit to Mr. Toufahi's consisted of us asking him questions about the AUI project and whether he thought it had benefitted him. He had some interesting answers concerning the government and how it could do a lot more to help him as well as other farmers around the area to be able to better afford farming equipment.

Mr. Toufahi said that the government still has a lot it is able to do in order to support and help the farming community. For example the price for equipment, medicine, and fertilizers is extremely expensive for the farmers. Mr. Toufahi said that the Technology Center helped them a lot when it first started. They answered his questions about how much to water their crops and what kind of medicine to use for diseases that their crops may have. Despite this, we believe that he needed this information and was telling us this so that he could be in agreement with what he thought DPA officials wanted to hear, even though they were not present. He told us that he visits the Technology Center about 2 times a week. However, when we went to the Technology Center they told us that they barely have any visits per month by farmers.

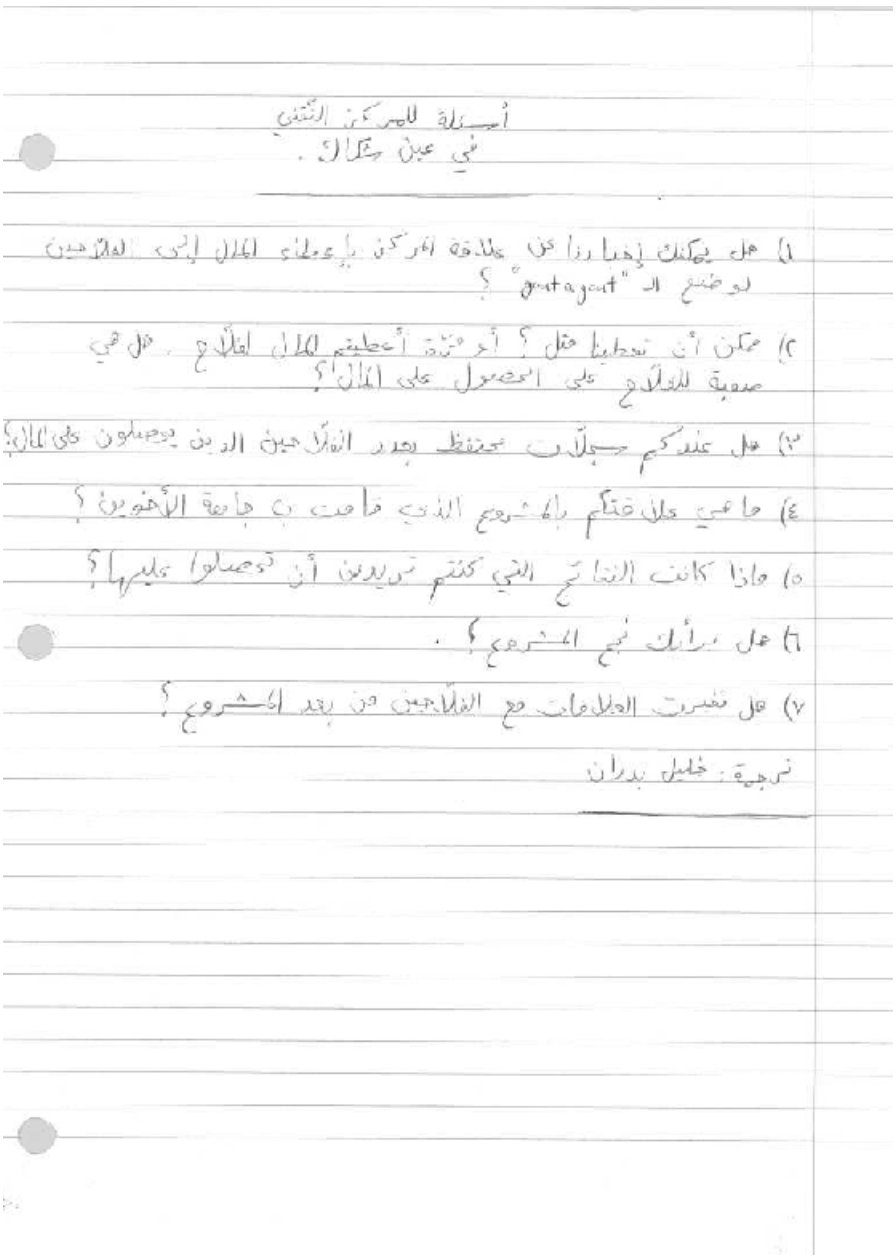
The project improved his relationship with the other farmers in the area and doing the job of introducing and spreading the idea of drip irrigation, but they are not adapting to it due to the hard process. His family nearby also owns another small farm that have drip irrigation as well. He said that in order to install the drip irrigation system you would have to have a good amount of money at first. When we asked about how Al Akhawayn's project helped with the government issues, he said that it did not do anything in that part. He believed the university could have proposed to make the equipment and medicine cheaper to make it easier for the farmers.

