USAID | AFGHANISTAN

FROM THE AMERICAN PEOPLE

Afghanistan Water, Agriculture and Technology Transfer (AWATT)

Cooperative Agreement No. 306-00-08-00506

FINAL REPORT

2008-2011

September 30, 2011

Southern Illinois University Carbondale

Colorado State University

NM STATE UNIVERSITY

AWATT

This publication was produced for review by the United States Agency for International Development. It was prepared by New Mexico State University.

Table of Contents

Executive Summary 3

Overview 5

Component 1: Integrated Water Management 8

Component 2: Appropriate Agricultural Technology 25

Component 3: Technical Assistance to MAIL 39

Lessons Learned 43

CD ROM Annexes ..... Attached

Executive Summary

On March 3, 2008, the United States Agency for International Development (USAID) awarded to New Mexico State University, as the lead of consortium of four Universities; including Colorado State University (CSU), University of Illinois at Urbana-Champaign (UIUC), and Southern Illinois University at Carbondale (SIUC) a Cooperative Agreement for the Afghanistan Water, Agriculture and Technology Transfer (AWATT) Program. The program ended on June 30, 2011. AWATT's purpose was to provide support for the U.S. Government goals of increasing agricultural output, increased agricultural-sector jobs and incomes, and increased confidence of Afghans in their government.

AWATT's activities were in high demand as evidenced by AWATT's presence in more than three-fourths of the provinces in Afghanistan. AWATT contributed to the increased effectiveness of the Afghanistan Government's Ministry of Agriculture, Irrigation and Livestock (MAIL) at the national and provincial level. Programs were delivered in Taliban sympathetic areas as well non-Taliban regions.

The AWATT program introduced water management practices and agricultural technologies that routinely increased agricultural output per unit of land by 50% or more and increased the area of cultivatable land by nearly 9,000 hectares. AWATT activities created direct employment for some 2,500 temporary full-time equivalent jobs and resulted in increasing cultivatable land area which created employment potential for 134,000 additional permanent farm jobs. AWATT provided training opportunities for more than 6,600 individuals, including more than 500 MAIL staff and 330 women.

The original main objective of AWATT was to increase opportunities for Afghans to access information and knowledge on appropriate technology, provide the tools and mechanisms for policy and institutional changes that would enhance the management of the supply and demand of water resources, and development of a legislative framework for tenure and rights over private and common land in the rural areas. These objectives were modified in 2010 following changes in U.S. Government strategy and at the request of USAID in response to GIRoA (Government of the Islamic Republic of Afghanistan) ministry concerns and the Afghan First policy. The end result was a program whose final objective was to improve community and farm level management of the supply and demand of irrigation water resources with the overall goal to increase agricultural productivity and food security in Afghanistan. In order to accomplish this objective, AWATT pursued the implementation of three program components namely; (1) Integrated Water Management, (2) Appropriate Agricultural Technology, and (3) Technical Assistance to MAIL.

All publications and many more materials produced by the AWATT team are included on an Annex CD attached to the back cover of this final report. In addition, a DVD containing four 15-17 minute videos of four aspects of the AWATT project is also attached.

Specific Objectives

Integrated Water Management: AWATT developed an efficient and equitable community-based irrigation water resource distribution and management system that led to improved agricultural productivity such as; Crops assessments and analyses of irrigation systems provided insight for improving water delivery systems and water use efficiency; Five hundred Mirabs were trained to improve water management and use measurement-based water management systems to assess water availability and variability during the cropping season; The rehabilitation of 12 canals and karezes increased the amount of cultivatable land by 8,940 hectares impacting 120,000 people in 40 villages; Improved natural resource management was implemented on 709 hectares as a demonstration of upper watershed rehabilitation through the construction of terraces, check dams and the establishment of tree seedlings; The development of more than 46,000 tree seedlings had a secondary benefit of creating meaningful employment opportunities for more than 200 women through the "Foster Mum" program; Water conservation technologies such as laser land leveling and drip irrigation demonstrated increased yield potential for a variety of crops.

Appropriate Agricultural Technology: AWATT identified appropriate agricultural technologies to increase agriculture productivity and rural incomes in areas subject to seasonal drought and high risks of land degradation, deforestation or loss of biodiversity; The forage program recognized and promoted the importance of an integrated crop-livestock production for watershed management; More than 500 forage demonstration plots introduced high-yielding forage species (pearl millet, sudan grass, cowpea, and Egyptian clover) to farmers in seven provinces; More than 2,500 kg of improved foundation seed was produced and delivered to MAIL for seed increase and distribution to farmers; An integrated rangeland watershed rehabilitation demonstration project introduced sustainable agricultural practices including the rehabilitation of farmland and discouraging unfettered grazing of upper watershed catchment areas; An improved system of rice production that doubles yields while using about half as much water as a conventional production system was introduced; Women were provided information and training in the use of appropriate technologies, including food preservation techniques, use of solar food dryers, backyard poultry, and beekeeping.

Technical Assistance to MAIL: AWATT provided technical assistance to improve MAIL's irrigation and watershed management decision making strategies and outreach

capabilities through the transfer of technical skills to the staff of Ministries, Faculties of Agriculture of Afghan Universities, and Agricultural Vocational Schools. The ultimate result was to improve the quality of agricultural production, natural resource management, and irrigation management services delivered to rural communities by MAIL. AWATT provided training to MAIL staff in; the installation and use of water measurement staff gauges, watercourse lining and farm turnout installation, AutoCAD for irrigation engineers, and implementation of the new Afghanistan Water Law. Support to MAIL was also provided through AWATT activities to enhance universities and agricultural vocational schools by developing teaching and internet laboratories and the training of TVET instructors and principals. More than 500 of the MAIL staff received practical training through participation in the implementation of AWATT program activities; which will be continued on a sustainable basis after closure of the AWATT program in Afghanistan.

Overview

With more than 75 percent of the population living in rural areas, Afghanistan is an agrarian country whose economy is based on agricultural products and livestock. Water is a critical element for improving rural livelihoods and when this project began, only two to four percent of land was cultivated due to limited access to water and irrigation.

USAID/Afghanistan and other development organizations saw water resource management and land security as two critical areas where international support was needed to improve the performance of Afghanistan's agriculture sector. Land and water are viewed as complementary resources which AWATT felt was best managed with an integrated approach.

Obstacles to increasing Afghanistan's agriculture sector productivity and output included: 1) the lack of an integrated water basin scale framework for analyzing land use and water policy proposals; 2) the lack of current information on water systems, irrigation, and water supplies needed to estimate the scale of rehabilitation in water management and water supply schemes necessary to secure recovery of the country's agriculture and livestock production as well as the delivery of safe water for domestic purposes; and, 3) the lack of institutional capacity and facilities to train future generations of Afghans in state-of-the-art analysis, evaluation, and design of land use, water and technology policies and programs.

Water is a critical element for improving rural livelihoods in Afghanistan, where now only two to four percent of land is cultivated due to limited access to water and irrigation. Afghanistan's provincial water systems are in various stages of functioning. Years of deterioration without maintenance, and destruction from multiple wars left 18 of Afghanistan's 31 provinces without a water supply system, seven provinces with systems that were 50-75 percent active, and six provinces with systems that were not functioning.

The rural population is dependent on water from springs karezes and canals for water that is used for irrigation, human consumption, and animal consumption. Often these sources are polluted before they reach villages.

Prolonged periods of drought have had devastating impacts on the water resources of the country, on agriculture and livestock, as well as on economic and social life. Many lands are irrigated by spring-water seeping from the underground and flowing to the surface. These lands are thereby directly dependent on and affected by the lowering of the ground-water table that occurs during drought periods. Afghanistan's ground-water table is also threatened by contaminants such as gasoline and diesel from shops, and from the overuse and misuse of pesticides and chemical fertilizers. Various agencies have sunk wells throughout Afghanistan in order to alleviate immediate needs. However, there is no coordinating body, and often deeper wells have had adverse effects on shallower springs and wells supplying water in other parts of the country.

AWATT was designed to help develop Afghanistan's agricultural institutional framework for effective supply and demand management of the country's limited water resources and to catalyze policy reforms to provide a mechanism to increase the efficiency of supplying water for agriculture. The AWATT program was funded by the USG (United States Government) through a Cooperative Agreement with USAID-Afghanistan's Office of Agriculture (OAG). The Afghanistan-based AWATT team was led by New Mexico State University (NMSU) and included partner universities: Colorado State University (CSU), Southern Illinois University Carbondale (SIUC), and the University of Illinois at Urbana-Champaign (UIUC). The Cooperative Agreement between AWATT and USAID was implemented on March 3, 2008 with an initial budget of $19,842,135. In FY2010, AWATT's program description was revised twice, in February and in June, "to reflect the needs and realities on the ground as well as respond to the GIRoA line ministry concerns and the new USG Agriculture Strategy and the Afghan First policy." On March 2, 2011, at the end of the original agreement period, the Cooperative Agreement's completion date was extended from March 2, 2011 to June 30, 2011 and the total program funding was decreased by 19% or by $3,785,839 to $16,056,296. AWATT spent $18,526,396 in funds on the program.

The USG Agricultural Assistance Strategy for Afghanistan includes objectives; 1) to increase agricultural sector jobs and incomes, and 2) to increase Afghans' confidence in their government. While the initial focus of AWATT was extremely broad, over the course of the three-year program as guided by USAID, AWATT was honed and refined to better meet the USG objectives. AWATT's modified objective was to *improve the community and farm level management of the supply and demand of irrigation water resources for increased agriculture productivity and food security in Afghanistan*. In targeting this objective, the AWATT program was designed in three components. These components were; 1) Integrated Water Management, 2) Appropriate Agricultural Technology, and 3) Technical Assistance to MAIL. Each component was supported by several unique projects developed

and delivered by subject matter experts from the universities comprising AWATT or subcontractors retained by AWATT.

Component 1 of AWATT's program was Integrated Water Management (IWM). The goal here was to develop an efficient and equitable community based irrigation water resource distribution and management system to improve agricultural productivity.

Component 2 focused on the transfer of appropriate agricultural technologies to Afghan farmers. The specific goal in this case was to identify and introduce technologies to increase agricultural productivity and rural incomes in areas subject to seasonal drought and high risks of land degradation, deforestation, or loss of biodiversity.

Component 3 of the AWATT approach was to provide Technical Assistance to MAIL. Within this component, AWATT provided technical assistance to improve MAIL's irrigation and watershed management decision making strategies and outreach capabilities. This was accomplished through, training and the transfer of technical skills to staff of Ministries, Faculties of Agriculture of Afghan Universities and of Agricultural Vocational Schools, with an ultimate goal of improving the quality of agricultural production, natural resource management and irrigation management services delivered to rural communities by MAIL.