We were unable to meet with Mr. Ezzayani, however we did send him a thank you letter telling him how we appreciated his help and hospitality.

Appendix F – Questions for Technology Center Officials

1. What type of training do you [the workers] have?
2. Do you have any way of keeping track of when people use the center?
3. How often do people come into the center?
4. Are any local farmers using the Center, and when was the last time?
5. Who else is using the center?
6. What types of questions do people have when they use the center? Water? Crops? How to use computers?
7. What are the strategies used to teach the farmers?
    a. Pictures/videos?
8. Do you know of any farmers in the area that have implemented drip irrigation?
    a. Did they use the Technology Center to find information?
    b. Have they used government grants or loans?
    c. Do you have records of this?
9. What is the condition of the equipment at the center?
    a. Who is responsible for repairs/updates?

Appendix G – Questions for Technology Center Officials in Arabic



أسئلة للمركز التقني
في عين جنّاك .

١) هل يمكنك إعطاءنا فكرة أكثر عن علاقة المركز بإعطاء المال إلى الفلاحين لوضع الـ "greenhouse" ؟

٢) ممكن أن تعطينا مثل ؟ أو حتى أعطينا المال للفلاح . هل هي صعوبة للفلاح على الحصول على المال؟

٣) هل عندكم سجلات تحتفظ بها عن الفلاحين الذين يحصلون على المال؟

٤) ما هي علاقتكم بالمشروع الذي قامت به جامعة الأخوين ؟

٥) ماذا كانت النتائج التي كنتم تريدون أن تحصلوا عليها ؟

٦) هل برأيك نجح المشروع ؟ .

٧) هل تغيرت العلاقات مع الفلاحين من بعد المشروع ؟

ترجمة : خليل بدران

Appendix H – Questions for Technology Center Officials in French

1. Quel type de formation avez-vous?
    a. Avez-vous une façon de garder une trace de quand les gens utilisent le centre ?
    b. Combien de fois pendant le mois les gens viennent dans le centre?
    c. Y at-agriculteurs locaux en utilisant du Centre, et à quand remonte la dernière fois?
    d. Qui d'autre utilise le centre?
    e. Quels types de questions les gens ont quand ils utilisent le centre? À propos de l'eau? Cultures? Ou comment utiliser un ordinateur?
    f. Quelles sont les stratégies utilisées pour enseigner les agriculteurs?
2. Photos / vidéos?
    a. Connaissez-vous les autres agriculteurs de la région qui ont mis en œuvre l'irrigation goutte à goutte?
3. Ont-ils utiliser le centre de technologie pour trouver des informations?
4. Ont-ils utilisé des subventions ou des prêts?
5. Avez-vous des enregistrements de cette situation?
    a. Quel est l'état de l'équipement au centre?
6. Qui est responsable pour les réparations / mises à jour?

Appendix I – Notes from Technology Center Officials' Interview

Note: they did not answer our questions directly, but we carried out a conversation with the assistance of Dr. Kettani that answered some of the questions. Many of our originally planned questions proved to be irrelevant, especially in light of the low utilization of the center.