To fulfill the needs within each component, AWATT supported a wide range of projects. Staff acted in many different roles and capacities – as subject matter experts, as teachers, as advisors, as colleagues, and as mentors, to name but a few. Project resulted outputs such as;

- Skill building and knowledge transfer for Afghan farmers, MAIL extension agents, and community level water masters
- Advising and training the GIRoA staff at the Ministry of Agriculture, Irrigation and Livestock (MAIL); the Ministry of Energy and Water (MEW); Faculties of Agriculture of Afghan Universities through Ministry of Higher Education and Agricultural Vocational Schools of the Ministry of Education; as well as the USG Provincial Reconstruction Teams (PRT)
- Demonstration of technologies to improve agricultural production and water use efficiency with farmers, Afghan universities, and research stations
- Study tours with irrigation engineers and vocational school headmasters resulting in first-hand exposure to new ideas and models
- Infrastructure projects such as; ditch lining, refurbishment of karezes, and employment of local labor in the construction efforts
- Upper watershed restoration and stabilization projects that involved local workforce in the construction of terraces and enlisting women (Foster Mums) to grow the tree stock used in planting
- The introduction of new technologies to improve agricultural production such as; laser leveling, raised beds, use of UDP fertilizers, SRI, hoop houses, high yielding forage, and on-farm water management.

- The introduction of technologies to improve lives and public health such as solar dryers, solar pumping, and food processing and forage management techniques taught to women.

AWATT filled a gap in Afghanistan as one of few programs that specifically targeted building human and institutional capital rather than focusing largely on infrastructure projects. The knowledge, skills, and abilities imparted on Afghans by AWATT will be utilized and passed on to other Afghans in the future.

An independent survey conducted in the final months of the AWATT program; reported that for farmers and government staff who participated in AWATT trainings or attended AWATT events (Annex Report 6.11);

- 96% of farmers said they learned a new skill
- 89% rated trainings as "*excellent*" or "*good*"
- 93% of farmers said they had *implemented the technology* on their farm
- 100% of farmers who said they had implemented a learned technology reported that they believed it *increased their farm's productivity*
- 100% of farmers who said they had implemented a learned technology reported it *saved them time on their farm*: of which 58% indicated it saved them more than 3 minutes per day
- Farmer *productivity increases* ranged from 7% for wheat to 190% for onions
- Farmer *incomes increased* as much as $620 over the previous year
- 96.5% of government staff reported *increases of learning or awareness* as a result of their AWATT training
- 98% of government staff reported applying what they learned inside the workplace
- 74% of government staff said they imparted their skills to another employee
- 65% of government staff stated that their institution or department had made changes in internal processes as a result of AWATT training

Component 1
Integrated Water Management

With more than 90% of the water withdrawals in Afghanistan accounted for by agriculture, proper water management is unquestionably critical to the achievement of accelerated agricultural production. Afghanistan's water problems stem from shortages in fresh water resources coupled with widespread inappropriate use of the country's watersheds, aquifers, and river basins.

Human pressure, deforestation, depleted watersheds and poorly designed and maintained conveyance systems contribute to water supply problems, which are aggravated by unregulated use in all sectors: household, agricultural, and industrial. As population increases, agricultural production intensifies, and industries expand, water supply problems in Afghanistan will become more critical, especially during periods of drought.

In order to maximize and conserve water resources for agricultural production, AWATT helped fill an urgent need by reviewing irrigation and water management practices and developing programs, in close consultation with MAIL, to achieve efficient and equitable community-based water resource distribution and management systems.

The IWM component included objectives to:

- Introduce measurement-based water management systems to assess water availability and variability during a cropping season, to promote efficiency and equity in water distribution and to determine crop water requirements;
- Introduce proven water conservation technologies that are replicable, such as laser land leveling, furrow, raised bed irrigation and farm water turnouts;
- Assess feasibility and development of a watershed reservoir; in Balkh Province;
- Improve irrigation management through water users associations, training of Mirabs (water masters or keepers who manage the secondary and tertiary level irrigation systems), and a more effective MAIL Department of Irrigation;
- Assist MAIL and its newly established Irrigation Department in their participatory approach to establish Integrated Water Management programs across Afghanistan.

The AWATT program accomplished the following specific activities.

1. Measurement-based water management systems

Irrigated agriculture in Afghanistan is characterized by very low productivity of water. AWATT played an important role in introducing measurement based and more efficient water management systems; introduced and demonstrated water conservation technologies; improved irrigation management by working with stakeholder groups and MAIL; and through the establishment and demonstration of Integrated Water Management programs across Afghanistan.

With the exception of a few public canals, most of the 28,000 to 30,000 irrigation channels in Afghanistan are maintained and operated by individual local farming communities. These canals are often poorly maintained and incur substantial water losses through seepage and leakage. Field measurements by AWATT in selected Nangarhar and Balkh irrigation canals showed that between 30% and 50% of the available irrigation water is lost during transmission, and losses in the field and tertiary channels, in many cases, may be higher than in the main and secondary canals.

Measurement-based Water Management

In what was to become the first ever monitoring program of informal irrigation systems in Afghanistan, AWATT introduced measurement-based water management systems to assess water availability and variability during the cropping season. Water measurement systems were installed at

25 sites on selected canals in Balkh and Nangarhar Provinces (Annex Reports 1.1 & 4.2). The selection of the canals and monitoring points was done in consultation with staff from MAIL and Ministry of Energy and Water (MEW) and local Mirabs. It is important to note that the irrigation systems in Balkh and Nangarhar were quite different in nature and characteristics; The Nangarhar irrigation system is a mostly water abundant system with wheat and rice as major crops while; the Balkh system is water short with wheat, melon and vegetables as major crops. Similarly, there is almost no groundwater use for agriculture in Nangarhar irrigation canal commands while many tubewells or dug wells are being used in the Balkh irrigation canals, especially in the tail sections. Benchmarks were established and staff gauges were installed near the head, middle and tail sections of the canals to evaluate water availability and distribution. Water losses were measured and the physical conditions of the channels were noted. Flow records indicate in average and dry years that river supplies are unable to satisfy irrigation demand and as much as one-third of the water does not reach the fields. Inequities in water distribution among farms was observed and training and awareness sessions were organized with Mirabs and water users, to teach them how to recognize and rectify inequities in distribution and to improve delivery to lower reaches of the canals. Through these efforts, MAIL staff, MEW staff, and Mirabs were trained on the measurement-based aspects of irrigation system operations. The following (Chart 1) shows poor water distribution in a selected canal in Nangarhar during summer 2009.

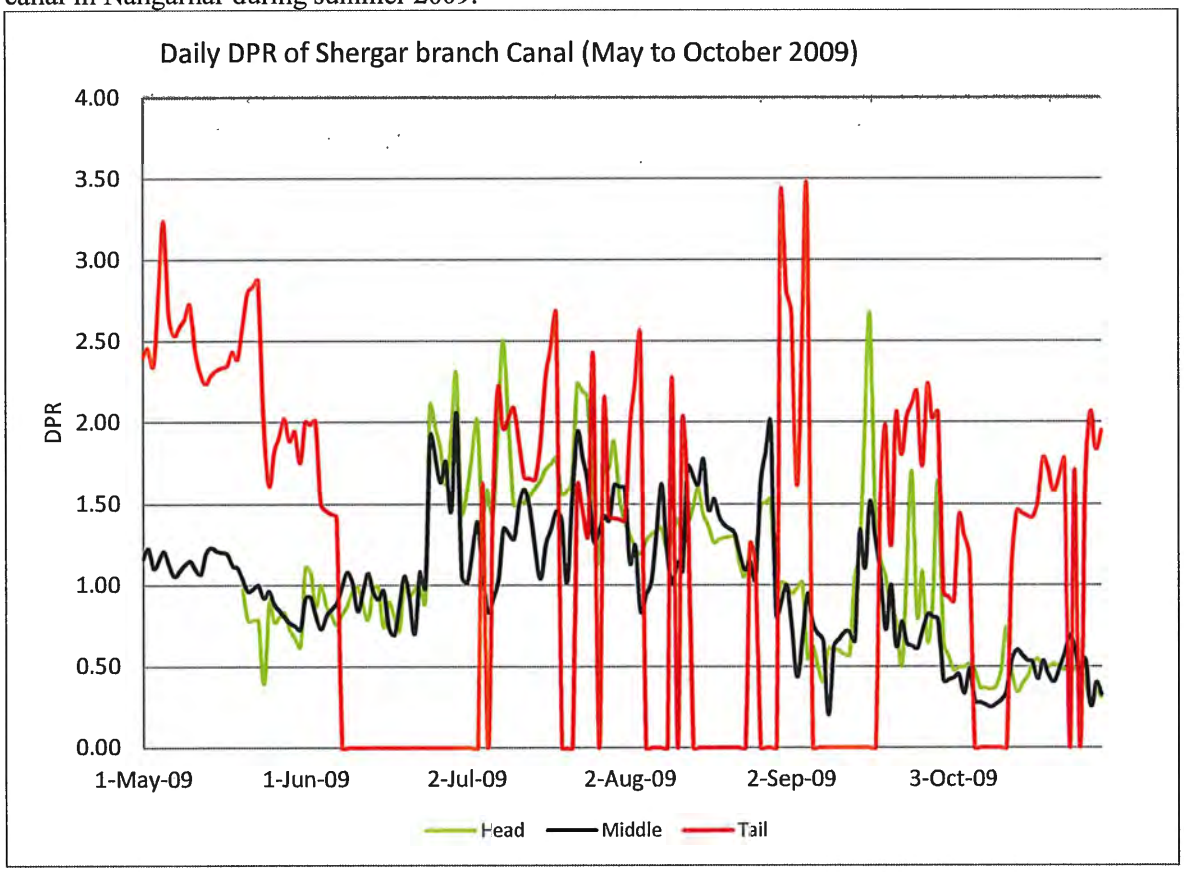


Chart 1: Daily water distribution at head, middle and tail of Shergar canal in summer 2009.

By default or agreement among water users, each point should get its due share of water based on land being irrigated below that point, however; the Chart shows that head has continuously drawn more water than middle and tail; in some cases more than 1.50 to 2.0 times of its due share (July and August). Variations at the tail end are very high where it has either been receiving much more than its full supply or no water at all for much of the summer season. These variations have been shown by DPR (delivery performance ratio) which is the ratio of daily discharge at a point to the design discharge of that point. Because, there is no design data available in Afghanistan, seasonal average discharge at the concerned monitoring point has been taken as baseline.

This poor water distribution has serious economic implications for water users along the canal. Access to water availability seriously affects the cropping pattern as shown below (Chart 2) for the same Shergar branch canal in Nangarhar. Rice was planted at 52, 42 and 7 percent of the area in the head, middle and tail respectively while; corn cultivation was done in 28, 45 and 77 percent of the area for the same locations as affected by water availability. At the same time, average rice yield in Nangarhar is 3.5 t/ha and corn is 2.14 t/ha with average 2010 prices of $600 and $300 per ton for rice and corn, respectively.