1. What type of training do you [the workers] have?
2. Do you have any way of keeping track of when people use the center?
    a. We do not keep record of the amount of people that use the center.
3. How often do people come into the center?
    a. When the center first started giving the seminars after the project, they were well attended. However, after that not many people were coming.
4. Are any local farmers using the Center, and when was the last time?
5. Who else is using the center?
6. What types of questions do people have when they use the center? Water? Crops? How to use computers?
    a. When they do come to us, they have questions about certain fertilizers, or medicine for their crops.
7. What are the strategies used to teach the farmers? Pictures/videos?
8. Do you know of any farmers in the area that have implemented drip irrigation?
9. Did they use the Technology Center to find information?
10. Have they used government grants or loans?
11. Do you have records of this?
12. What is the condition of the equipment at the center?

a. [Observation] From what we saw at the center, the equipment has not been used for quite the time, since all of it was covered in dust. The computer, the desks and chairs, as well as the forms seemed like they have not been touched for a while.

13. Who is responsible for repairs/updates?

Appendix J – Additional Notes on Technology Center Visit

We conducted the interview of the Technology Center officials with the help of Professor Driss Kettani from AUI acting as a translator. He was one of the authors of the project, and knew the answers to most of the questions we asked, however he got the answers from the DPA officials and then added to them to clarify or correct.

The center, according to the officials, did not completely reach the goals that had been set for it. The main reason for this is the lack of communication and advertising to show the people in the area the function of the center and how it may help them. The center supplies the farmers with the forms necessary to apply for the loans and grants from the government. It is a connection between them and the DPA which is located in Sefrou, far away from Ain Cheggag. The center is not known about in the community, and needs to have flyers or be talked about in the souks so that more people will know about it. The officials also said that they are not satisfied with the results of the center, but they believe that they have done their best in their job. They said that ways the center could be more useful is if the center was relocated, or a whole new center created in a nearby more agricultural town where more people would make use of it.

Appendix K – Questions for the ABHS

1. Can you please explain your involvement in distributing government money to farmers for drip irrigation systems?
2. Do you have records of the number of farmers that have gotten grants and loans?
3. What do you feel the outcomes of the project were? Do you think it was successful?
4. Did your agency's interactions with farmers change as a result of the project?

Appendix L – Notes from ABHS meeting

This is a direct transcript of the notes taken by group members during the presentation given to us by Abderrahmane Haddourha of the ABHS.

Met with a woman in her office. Prof. Addison explained project and made introductions

Moved to a conference room where Haddoura joined and gave PowerPoint presentation originally given in February for unknown [to us] purpose. The presentation was displayed in French and he spoke to us mostly in French but with some English. ABHS officials were very welcoming - brought tea in during their presentation

PowerPoint presentation covered the role of the agency, preempted many of our opening questions.

Principles of the agency covered:

-Examine and give advice on *Plan National de l'Eau* (National Water Plan, PDAIRE)

-Encourage protection of resources

-Public structure, so it has moral responsibility

Agency must ensure PDAIRE is applied and properly structured

-For PDAIRE, there is a *Conseil d'Administration* (Administrative Council) that makes the guiding decisions

The council consists of: 25% representatives of public establishments, 33% representatives of the state, 42% representatives of Agricultural 'chambres,' commerce, industry & services, local collectives

Income comes from

-charging polluters based on how much they pollute

-the state provides additional income

The Sebou is one of nine basin agencies and the Sebou Basin has 6.5 million inhabitants, estimated to be 9 million by 2030

It contains 17 provinces, but only 8 are totally encompassed

The area in the basin is responsible for approximately 65% of Moroccan olive production, and 50% of Moroccan sugar production, as well as about 60% of the nation's production of leather, as well as large production of paper and textiles.