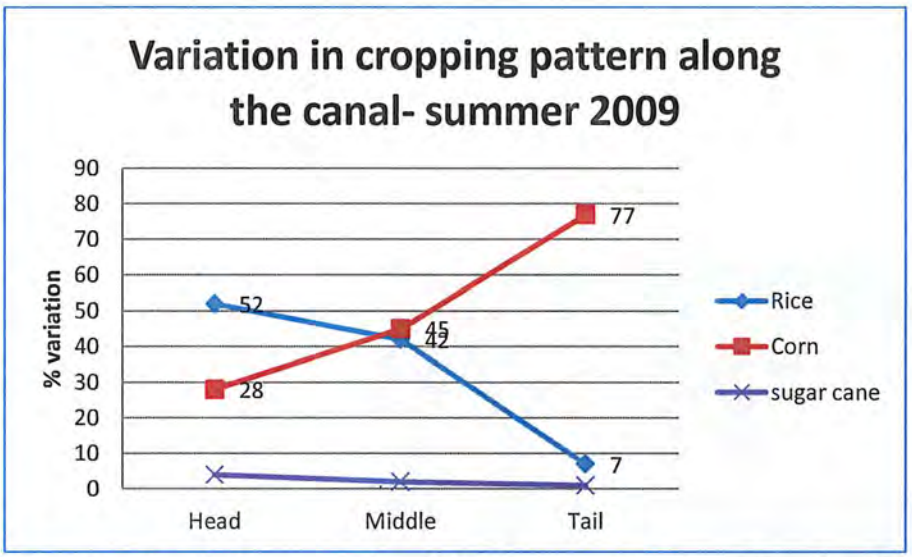


Chart 2: Cropping pattern along the Shergar canal as affected by water availability and Siagard canal daily gauge readings from head to tail for July 2009

Participatory Construction of Weirs for Improved Water Distribution

As a part of its plan to improve water distribution and management, AWATT designed and built water distribution structures on the Shergar branch of the Kaama Canal in Nangarhar. The water users and elders of the area were consulted and agreed to contribute in kind support to the cost of the weirs' construction. AWATT provided technical support and material while the water users provided the labor. After detailed engineering surveys and designs, three weirs were constructed on the canal, which have proven to substantially improve water conveyance and management in the area. The canal irrigates about 800 hectares of land in Gouj, Shergar, and Wat of Kaama district. The structures in the Shergar

Branch were centuries old and lacked proper mechanisms to regulate and control the flow. The new canal installations have resulted in savings of 10%-15% of the irrigation water that was previously lost to ineffective management systems. Agricultural production in the area has improved impressively as a result of the extra water, with increased crop production of at least 25% (Annex Report 2.13). Mercy Corp and other NGOs have constructed many small weirs in this area on the same canal recently.

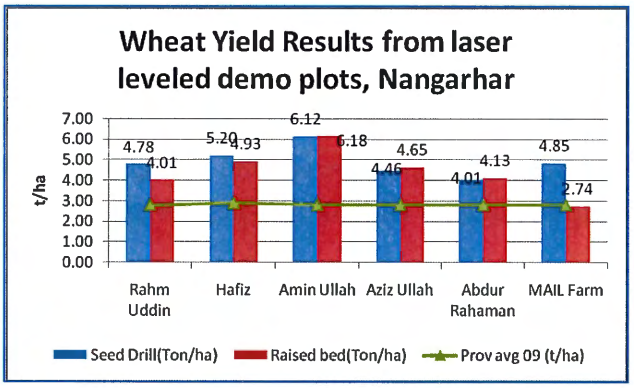
2. Proven water conservation technologies

A number of water conservation technologies were implemented and demonstrated by AWATT.

Laser Land Leveling

AWATT successfully introduced laser land leveling as a technology for more efficient and effective irrigation management resulting in increased farm productivity. Laser leveling was applied to a variety of crops (wheat, chili pepper, sweet corn and tomato) and locations to demonstrate the water conservation and yield benefits of laser leveled land as compared to adjacent unleveled, traditionally irrigated land. Wheat grain yields from the laser leveled AWATT demonstration plots in Balkh and the Eastern region increased by more than 50 percent compared to the respective provincial averages. More than 110 leveled wheat demonstration plots were developed, in seven provinces of Afghanistan including Nangarhar, Konar, Laghman, Parwan, Mazar-e-Sharif, Samangan and Herat. (Annex Report 2.15)

Laser leveling applied to demonstration plot in Balkh Province, December 2009



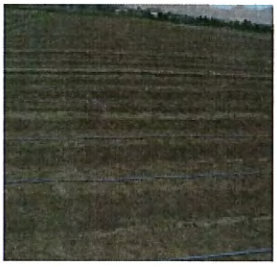
An interesting result from 2009 was the highest yield of more than 6 t/ha at the tail demonstration plot of Mr. Aminullah and the 2010 results have shown the highest yield of 7.4 t/ha from the MAIL Urdu Khan Research Farm in Herat.

Irrigation Technology

Like many other countries, farmers in Afghanistan produce high value crops like chili pepper, tomato and sweet corn on a small scale for the family's own consumption and to supplement the family's income through cash sales. But problems with the use of appropriate technology and water management (water efficiency) are often reasons farmers do not get optimum levels of production. AWATT with the cooperation of the Afghanistan Sustainable Agriculture Program (ASAP) and MAIL developed a demonstration plot for technology transfer and water optimization at the Badam Bagh research farm near Kabul. The site was arranged as two blocks (laser leveled and unleveled) to compare crop yield and water efficiency; and three crops (tomato, chili pepper and sweet corn). Plots were established under three different irrigation systems (drip, furrow and flood) to find out which system was more efficient. Flow meters were installed to measure the water applications.

Furrow System

Flood System



Drip System

The study revealed the drip irrigation system saved water and produced the highest yield (11 ton/ha of chili pepper and 45,292 ears/ha of sweet corn), using 3,125 cu meters and

2,333 cu meter of water per ha, respectively. The furrow system was second most efficient and produced good yields (10 ton/ha of chili and 40,475 ears/ha of corn, while using 4,600 cu meter and 2,950 cu meters of water, respectively. Flood irrigation was least efficient and produced low yields (7 ton/ha of pepper and 39,200 ears/ha of corn) while using 7,435 and 5,710 cu meters/ha of water, respectively. The quality of produce from the flood irrigated system was of lesser quality with 52% of pepper plants affected by phytoptera. (Annex Report 5.35)

Sweet Corn Harvesting

Chili Pepper Harvesting

Concrete Farm Turnouts

The introduction of concrete farm turnouts resulted in savings of water, time and expended effort as compared to traditional on-farm irrigation systems in Afghanistan. The turnouts provide for more efficient control of water deliveries and shut-offs. Water users overwhelmingly responded to the concrete turnouts that were installed in a participatory mode, where the water users provided labor and AWATT/MAIL provided materials and offered technical support. AWATT participated in the installation of approximately 500 turnouts in Balkh and Nangarhar provinces. However, expressed demand indicates a need for thousands more to be installed for efficient and effective use of water. AWATT trained dozens of MAIL engineers to plan, design, and install these turnouts, and teach others how they work. (Annex Report 4.6)

Because of limited technical and fabrication capacity in Afghanistan, the concrete turnouts were initially imported from Pakistan. The recent development of capacity in Afghanistan now allows for local fabrication of at least some turnouts.

Concrete Turnout:

Before

After

Watercourse Linings

As discussed earlier, the traditional irrigation system of Afghanistan is prone to huge water losses through seepage and leakage. A project to line tertiary or on-farm canals with precast parabolic segments (PCPS) was initiated by AWATT to improve water delivery and reduce maintenance and operation requirements. The large concrete sections necessary to line the canals were not available in Afghanistan and it was not practical to import sections from Pakistan, so molds and other equipment necessary for the manufacturing process were imported from Pakistan to Jalalabad where a yard was established by a Pakistani and some Afghan partners. Skilled people trained local masons and laborers in the manufacturing and curing of PCPS and farm turnouts as part of the AWATT technology transfer and capacity building process.

> Farmer in Sarachai Naghlo expresses his view below:
>
> Water Turnouts are new technology installed by AWATT in the on farm water courses in Sarachai Naghalo, its very effective technology farmers is very impressed by this technology I am thankful to AWAAT for installing the turn out now my small son can easily close and divert the water to other side. It saved the time before while I diverted water to other direction it was normally taking 30 minutes now I can divert it in at least in 30 second.

The first PCPS were installed at Shesham Bagh Research Station in Jalalabad a 625 meter watercourse for delivering irrigation water to experimental plots (Annex Report 2.16). This research farm was the best place for the introduction and demonstration of this technology because it is visited by all types of professionals in agriculture and water users in the vicinity.

Newly lined watercourse in Sheshambagh

Msrs. Safi and Fayez during opening ceremony

Canal and Karez Linings

A collaborative effort between AWATT and the Herat PRT resulted in the lining of Kareze Bibi and 11 additional delivery canals and karezes in the Shindand district (Annex Report 4.75). By reducing canal seepage and waste, these efforts resulted in an estimated 300 percent increase in cultivatable land by placing watercourses 'on-grade' and bringing new land into production. Collectively the canal and karez linings affected 40 villages and 120,000 people; brought 44,750 jeribs (8,940 ha) of irrigated land into production; and

> The *Arbab* of one village said *"Nobody has ever helped us. First the Russians came, then the Mujahideen came, then the Taliban came. They all made promises, but nobody helped us. You are the first one who has helped us. May God reward*

created 185,000 person-days of temporary employment and an opportunity for 134,250 permanent farm employment jobs (based on creation of 3 agricultural laborer jobs per jerib of new production) (See Table Below). The rock and concrete lining of the karezes (which are typically unlined gravity flow channels that access underground aquifers) contributes to reduced maintenance, more available water, and demonstrated improvements that can be replicated. Watercourse lining activities require some imported materials, such as cement and rebar to reinforce the concrete, but these efforts make significant, albeit it temporary, contributions to local communities through the provision of jobs for locally available unskilled labor.

> Another villager said with amazed excitement, *"You told us you were going to increase our water … and you did!"*

Karez:

Being Cleaned

After Being Lined

An innovative adjustment to the lining of Karez Bibi provided an intervention that has likely not been accomplished or even considered in nearly 3,000 years of karez system operations. The water in karezes flows uncontrollably all year and farmers have little control of the discharge rate. In addition to lining Karez Bibi, AWATT built a control structure at the outlet of the lined karez to store water in a natural underground aquifer and allow water users to control water flows from the karez based upon need. This essentially transformed the karez into an underground reservoir, similar to a dam, but better because the underground reservoir does not evaporate or seep out. (Annex Report 4.8)

Governor Omarzai, the governor of Shindand, and a former Talib commander, said in his letter of appreciation *"Projects of this caliber have never been implemented in our area by any organization."*

AWATT SHINDAND DISTRICT IRRIGATION ACTIVITIES

Rehabilitation Project	Number Impacted		Potential Total Cultivatable Land		Previously Cultivated Area		Resulting New Cultivatable Land	
	Villages	Pop'n	Jeribs	Hectares	Jeribs	Hectares	Jeribs	Hectares
Karez-Bibi, Karez and Canal	1	2,800	2,500	500	600	120	1,900	380
Canal-Soor	10	30,000	20,000	4,000	4,000	800	16,000	3,200
Kola-Shor Diversion Dam and Canal	1	4,200	800	160	100	20	700	140
Parmakan Diversion Dam and Canal	7	37,000	25,000	5,000	5,000	1,000	20,000	4,000
Abgarmak Karez and Canal	1	4,500	800	160	100	20	700	140
Nayesk Karez and Canal	1	5,000	850	170	200	50	650	120
Nayesk Retaining Wall	To stabilizes the delivery canal of Nayesk Karez and will protect the agricultural lands from erosion							
Sangestan Karez	1	4,000	1,000	200	800	160	200	40
Sangestan Canal	Same as above							
Shorab Upstream - Canal	10	30,000	600	120	3	1	600	120
Shorab Downstream - Canal and Potable Water	Same as above							
Kah Canal	8	2,500	8,000	1,600	4,000	800	4,000	800
TOTALS	**40**	**120,000**	**59,550**	**11,910**	**14,803**	**2,971**	**44,750**	**8,940**

Temporary Employment: 185,000 person-days*

Additional permanent farm employment: 134,250 jobs**

** Number of additional jeribs potentially cultivated resulting in access to irrigation water x 3 agricultural workers.

Source: Annex 5.21)

AWATT Watershed Rehabilitation program - Terracing at Samarkhail hills, Nangarhar Province in May 2010

3. Feasibility and development of watershed reservoirs

MAIL identified a small reservoir site in Mata Khel, Farza district of Kabul province, for storing surplus snowmelt and rainwater to irrigate some 500 hectares during water-short periods. AWATT with participation of the MAIL Department of Irrigation (DI) evaluated the socio-economic dimensions of the reservoir in Mata Khel. This analysis determined the value of water for agricultural use is about 2.5 cents per cubic meter, meaning a net present value of the small reservoir of about $400,000, and nearly $800,000 for the larger, off-line reservoir. These initial projected values are well above the estimated cost of building the reservoir, but require further study before committing to the project. AWATT's role here was as a technical advisor.

4. Improved irrigation management

Irrigation System Diagnostic Analysis

A two-week intensive Diagnostic Analysis (DA) of irrigation systems in Mazar-e-Sharif and the Balkh watershed involved a group of 30 officials from MAIL, MEW and other government and non-government organizations in Afghanistan. The DA was a structured investigation examining the irrigation system to identify and analyze existing problems and limitations using a multidisciplinary team. In addition to providing background information on water management issues, crop water requirements and farm economics, participants participated in class work, demonstrations of water measurement techniques and a farm survey and gained a better understanding of the need for improvements in the efficiency of water deliveries and the need for further training. One of the more significant findings from the analysis of farm-level data and analysis of village water-delivery practices was that the typical Afghan Mirab (the person responsible for irrigation water distribution) assigns water allotments per field by providing water access for specified periods of time, instead of measuring the amount of water delivered to a field. Because water availability is uncertain, farmers near the headwaters of a canal typically use their entire allotted 'turn' which contributes to over-irrigation and reduced crop yields, while those at the mid- and lower reaches often have higher crop yields. (Annex Report 4.2)

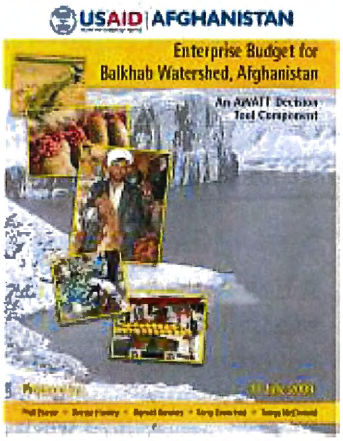
Crops Assessments

The knowledge of when to irrigate and of how much water to apply per irrigation is important to improved farm production, increased gross farm profits, and the judicious use of Afghanistan's scarce water resources. Using GPS units and walking from field to field, AWATT staff completed crop assessment surveys in the Shergar Branch canal in Kama district of Nangarhar and in the Balkh Canal of Balkh province. Engineers also calculated average potential evapotranspiration, rainfall, and irrigation water requirements for 11 major crops grown in the region (wheat/barley, alfalfa, cotton, melons, onions, tomatoes, peppers, eggplant, apples, grapes, and plums/apricots). In general, the AWATT team observed a severe shortage of water in all of the sampled canals' irrigation service areas. As a result, farmers in these service areas were cultivating only a small percentage of their arable. Peak water demand was found to be in May and June and in-line or on-line water storage needed to be explored as a solution for overcoming these water deficit situations.

There was also an observed need for conservation and better management of water resources in the area. Improved water management practices such as raised beds, better flow control structures, and land leveling were identified as potential solutions for increased water efficiency.(Annex Reports 4.2 and 5.8)

Enterprise Budgets

Cost and return estimates are critical to the assessment of technological demonstrations and ultimately, the recommendation of technologies to smallholder farms. A critical "filter" in assessing what technologies to introduce to Afghan farmers is to first assure that it is economically viable. AWATT developed detailed crop cost and return estimates representative of the Balkhab basin. The costs and return budgets were based on three distinctly different areas encountered as one follows the flow of water (head waters, middle, and tail waters). As one moves from the head waters to the tail waters, different crops and cropping patterns were found because of such things as climatic differences, changes in soil characteristics, rainfall patterns, and the availability of water. The cost and return estimates were compiled into a working paper "Enterprise Budget for Balklab Watershed Afghanistan" (Annex Report 5.3).



The developed crop budgets were used to support an AWATT workshop as a training tool for persons from MAIL, Universities, and the private companies from Afghanistan (Annex Reports 5.5 and 5.6)

Training of Mirabs

While documents published by various donors and research organizations made a passing mention of the Mirabs - Afghanistan's village water masters - little was done to involve them systematically in the Integrated Water Management (IWM) participatory process. AWATT was the first USAID project to recognize the importance of capitalizing on the Mirabs' important function in creating workable Water Users Associations and the

introduction of sustainable irrigation practices at the farm level. AWATT's initial work with Mirabs led to the first-ever MAIL-convened workshops (in February, August and November 2010) involving 230 of these grassroots water managers. These conferences/workshops contributed to the sharing of practical information from AWATT's fieldwork and a greater understanding of the Mirabs' vital role in national water conservation, equitable distribution, and food production, as well as in the uniform implementation of Afghanistan's new Water Law (Annex Reports 2.15, 5.15 and 5.16).

5. Integrated water management

Decades of war and weak governance have created huge negative impacts on Afghanistan's natural resources. Deterioration of vegetative cover is a major problem for efficient water resources management. Extensive destruction of forest cover resulting from over-exploitation of natural and manmade forests for timber and fuel wood have resulted in denuded lands and mountains, serious erosion, shortages of fuel wood, insufficient wood products to meet demands for reconstruction, damaged irrigation systems, reduction in agricultural productivity, security of food and chronic hunger.

Management of upper watersheds and catchment areas by building watershed management infrastructure including terraces and check dams offers potential to conserve water and improve groundwater replenishment.

Check dam construction and final check dam No 4 at Kashmond Kala village in Dare Noor District, Nangarhar Province, 2011

Watershed Reclamation

AWATT designed and implemented a Watershed Reclamation pilot program in the provinces of Balkh, Nangarhar and Nuristan with potential for replication throughout the country. The programs' objectives were to encourage communities to reclaim their destroyed watersheds by developing and transferring technology and skills. The watershed projects involved multiple integrated components, including terracing hillsides and constructing check dams to increase water infiltration and reduce erosion and establishing tree seedlings for revegetation. The watershed reclamation process also involved the removal of animals from the upper watershed for a period of time to allow the

establishment of grass, forbs and tree species that have been eliminated by overuse and overgrazing. The animal grazing efforts and associated increases in forage production that are necessary to keep these animals in farmed areas are reported under Component 2 of this report. The Watershed Reclamation project provided temporary employment for more than 600 laborers in the three provinces.

"I am working here to earn money and learn about agriculture." says Abdul Khaliq, an 18-year-old student laborer, while digging a terrace on a rocky Nuristan hillside

Terracing

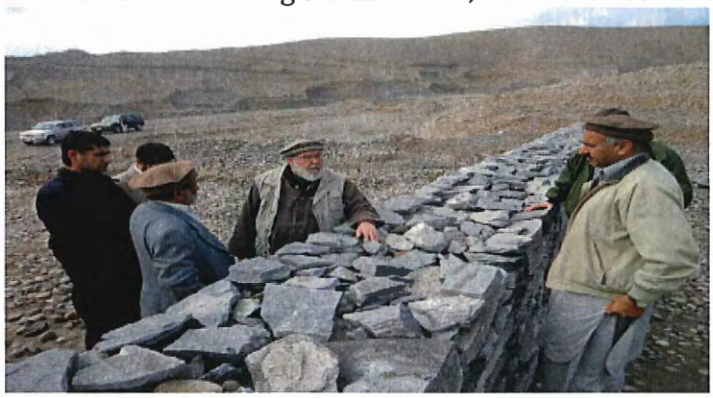
Terracing of hillsides was conducted as a pilot program in the provinces of Balkh, Nangarhar and Nuristan. Terracing is a soil conservation practice applied to sloping land to prevent rainfall runoff from accumulating and causing serious erosion. Terraces consist of ridges and channels constructed across-the-slope. Working with local officials at MAIL, the terracing projects served to: build local capacity through training and awareness; decrease erosion of scarce arable land; reduce river sedimentation; increase agricultural production; and boost local incomes. A total of 709 ha of terraced land was constructed by AWATT in the provinces of Balkh (309 ha), Nangarhar (250 ha) and Nuristan (150 ha) (Annex Report 2.16). The project also benefited some local women through the Foster Mum program where they nurtured thousands of seedlings in home nurseries for planting on the terraces.

Ideal Terrain

Without Terracing

Check Dams

Check dams are small dams or structures constructed across a drainage ditch or channel to lower the speed of concentrated water flows following storm events, and were used in conjunction with terraces to conserve soil and allow hillsides to become revegetated. A total of 83 check dams were constructed, by AWATT, in the watershed reclamation areas in Balkh, Nangarhar and Nuristan. As a sign of adoption of the technology, the Nangarhar Tree Army has built an additional 490 check dams as of March 2011. (Annex Report 2.16) The terracing and check dam construction activities provided 435,600 person days of temporary employment.