In 2010, there was an estimated 1067 cubic meters of water per person per year in the basin. This is an average, some areas were higher, and some areas were lower.

In 2030, this is predicted to drop to 735 cubic meters per person per year.

1000 cubic meters per year is internationally recognized as a danger level

Land usage in the basin:

-108,000 hectares are used for large scale farms

-1,200,000 hectares are forests

600 mm of precipitation per year

Water infrastructure:

-10 large dams

-can store 5872 Mm^3

-44 small dams

-4 hydroelectric stations

Water deficit:

1579 Mm^3 per year enters

1737 Mm^3 leaves

157 Mm^3 deficit annually

National Water Strategy:

Irrigation usage is approx. 2,000 Mm^3 / year nationally

Irrigation usage in the Sebou Basin is ~500 Mm^3 / year (25%)

End of PowerPoint

We told them that we had some questions we wanted to ask them. They seemed to want to avoid this and put another PowerPoint up for us to watch. At the end of the second

PowerPoint, Professor Addison explained our project to the man and then Khalil asked the questions we had prepared in Arabic.

He did not know anything about the AUI project, and said to ask the first woman we met. He said he understood the application process to be quick and easy though. Provided us with the power points upon our request.

From the woman:

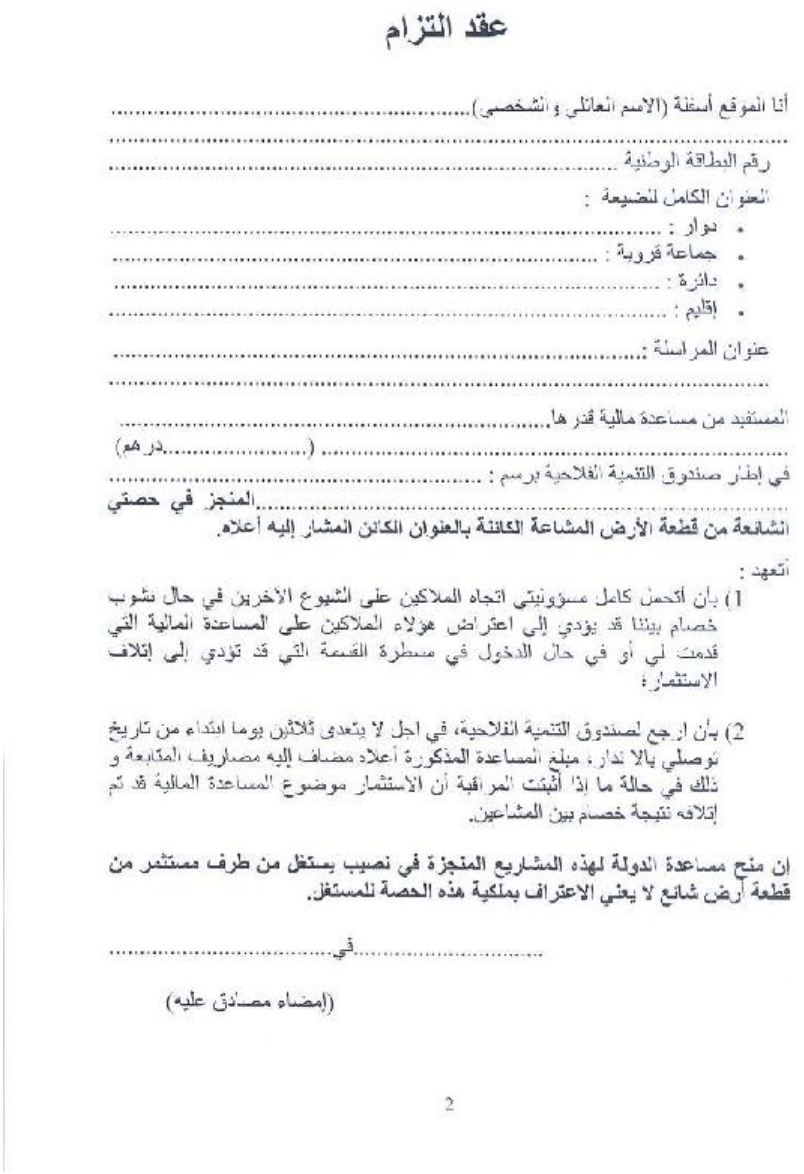
Small farms (<1 hectare) can get the entire drip irrigation installation covered by government, must pay 40% up front

Larger farms can get 60% of total cost covered

The basin agency is not involved in decisions regarding this project.

Appendix M – Forms at the Technology Center

The following are scans of the forms available at the Technology Center, along with brief descriptions of the forms in English.



عقد التزام

أنا الموقع أسفله (الاسم العائلي و الشخصي).....
.....
رقم البطاقة الوطنية .....
العنوان الكامل للضيعة :

- دوار : .....
- جماعة قروية : .....
- دائرة : .....
- إقليم : .....

عنوان المراسلة :.....
.....
المستفيد من مساعدة مالية قدرها.....
..... (.....درهم)
في إطار صندوق التنمية الفلاحية برسم : .....
.....المنجز في حصتي
الشائعة من قطعة الأرض المشاعة الكائنة بالعنوان المكان المشار إليه أعلاه.

أتعهد :

1) بأن أتحمل كامل مسؤوليتي اتجاه الملاكين على الشيوع الآخرين في حال نشوب خصام بيننا قد يؤدي إلى اعتراض هؤلاء الملاكين على المساعدة المالية التي قدمت لي أو في حال الدخول في مسطرة القسمة التي قد تؤدي إلى إتلاف الاستثمار؛

2) بأن ارجع لصندوق التنمية الفلاحية، في اجل لا يتعدى ثلاثين يوما ابتداء من تاريخ توصلي بالا تدار ، مبلغ المساعدة المذكورة أعلاه مضاف إليه مصاريف المتابعة و ذلك في حالة ما إذا أثبتت المراقبة أن الاستثمار موضوع المساعدة المالية قد تم إتلافه نتيجة خصام بين المشاعين.