Foster Mum - Gender Benefits

The Watershed Reclamation program had a secondary benefit of creating meaningful employment opportunities for more than 200 women through participation in the "Foster Mum" program. Through this program women were trained in nursery-raising practices which were adapted to a single household production level. The Foster Mums were paid to grow tree seedlings for transplanting at the reclaimed watersheds. The women were provided the seeds or young seedlings to raise, which were then sold back to AWATT in the spring when ready for transplant. AWATT, in-turn, donated the seedlings to the provincial forestry departments for planting on the reclaimed watersheds. Collectively, the Foster Mums produced 46,000 seedlings. (Annex Report 2.16)

The Foster Mum program was targeted at, but not exclusively limited to, households where widows or other women sole providers were the only income sources for the household. The 200 women who participated in the program were provided with polyethylene bags, soil, sand, and manure as well as seed and shade materials, and water sprayers. They were encouraged to visit each other's nurseries to compare growth and share information on production practices. Each Foster Mum nursery produced 500 seedlings, which at Afs 30 per plant, gave the women a potential income of Afs15,000 (USD $345) for their season of nurturing, in most cases, effectively doubling their income from

other sources. Each Foster Mum contributed the equivalent of 46 person days of work toward the tree growing program, which is equivalent to 23,000 person days of employment.

Tree Nurseries

Nursery production is critical to the watershed reclamation process in Afghanistan. AWATT staff conducted an extensive assessment of the status of twelve nurseries in four provinces in Afghanistan: Balkh, Kabul, Herat, and Nangarhar. Eight of the nurseries were public facilities and six belonged to MAIL or DAIL. Almost all nurseries can be described as horticulturally modified, producing primarily bare root saplings and bagged conifer saplings. The majority of the stock types are two to three year bare root deciduous, bare root samplings. In contrast to the US and elsewhere, the reforestation planting stock being produced in Afghanistan nurseries is significantly larger and the nurseries in Afghanistan demonstrated considerable innovation in their propagation strategies. During site visits, infrastructure limitations and proposed solutions were identified at existing nurseries and propagation protocols were evaluated and potential improvements were identified. (Annex Reports 7.30 & 7.31)

Forestry Assessments

AWATT initiated a series of forestry assessments aimed at restoring upper watersheds, the first such research done in Afghanistan in at least 30 years. AWATT foresters worked closely with the MAIL's Irrigation and Natural Resources Department to coordinate their efforts. The foresters worked with members of USACE to develop approaches to stabilizing upper watershed in areas where USACE planned to eventually build water storage infrastructure. The need for water storage and modernization of irrigation infrastructure is a primary concern of USACE, but in addition, upper watershed (or catchment) soil conservation measures need to be implemented to minimize the impacts from runoff and sedimentation. These upper zones have significant problems in terms of soil erosion, stream sedimentation, and management practices. There is a desire to get trees in the ground as part of rehabilitation work before any more dams are built. Too many times impoundment structures have been built only to fail 6-20 months later due to siltation and poor engineering.

In addition to the work with USACE, AWATT foresters were embedded with and worked with PRTs in Zabul, FOB Salerno (Khost), Wardak, Paktika, and Bamiyan to assist in planning watershed rehabilitation efforts.

Gamberi Desert Reclamation

Approximately 70% of Afghanistan's land area is rangeland, including the Gamberi Desert in the Shewa district of Nangarhar province. Generally, by definition, rangeland is land upon which the native vegetation is grasses, forbs and shrubs. Rangeland also includes areas where species of small and large bushes form open vegetation with less than 5 to 10% canopy cover. In Afghanistan such areas are known as deserts, which are mainly exposed to desertification; the process by which the potential productivity of rangeland is diminished by a combination of little or no plant cover, increased soil erosion by wind and water, reduced soil moisture due to increased runoff and evaporation and reduced biodiversity due to losses of both plant and animal species. At some point the loss of surface soil, plant cover and species becomes severe enough that the degradation is irreversible.

The Gamberi Desert is comprised of drifting or shifting sand. The typical desertification process here results in a loss of resilience in plant communities to drought, fire, flood, overgrazing, *etc.* It also leads to sharp declines in rangeland productivity including forage, fuel, wildlife and plants for medicinal uses or human food. Desertification also diminishes both the quantity and quality of water for downstream uses like irrigation and drinking water.

The Gamberi Desert Reclamation project was implemented to stabilize drifting sand with the aim of eventually restraining desertification. A total of 396,000 *Tamarix articulata* cuttings were produced and planted in 132,000 pits across a 100 hectare area in a 3 x 3 m spacing. The purpose of this planting was to establish vegetation that will stabilize the drifting sand in the windward direction from the site and eventually reclaim the site to rangeland. (Annex Reports 2.16 & 3.22)

These AWATT watershed reclamation efforts are expected to have a significant enduring effect on their local communities as they witness their ability to collectively improve both their environment and their incomes, and these technologies and skills are adapted by other locales. Initial assessments of the WRM projects indicate the process is working and should be considered for replication elsewhere. As would be expected in any desert environment, initial assessment of the Gamberi Desert Reclamation effort appears to be less successful, but warrants further evaluation and assessment into the future.

Component 2: Appropriate Agricultural Technology

More than three decades of war and civil conflict devastated Afghanistan's agriculture sector and isolated Afghans from new and improved agricultural technologies that are available in neighboring countries and countries with similar eco-systems.

Afghanistan is an arid country with limited arable land which is subject to seasonal droughts and flooding. Only 13% of the country's 65 million hectares are arable, of which about 40% is irrigable. Increasing land productivity per hectare, rather than expanding the area of production, is an appropriate strategy to accelerate growth of the country's rural economy.

The protracted social conflict, coupled with population pressures, lack of technical and managerial skills and sound policies have contributed to illegal tree harvesting and severe depletion of the country's rangeland and forest resources, including wetlands. Afghanistan's rural economy is resource-based and consequently needs to implement mitigating measures to prevent further destruction of the natural resource base.

In addition to providing easy access to information on improved agricultural production technologies, AWATT conducted adaptive research for innovative but simple technologies that could be easily implemented and replicated at program sites and in farmers' fields.

The introduction of agricultural technologies was in response to the needs of rural Afghans, their harsh circumstances and the capabilities of the government Ministries. By working with and through MAIL, AWATT ensured that the new and adaptive technologies were culturally acceptable. In addition to building human capacity at MAIL, AWATT delivered grassroots training to farmers in a number of areas and worked closely with other USG (USAID/OIEE and USACE) and donor efforts to strategically address water resources development issues on a national level.

By working closely with MAIL and MEW at the district and village level and by following rigorous scientific methods of testing for new ideas and measuring progress, AWATT avoided a top down or blanket approach to introducing new ideas, which helped ensure a well-informed and trained institutional memory to carry on the project activities.

In effect, AWATT tested combinations of various improvements to agricultural practices at the farm level and at the same time provided training and mentoring to engineers and agricultural extension workers in best practices, scientific methodology and critical thinking. By doing so, AWATT helped Afghan farmers, water users, Mirabs and local *shuras* decide for themselves what the optimum combination of improvements should look like for their particular farming community.

The Appropriate Agricultural Technology component included objectives to:

- To identify replicable and appropriate agricultural production technologies that will result in increased productivity per hectare

- To transfer technical knowledge to agricultural education, research and extension systems in Afghanistan for effective dissemination of results to users
- Coordinate and link private and public sector entities engaged in agricultural activities

The AWATT program accomplished the following specific activities.

Forage Production

Integrated crop-livestock production is critical for the development of Afghanistan's agricultural sector. The forage program was a significant part of AWATT's integrated watershed management program because, in order to establish trees and woody shrubs on the hillsides, livestock must be excluded from these upland areas for extended periods of time. To accomplish this, animals must be confined to farmlands in the lower watersheds and alternate sources of feed must be developed. Livestock feed can be expensive, difficult to obtain, and the protein content of many forages is insufficient for acceptable levels of animal production. AWATT's forage production program concentrated on the development of cost-effective, sustainable, high quality forages and the production of seed necessary for the continued propagation of these crops.

Forage production efforts were concentrated in Balkh, Nangarhar, Kabul, and Herat and expanded into other provinces through demonstration plots, field days, training programs, and research trials at MAIL facilities. Five hundred forty-seven forage demonstration plots, 22 applied research trials and 10 seed production sites were established. Other provinces benefiting from the pearl millet, sudangrass and cowpea training and demonstration plots were Herat, Nangarhar, Logar and Wardak. At the end of AWATT (June 2011), the forage technology transfer program, through demonstration plots, had been introduced in seven provinces Balkh, Nangarhar, Herat, Kabul, Parwan, Logar, and Wardak. 329 MAIL extension workers in seven provinces, listed above, received training in forage production and seed production; including a large number of MAIL researchers who have received specialized training in forage applied research at MAIL Dehdadi, Shishem Bagh, Badam Bagh and Herat Agricultural Research Stations. (Annex Report 5.37)

> Mr. Asadullah, Head of Extension Department at DAIL/Balkh province: "I highly appreciate AWATT-Forage program in Balkh for introducing of new forage crops for improving of livestock production in Balkh and secondly for training of our extension staffs."

Farm Resources Management

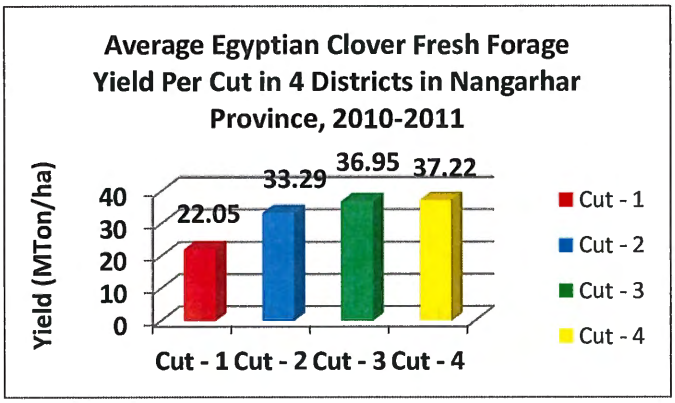
Almost all Afghan farmers keep animals of some sort and while there have been numerous assistance programs targeting livestock, most have been in the form of veterinary health. Until AWATT, none recognized the centuries-old Afghan practice of free-range grazing for sheep and goats as damaging to the upper watersheds which limits the production of meat and milk. The Farm Resources Management (FRM) project served to protect watershed

areas from overgrazing, introduce forage species that can be grown during the dry season, improve soil fertility, and developed seed production capabilities in Afghanistan.

A sustainable cropping system is an essential part of a complete farming system of soil, water, air, plant, animal, and human resources. Considering how the farm fits into broader watershed management (e.g. off-site effects and resource opportunities) is also fundamental to problem-posing and problem-solving, resource management success, and development of sustainable communities.

The focus of the FRM project was to break the cereal wheat/rice cycle in Afghanistan, which results in soil degradation, decreased productivity and organic matter, weeds, insects, and diseases. The FRM program integrates components required for a healthy farm: soil, water, crop rotations, forage legumes, livestock, farm community participation, and farm economics and incentives. The FRM project was initiated as an integrated soil, water and livestock project aimed at increasing farm productivity. FRM was developed in conjunction with the Nangarhar PRT and was conducted in collaboration with USAID-OAG, Missouri ADT, USDA, and the Department of Agriculture, Irrigation and Livestock (DAIL) in Nangarhar.

The FRM program is based on the introduction of Egyptian clover, a nitrogen-fixing forage crop that can be grown in rotation with traditional winter wheat or rice. In rotation, the clover contributes to higher yields of both cereal crops and contributes to increased sustainability through reduced water use, improved soil conditions and increase farm income from significant increases in crop, milk and meat production.



The FRM program used DAIL extension and research facilities in four districts: Chaparhar, Kama, Kuz Kunar and Behsood in Nangarhar. In addition to demonstration and research sites at the Shisham Bagh Research Farm and demonstration plots at the Nangarhar Valley Development Authority (NVDA). The program is replicable and expected to expand to other districts in the coming years. Participating farmers were provided seed and fertilizer for 25% of the actual cost.

The program utilized the services of the AWATT established soils laboratory in Chaparhar district; and had positive implications for the inclusion of women in the agricultural income equation and the FRM model included other AWATT introduced technologies including laser land-leveling, irrigation scheduling, quality seed varieties and crop rotations that include drought resistant annual forages for livestock forage. (Annex Report 4.38)

Pearl Millet

The project used pearl millet *(Pennisetum glaucum*) as a livestock forage to protect watershed areas from overgrazing, produce local sources of seed, and to introduce a hardy forage. Subsequently AWATT worked to establish 535 forage pearl millet demonstration plots in seven provinces: Herat, Balkh, Parwan, Nangarhar, Kabul, Logar, and Wardak which resulted in a 60%-80% increase in productivity per unit of land cultivated as compared to yellow corn (Jawari). Farmer adoption of pearl millet as a new crop is spreading. It is projected that as many as 3,000, neighboring farmers planted the new varieties after observing increased yields and increased incomes of the participating farmers. The improved variety of pearl millet (Shandawel 1) has resulted in 1) at least a 10%-15% increase in animal weigh gains, as compared to traditional forages, 2) at least a 15-20% increase in milk production per day, 3) as a results at least 15-20% increase in farmer household incomes.(Annex Report 8.14)

> Mr. Kateb Shams DG of DAIL-Balkh Province: "The result of pearl millet in Balkh Province was excellent" "I highly appreciate AWATT project; specially Dr. Hamdy Oushy and his forage team in Balkh for doing hard work to introduce improved forage varieties and improving of sustainable livestock production. This forage program was very useful for our farmers in Balkh Province."

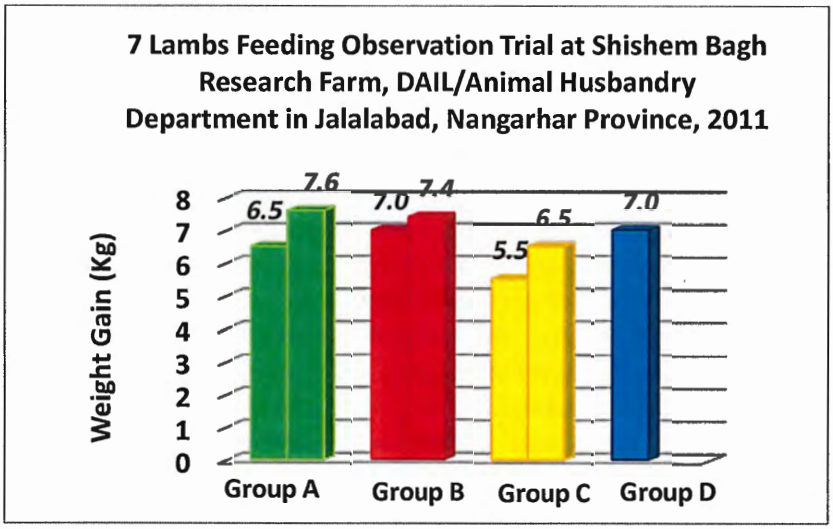
Sudangrass

Sudangrass (*Sorghum bicolor* subsp. drummondii) was used as an alternative livestock forage crop to pearl millet to protect watershed areas from overgrazing. It is a multiple–cut, drought resistant, nutritional, summer forage that produces 5-6 cuts per growing season. The project produced 806 kg of sudangrass foundation seed in 2010 at MAIL Agricultural Research stations in Balkh, Herat, and Kabul. Several sudangrass research trials and demonstration plots were carried out in 2010 at MAIL Agricultural Research Stations in Herat, Kabul and Balkh provinces and at agronomic research farms at Kabul, Herat, and Balkh University. The improved variety of sudangrass (Giza 1) resulted in a 50%-70% increase in productivity per unit of land cultivated. As many as 500 neighboring farmers have adopted the new varieties after observing the increased yields and increased incomes of the participating farmers. Field observations by farmers and extension workers indicated that like pearl millet, sudangrass was very useful in increasing milk production, weight gain and household incomes of farmers who fed these high quality forages to their livestock.

Forage Legumes

AWATT introduced Egyptian clover (*Trifolium alexandrinum)* to the FRM project for the ability to produce high quality forage that produces nitrogen, established quickly and makes excellent cover for crop rotations. Egyptian clover is a winter annual legume that can produce up to 50 tons of fresh green forage per hectare, from five cuts under irrigation (Annex Reports 4.5 and 9.15). Besides the biological benefits, Egyptian clover contributes to significant increases in milk production, with an average of 2 kg of milk per cow per day (Annex Report 3.22). Also, 20-27% increase in animal weight gain was reported in a feeding trial experiment of Egyptian clover hay for sheep and goats conducted at MAIL-Shishem Bagh Research Farm in May, 2011.

Animal Feeding Observation Trial at MAIL-Shishem Bagh Research Farm, DAIL/Animal Husbandry Department facility, Jalalabad, Nangarhar Province, May 2011.



Mr. Abdul Ghani Khan, "I am very happy from FRM program because I have own Dairy farm and I was in need for good forage and finally I got it in the form of Egyptian clover for the livestock as winter fresh forage and Perl Millet as summer."

The three AWATT introduced forages (pearl millet, sudangrass and Egyptian clover) have been shown to be adapted to growing conditions in Afghanistan and are well established among participating farmers and their neighbors and at least 120 MAIL and DAIL research and extension workers have been trained on improved forage production techniques.

Forage Cowpea

AWATT introduced forage cowpea to Afghanistan in 2010. Cowpea (*Vigna unguiculata*) is a leguminous forage crop, which can be grown in relatively infertile sandy soils. It is a fast growing, drought resistant, highly nutritional, and improves soil fertility by fixing atmospheric nitrogen. Cowpea crop is grown as fresh legume forage that can be planted in mixtures with pearl millet and sudangrass. AWATT tested forage cowpea in two replicated trials; 1) forage mixture experiments of cowpea with pearl millet, sudangrass, and local yellow corn (Jawari) in Heart province and 2) a forage crop varietal comparison experiment for pearl millet, sudangrass, cowpea, sorghum and Jawari at Kabul University. To sustain forage cowpea production in Afghanistan AWATT produced 399 kg of cowpea foundation seed from three provinces (Herat, Kabul and Balkh) in 2010. A large number of MAIL extension workers, researchers and farmers were trained in cowpea forage and seed production in Afghanistan. (Annex Report 4.12)

Foundation Seed Production

All farmers that participated in forage production activities and training also received training in seed production. This will enable them to produce their own seed and sustain improved levels of forage production year after year. Additionally, AWATT contracted with several farmers to produce foundation seed of pearl millet, sudangrass, and forage cowpea. Due to the intensive nature of seed production and the requirements for growing, harvest and cleaning, seed production activities produce increases in seasonal farm employment in the range of 500% - 800%. A typical farm that previously utilized 3 farmers for regular activities increased the number of seasonal workers to 20 – 25 when involved in foundation seed production (Annex Report 5.34).

AWATT's forage program produced the following forage foundation seed which was delivered to MAIL Seed System in order to multiply and produce certified seed:

"Mr. Pacha, many people are visiting me for seed, because they came to know about the quality and nutritional value of the Clover as compared to the traditional One."

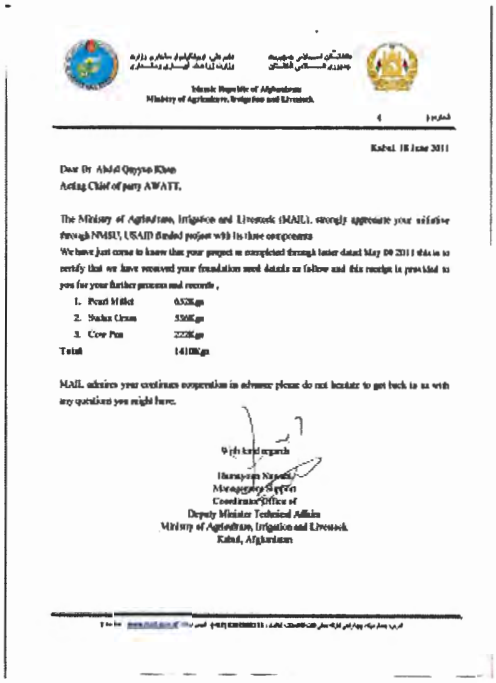
In 2009:

Pearl millet (Shandawel 1)	**750 kg**

In 2010:

Pearl millet (Shandawel 1)	668 kg
Sudangrass (Giza 1)	806 kg
Forage cowpea (Cream 1)	399 kg
Total Produced:	**2,623 Kg**

As referenced by the letter below, the AWATT foundation seed program produced 1,410 kg of foundation seed in the 2010 growing season:



Islamic Republic of Afghanistan
Ministry of Agriculture, Irrigation and Livestock

Kabul, 18 June 2011

Dear Dr. Abdul Qayyum Khan
Acting Chief of party AWATT,

The Ministry of Agriculture, Irrigation and Livestock (MAIL), strongly appreciate your initiative through NMSU, USAID funded project with its three components
We have just come to know that your project as completed through letter dated May 09 2011 this is to certify that we have received your foundation seed details as follow and this receipt is provided to you for your further process and records ,

1. Pearl Millet 652Kgs
2. Sudan Grass 336Kgs
3. Cow Pea 222Kgs

Total 1410Kgs

MAIL admires your continuous cooperation in advance please do not hesitate to get back to us with any questions you might have.