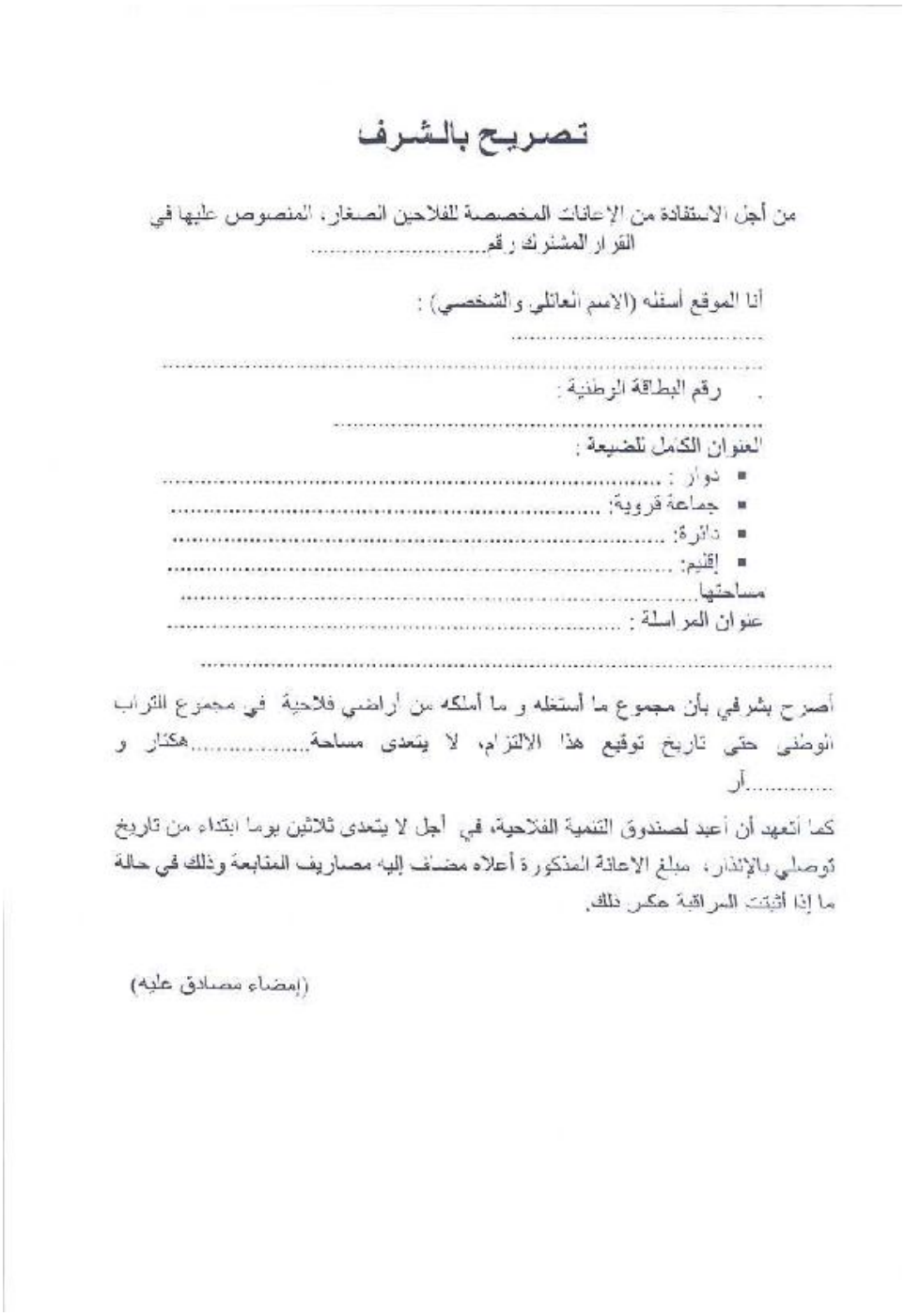
إن منح مساعدة الدولة لهذه المشاريع المنجزة في نصيب يستغل من طرف ممتثمر من قطعة أرض شائع لا يعني الاعتراف بملكية هذه الحصة للمستغل.

.....في.....

(إمضاء مصادق عليه)

2

This first form is a “Contract Commitment Form” that farmers have to fill out in order to rent a land from someone to farm on.



تصريح بالشرف

من أجل الاستفادة من الإعانات المخصصة للفلاحين الصغار، المنصوص عليها في القرار المشترك رقم.....

أنا الموقع أسفله (الاسم العائلي والشخصي) :

.....

.....

رقم البطاقة الوطنية :

.....

العنوان الكامل للضيعة :

- دوار : .....
- جماعة قروية: .....
- دائرة: .....
- إقليم: .....

مساحتها.....

عنوان المراسلة : .....

.....

أصرح بشرفي بأن مجموع ما أستغله و ما أملكه من أراضي فلاحية في مجموع التراب الوطني حتى تاريخ توقيع هذا الالتزام، لا يتعدى مساحة.....هكتار و .....آر

كما أتعهد أن أعيد لصندوق التنمية الفلاحية، في أجل لا يتعدى ثلاثين يوما ابتداء من تاريخ توصلي بالإنذار، مبلغ الاعانة المذكورة أعلاه مضاف إليه مصاريف المتابعة وذلك في حالة ما إذا أثبتت المراقبة عكس ذلك.

(إمضاء مصادق عليه)

The form above is a “Sworn Statement” form, or تصريح بالشرف. Farmers have to fill it out in order to benefit from the help that is provided to Small Farmers. The form includes a section where they have to specify how much land they have (Hectares) and are not allowed to exceed a certain area.

Engagement Fournisseur

Je soussigné[1] .....,

agissant au nom et pour le compte de .....