With kind regards

Hamayoun Nazeri
Management Support
Coordination Office of
Deputy Minister Technical Affairs
Ministry of Agriculture, Irrigation and Livestock
Kabul, Afghanistan

Animals

Livestock play a critical role on the Afghan farm by providing protein for household consumption and contributing to soil fertility through the deposition of manure. The FRM program implemented a series of interventions to keep small ruminants on farms at the lower watershed by:

- Providing simple fencing and shading structures for animals
- Providing temporary grain sources until forage crops mature
- Helping DAIL establish a livestock marketing system that connects with regional markets

ADT/Missouri in Nangarhar Province in collaboration with AWATT provided fencing, shading areas, and feeding facilities, as well as high quality seed for wheat and rice, and a training facility to improve irrigation and agronomic practices.

The forage program promoted the use of the services of the AWATT established soils laboratory and has positive implications for including women in the agricultural income equation. In addition, there were more than 100 forage demonstration plots on farmers' land, with farmers volunteering to plant pearl Millet at their own cost.

Rangeland Watershed Rehabilitation

The Rangeland Watershed Rehabilitation (RWR) project has rolled out a model development project in the watershed area of the village of Kashmond Kala in the Dare Noor district of Nangarhar Province. The initial efforts and focus of the RWR project is to establish a successful and replicable model integrated watershed rehabilitation project that can serve as a demonstration program for expanded implementation of a RWR program in Afghanistan.

The RWR project was owned by the Nangarhar DAIL and implemented by AWATT in cooperation with DAIL/NRM/Nangarhar, Nangarhar ADT, USAID/Nangarhar, Nangarhar PRT, US Army Corps of Engineers, Nangarhar Provincial Council, Dare Noor District Development Authority, and Kashmond Kala villagers. The RWR was designed to rehabilitate upper and lower watersheds through local community involvement. As part of this process, local villagers were involved in the development, implementation and sustainment process. RWM involved controlling water flow, improving vegetation cover, managing grazing, and implementing the Farm Resource Management (FRM) program in the connected lower watershed.

The project in Dare Noor consisted of three major activities: construction of a series of check dams to slow and help capture rainwater, direct seeding of new rangeland grasses and shrubs in the riparian areas to control erosion, and education and training of the local villagers to encourage them to adopt sustainable and efficient farm resource and watershed management practices. As a first step, local villagers constructed 6 check dams and terraces throughout the upper watershed as part of the RWR pilot project in the Dare Noor district. These watershed infrastructures and the reintroduction of trees, shrubs and grasses will conserve water, improve and diversify plant cover and improve groundwater replenishment in the area.

In the lower watershed, AWATT's Farm Resource Management program was introduced to establish sustainable agricultural practices that included rehabilitation of farmland and discouraged unfettered grazing of the upper watershed catchment areas. Two

Greenhouses and a nursery were established to provide a local source of shrubs and grasses including four-wing saltbush, forage Kochia prostrate, and four perennial grasses to revegetate the denuded hillsides with plantings on 613 terraces built throughout the upper watershed catchments.

Alternate livelihood training and support is provided to villagers and farmers in the affected watershed to diversify the economic base for the area and incentivize farmers and villagers to participate in and maintain the RWR project. Fifty village females were provided training and initial startup equipment by the US-ADT V Missouri/Nangarhar in small "backyard' poultry and beekeeping to provide an additional economic base to decrease the need for large animal flocks as a source of family income. Over time, reduced reliance on farm animals will allow the healing process to take place in the upper watershed. (Annex Report 5.33)

Seed Drills

Water being a scarce and unwisely used commodity in Afghanistan, AWATT made all possible efforts to introduce technology, techniques and enhance capacity of its users and managers for making it more productive. The wheat seed drill was introduced in Nangarhar and Balkh provinces as a technology that not only saves seed and fertilizer (DAP) but also saves time, labor and water due to smooth flow of water in lines. All laser leveled wheat demonstration plots were planted using seed drills. Herbicide and other pesticide applications are very easy and effective in seed drilled fields.

System of Rice Intensification (SRI)

Rice is a major cereal crop in Afghanistan, second only to wheat, but rice yields are almost half their potential. In an effort to improve livelihoods through technology transfer, AWATT introduced the System of Rice Intensification (SRI) in the eastern region (Nangarhar, Kunar and Laghman provinces). SRI is an improved method of rice cultivation where seedlings (8-13 day old) are transplanted in the field in a grid pattern without flooding or ponding water. Fields are irrigated only when cracks appear on soil surface. This method of production saves about 50% of the water used in traditional rice cultivation. MAIL and AWATT established SRI demonstration plots on farmers' fields in the eastern region during 2010 rice season and got results shown in Chart 3. Average rice yield in eastern region is 3.5 t/ha while yield from demonstration plots from a minimum of 4.4 to 8.7 t/ha. Field observations and interviews with selected farmers showed that demonstration plots were irrigated 18-22 times against 40-50 times of traditional plots.

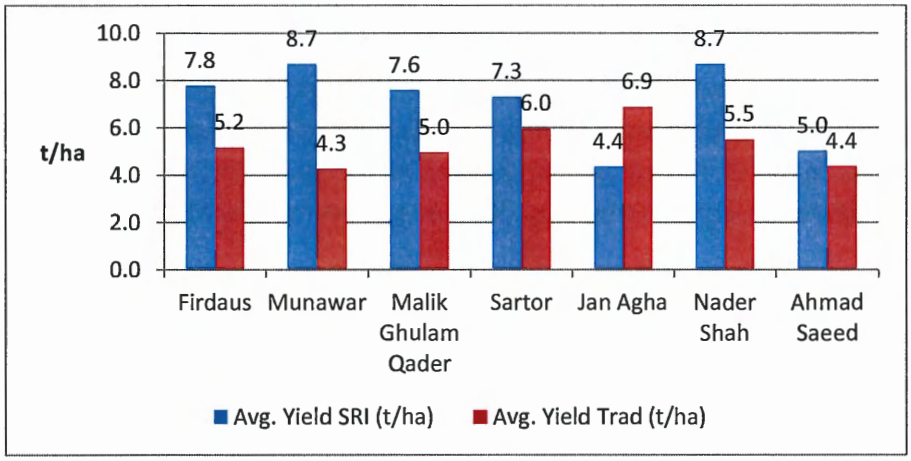


Chart 3: SRI results from demonstration plots in eastern region of Afghanistan during 2010 rice season.

In addition to the seed and water savings, results from other implementers' work on SRI in Baghlan and Kunduz showed a doubling of rice yields as compared to traditional production systems. Replication of the SRI method of rice production is easily adoptable in other areas of Afghanistan where farmers can increase levels of production while saving water. (Annex Report 5.24)

Food Preservation

A total of 68 women in Balkh province were provided training in fruit preservation techniques. These skills provide women with a means for extending the shelf life of locally grown crops for both home consumption and potential resale in local markets. Consequently, the skills developed not only contributed to diversified home nutrition but also to improved household incomes and new business opportunities for women. (Annex Report 1.1)

68 women were trained in food processing in Balkh Province

Solar Dryers

AWATT designed and conducted trainings on the construction and use of solar fruit and vegetable dryers in Parwan Province. Drying helps preserve and extend the market

window for many fruit and vegetable products. This work produced direct benefits for women in the region.

Through this program, two Afghan carpenters were taught to build different types of dryers and orders for drying units have grown. Commercialization of the solar dryers was rapid as indicated by the receipt of nearly 3-dozen orders during the first growing season. Through the NGOs the dryer technology diffused to several other Provinces.

The drying units create value for Afghan women and their households by offering an alternative to the way fruits and vegetables are currently dried (placed on a rock). The drying units are a more sanitary and result in higher yields of dried fruit with higher nutritional content. The Parwan women's groups have agreed to cost share 50% for each dryer (US$250 per dryer including labor and materials) (Annex Report 1.1)

Solar dryers were built & distributed through an AWATT / MEDA cooperation

Evaluation and demonstrations of high value crops (HVCs)

In the initial years of the program, AWATT utilized subcontracts with Joint Development Associates (JDA) IFDC, and Mennonite Economic Development Associates (MEDA) to conduct evaluations and trainings relating to high value crops production and water conserving technologies.

AWATT Supported JDA Work

JDA demonstrated and assessed a number of crops and technologies for AWATT. Demonstrations were conducted at the JDA research farm at Dedadhi in Balkh Province and at local farmers in the regions served by JDA (Annex Report 2.9). The scope of work developed between JDA and AWATT was quite diverse and included;

1. Oilseeds and Processing
2. Deep Placement of Urea Fertilizer (UDP) for high-value crops and rice
3. Vegetable Production
4. Strawberry Production in High Tunnels
5. IPM for Melon Fly Control
6. Perennial Horticulture Crops – Microirrigation

7. Farm Mechanization to Improve Farmer Productivity
8. Work with BUFA Supporting the Soils Laboratory

Field preparation of plastic mulch and an installed drip irrigation system

AWATT Supported IFDC Work

The IFDC role under AWATT was to improve the production systems for high-value crops and demonstrate those systems to Afghan farmers, thereby increasing knowledge and building demand for appropriate technologies aimed at improving income opportunities for smallholder farmers. IFDC conducted 20 demonstrations in six provinces (Kabul, Balkh, Baghlan, Kunduz, Herat and Nangarhar) and involved production systems for chili peppers and tomatoes (Annex Reports 2.10 & 5.7). Under its scope with AWATT, IFDC tested and demonstrated improved technologies in the following areas:

- **Fertilization schemes**: urea and fertilizer deep placement technologies (fertilizer briquettes versus granular fertilizers) and fertigation by injecting fertilizers dissolved in water through the drip irrigation tubing.
- **Drip irrigation**: a gravity-fed system using the Chapin ¼ Acre Drip Kit.
- **Plastic mulch**: crop production performance (weed control, earliness, increased yields, etc.) when plants are grown under plastic mulch of different colors and plants grown without plastic mulch.
- **Staking:** Both pepper and tomato plants will be grown with staking (using of wooden stakes) and tying (using twine) of plants in order to minimize lodging.

Each of the technologies provided a distinct "set" of benefits to potential end users. Improved fertilization schemes were implemented to improve the quality and quantities of yields; the use of balanced fertilization and fertilizer deep placement was a core component and an area of IFDC expertise. Drip irrigation was demonstrated to achieve water conservation and plant health improvement by providing moisture at time of need. Mulching with plastic mulch was demonstrated intending to show multiple benefits, including increased early and total yields. Plastic mulch also improves moisture retention; this is a substantial factor in water management such as watermelon, melons, and cucumbers. Lastly, staking and tying of plants improves fruit quality by keeping plants and fruits off of the ground.