(*Raison sociale et forme juridique de la société*),

adresse du domicile élu, ...,

atteste avoir pris connaissance des dispositions prévues dans le cahier de charges objet de la Norme Marocaine n° 12.1.100 (Installation d'irrigation localisée – Exigences générales), et m'engage à les respecter dans le cadre de l'équipement en irrigation localisée de l'exploitation ci-dessous présentée :

- Bénéficiaire.....
- Lieu d'installation (exploitation support de l'investissement) :
  - . Douar :.....
  - . Commune Rurale : .....
  - . Cercle : .....
  - . Province :.....
  - . Périmètre d'irrigation[2] .....
- Superficie totale de l'exploitation : ..... Ha
- Superficie nette équipée (objet de la demande de subvention et de la prime) : ..... Ha

Fait à ....., le .....

Signature et cachet du Fournisseur

1 Personne physique ou morale.

2 Préciser le nom du périmètre d'irrigation, si l'investissement est réalisé à l'intérieur d'un périmètre de grande hydraulique ou de PMH.

This form is for describing the amount of land that one has that is under drip irrigation system. This is one of the forms used to apply for funds for reimbursement of drip irrigation.

ROYAUME DU MAROC

MINISTERE DE L'AGRICULTURE ET
DE LA PECHE MARITIME

DPA : .....
ORMVA : .....

DEMANDE D'APPROBATION PREALABLE

Nom et prénom : .....CIN n°.....
Raison sociale : .....
CT/CDA/CMV : .....
Adresse complète de l'exploitation agricole :

. Douar : .....
. Commune Rurale : .....
. Cercle : .....
. Province : .....

Adresse de correspondance[1] : .....
.....

⇨ Caractéristiques de la superficie totale de l'exploitation :

- Superficie totale de l'exploitation :
  - Irrigué : ..... Ha
  - Bour : ..... Ha
- Superficie plantée : ..... Ha
- Statut de la terre :
  - Melk : ..... Ha
  - Collectif : ..... Ha
  - Réforme agraire : ..... Ha
  - Autes : ..... Ha

⇨ Mode de faire valoir :

Mode	Direct	Indirect[2]
Superficie (Ha)	.....	.....

⇨ Effectif du cheptel :

Espèce :	Bovins	Ovins	Caprins
Nombre de têtes :	.....	.....	.....

⇨ Objet de la demande .....
.....

Fait à ....., le.....

Signature du postulant

1 Adresse précise où le postulant peut être contacté (téléphone, fax, boîte postale,...).
2 Prise en location, associations, diverses,...

Appendix N – Drip Irrigation Summary

Drip Irrigation, which is also known as micro or trickle irrigation is a method that is being adapted by many farmers around the world. Farmers are finding better crop yield and quality when using drip irrigation and are finding it to be more cost efficient in the long run. This technique supplies water to the roots of the plants by dripping slowly from hoses or "drip emitters". Filters are also installed in the system to prevent any minerals or sediments from going into the hoses and clogging them up, providing a better watering stream to the plants.

There are many advantages to the installation of drip irrigation including water conservation, the reduction of weed growth around the plants, healthier growth of plants, saving money, and the flexibility of application in different terrains that the system has. (Irrigation Direct, 2011). Water is conserved when using drip irrigation since it is distributed evenly and consistently across all the plants. Each plant gets water right into the roots which promotes its health and immunity to diseases. The reduction of weed growth is due to the precise dripping of the water directly to the plant. Flooding the fields from the canals as a lot of farmers do in Morocco creates a higher chance that weeds will grow in between the plants causing farmers to spend more time in the maintenance of their fields. The drip irrigation technique also saves the farmers a great amount of money. Although the installment of the system requires a big amount of money, in the long run farmers will notice the efficiency of the technique and how much it saves their resources. One of the last advantages is that the system has an extremely flexible terrain application. Farmers are able to use it on hilly terrains, and steppes. This flexibility allows farmers from many different areas to adapt to this technique.