AWATT Supported MEDA Work

MEDA staff participated in and assisted with several workshops/trainings organized by AWATT:

- Water and Plant Protection Management for High Value Crop Production Workshop
- Solar Drying Training
- Micro Drip Irrigation Training

Through these activities, MEDA staff worked with AWATT to introduce and deliver training on Integrated Pest Management (IPM), micro irrigation techniques, and solar drying training to women farmers. (Annex Report 2.10)

Transfer Technical Knowledge

Information Technology Renovations

AWATT collaborated with Purdue University's Advancing Afghan Agriculture Alliance Program (A4) to renovate two facilities at Kabul University: a teaching lab and an Internet lab. The project involved the installation of 70 computers along with new wiring, desks, carpet, and painting. Each computer was installed with its own battery backup, Windows OS, and Microsoft Office 2007 Suite. A4 purchased the equipment and AWATT provided the installation and technical support. In addition to the initial installation, AWATT worked with the Faculty of Agriculture Lab Assistant to build a sustainable environment for these two computer labs. AWATT trained the Lab Assistant to use Symantec Ghost to clone old computers with new images allowing the computers to be repurposed for use by faculty members. Upon completion of the labs, AWATT provided computer application training to students and faculty (Annex Report 1.2).

At the request of the Department of Agricultural Economics at Kabul University, AWATT provided training to teaching faculty on the basics of computer hardware, the use of common software packages such as MS Office, and computer use for scientific investigation. Through AWATT' contributions, , a full time IT expert was engaged in training students and faculty at Kabul University's College of Agriculture and at the various MAIL and DAIL facilities resulting in improved skills in agriculture related software and scientific research methodologies using the Internet.

Laboratories

Soils Laboratory

A soil testing laboratory has been established at Balkh University in Mazar-e-Sharif by AWATT and the Accelerated Sustainable Agriculture Program (ASAP). The purpose of the lab is to provide soil testing services to local farmers and to train students in the use of laboratory methods to evaluate soil fertility. Farmers can submit soil samples to be analyzed for pH, electrical conductivity (salts), nitrate-nitrogen, phosphorus, and potassium. The laboratory was established to provide farmers with a place to have soil

tested to help make accurate management decisions about fertilizer and to determine if fertilizers are accurately labeled. (Annex Report 4.9)

Workshops and Trainings

A listing of trainings provided by the AWATT program is included as an attachment on the index CD to this report. Preliminary data indicates AWATT conducted more than 127 trainings and workshop opportunities during the life of the project with more than 6,600 individual participants attending nearly 11,000 contact days of training. Women accounted for more than 5% of the 337 training participants.

Component 3: Technical Assistance to MAIL

The development, since the late 1970's, of agricultural and natural resource skills and capabilities by MAIL staff and other Afghan professionals has been limited due to personnel and funding limitations and isolation from external research influences. The AWATT technology transfer component overlapped extensively with the water management practices of Component 1 and the technology transfer efforts of Component 2. Although many of the activities previously listed in Components 1 and 2 were knowledge transfer or technical assistance activities, they are not mentioned again, in this section, to avoid duplication.

AWATT's aim was to provide technical assistance to MAIL that would lead to improved irrigation and watershed management decision making strategies and outreach capabilities through the transfer of technical skills to Ministry staff and Faculties of Agriculture at

Afghan Universities and Agricultural Vocational Schools with the ultimate goal of developing sustainable levels of increased agricultural production.

Current, pertinent information from outside Afghanistan is needed to compensate for the dearth of information from the past 30+ years and a strategy for continuous future updates needed to be established. To this end, AWATT worked as a close collaborator with MAIL at the driving center both nationally and in the provinces. The AWATT team responded with technical assistance whenever requested and available. Local MAIL staff members were provided with on-the-job training and special trainings were organized as needed for the engineering and agriculture staff.

The Technical Assistance to MAIL component included objectives to:

- Provide technical assistance and training to MAIL to improve their skills and ability to plan, design, manage and implement water and renewable resource activities at the district and farm levels.
- Provide technical assistance to MAIL to develop policies, rules, and regulations to implement the Water Law and Natural Resource user rights.
- Provide technical assistance to MAIL to improve the Mirabs system and to examine the benefits and costs of establishing users associations in irrigated areas.

The AWATT program accomplished the following specific activities.

1. Management of Water and Renewable Resources

Egypt Study Tour for MAIL

To enhance the capacity of Afghan professionals to improve water and land management and increase farming incomes, AWATT organized a 12-day study tour to Egypt in early 2011. The tour was conducted in collaboration of the Egyptian Ministry of Water Resources and Irrigation (MWRI). The group of 10 MAIL professionals visited the ministries of water resources and irrigation and agriculture and the associated departments involved with water management, land reclamation and capacity building. Modernization of irrigation infrastructure for improving water management, use of water conservation technologies, satellite images and telecommunication system have helped Egypt save about 27 percent of its water. A field visit to Lower Egypt's irrigated agriculture near Alexandria enabled participants to observe and discuss multiple technologies and improvements that could be adapted to Afghanistan. Water users associations have been very effective in reducing the operation and maintenance costs of pumping water at the tertiary canal level by about 60-70 percent. The tour was very useful and productive and all participants learned many new things that could be applied in the Afghanistan context (Annex Reports 2.16 & 7.29)

Water Measurement and Irrigation Training

AWATT delivered training on installation of staff gauges, discharge measurement, AutoCAD, efficient use of water, crop water requirements, soil testing, and gender development.

Training on Watercourse Lining and Farm Turnout Installation

AWATT's two-week training on "lining watercourses and installing farm turnouts" held in Jalalabad in April 2010 provided training for 21 Irrigation Engineers from MAIL Irrigation Department. The training covered topics in: watercourse improvement, creation of water users' associations, surveying, design, cost estimating, implementation, monitoring and maintenance of watercourses, and construction of turnouts. The training combined class work and practical field exercises. Participants also learned to establish benchmarks along irrigation canals and measure discharges, using cutthroat flumes and current meters. (Annex Report 7.17)

AutoCAD Training for Mail Engineers

A ten-day educational session was conducted in AutoCAD for irrigation engineers from MAIL and the Ministry of Energy and Water. The AutoCAD software is used to design irrigation systems from the canals throughout the cachment area. MAIL engineers had been doing designs by hand, but the training enabled them to design with greater speed and acuracy. The session was attended by 18 Ministry staff including 3 women. The workshop was conducted by local Afghans familiar with the AutoCAD software. AWATT purchased copies of the software for use by MAIL as well as computers and plotters for three work stations.(Annex Report 1.1)

More Effective MAIL Department of Irrigation

With the introduction of proven water management and agricultural production technologies and techniques to help increase productivity, MAIL staff in the Eastern and Northern regions better understand the practical aspects of off- and on-farm water management.

In 2010, two irrigation engineers were identified and recruited to join the AWATT team to install farm turnouts and line watercourses in the northern and eastern regions. The engineers were stationed in Mazar and Jalalabad and worked as mentors to engineers from MAIL, four of whom received on-the-job practical training to develop expertise on selection, surveying, designing and implementing conservation techniques such as lining watercourses and installing farm turnouts. The engineers (MAIL and AWATT) met regularly with the Mirabs, water users, and elders of the area to build rapport and trust, and to seek advice on the selection of watercourses where the turnouts were to be installed.

2. Water Law Implementation

Afghanistan's Water Law

Afghanistan's new Water Law places responsibility for on-farm irrigation with MAIL. AWATT provided technical assistance to MAIL to assist in developing policies and regulations to implement the Water Law through its provincial offices. AWATT also worked closely with MAIL staff to help them understand and implement the law, in particular with reference to on-farm irrigation strategies that employ best practices in water use and agricultural production technology. More than 250 MAIL staff members and community Mirabs were trained in these practices.

3. Water User Associations

AWATT created awareness about Water User Associations (WUA) in the districts of Kaama and Behsood (Nangarhar) and Plasposh (Balkh) to encourage their water users' involvement in the lining of watercourses and installation of turnouts. These associations were supposed to manage their irrigation water and operate and maintain their canals. Typically, Mirabs operate and maintain the irrigation canals the way they have done for centuries. Working together AWATT and MAIL were able to streamline the Mirab institution to help them improve village level water management in Nangarhar and Balkh provinces on canals where AWATT had monitoring activities.

4. Other Technical Assistance

The development of skills and capabilities by MAIL staff included many components other than those categorized above. Strengthening the educational system at the university and TVET levels will produce long-term benefits to MAIL through the education and training of students, many of whom may be future employees of MAIL or other agencies/organizations who will support the functions of MAIL. Development of informational technologies at MAIL and the development of operational capabilities produce multiple benefits and allow current MAIL employees to work more efficiently and access to information and resources that otherwise would be unavailable.

Teaching and Internet Laboratory Improvements

AWATT collaborated with Purdue University's Advancing Afghan Agriculture Alliance Program (A4) and the Faculty of Agriculture at Kabul University to renovate two facilities: a teaching lab and an Internet lab. The project involved the installation of new wiring, desks, carpet, and painting. A total of 70 computers (each with a battery backup, Windows OS, and Microsoft Office 2007 Suite) were installed in the labs. A4 purchased the equipment and AWATT provided the installation and technical support. AWATT also worked with the Faculty of Agriculture Lab Assistant to build a sustainable environment for these two computer labs by training the Lab Assistant to use Symantec Ghost to clone old computers

with a new image to be delivered to other Faculty members that are in need of a computer (Annex Report 3.13).

Upon request, training on computer basics (hardware, common software such as Microsoft Office, and use of computers for scientific investigation) was provided to of the faculty in the Department of Agricultural Economics at Kabul University.

TVET Training

In addition to working with MAIL employees, AWATT worked with the education sector by providing training for agriculture instructors at the Technical and Vocational Education Training (TVET) System. The capstone event of this component was an Egypt Study Tour, which gave the Principals of three Institutes (Agricultural Vocational Institutes in Mazar-e-Sharif, Jalalabad and Herat) a ten-day period (December 3-12, 2010) to study the Agricultural Technical School (ATS) system in that country and the USAID-funded Value Chain Training (VCT) project that is assisting the ATS system. During their time in Egypt, this group used the SWOT analysis procedure to develop strategic plans for their respective Institutes. These plans will guide their future directions and provide improved levels of training for future MAIL employees. More than 800 students per year (approximately 250 students at each institute) receive benefit from this training (Annex Reports 4.11, 7.23 and 7.25).

Education of Students

AWATT also contributed to the development of MAIL's future capacity through student education. Through an AWATT sponsored student internship program, 2, 3 Master of Science Afghan students completed degree research work from the Water Management Department at the Agriculture University of Peshawar in Pakistan. In fall 2011, three Afghans (2 former AWATT employees and 1 industry affiliated student) have begun studies at NMSU. Each will be able to contribute to the development of MAIL and the Afghanistan agricultural sector after completion of their university studies and upon returning to Afghanistan.

Lessons Learned

During the past three years, AWATT and its implementing partners have learned many valuable lessons about what works and doesn't work in Afghanistan. These lessons that follow are general, high-level lessons presented in the spirit of helping those in on-going and future projects to build on the experiences of AWATT. Other project specific lessons follow.

The lessons presented in this section are in the context of the broader mission of AWATT; to help create jobs, to increase farm outputs and thereby increase incomes, and to explore new ways to improve gender equity.

1. ***Security issues are a concern***. Security in Afghanistan is a global concern for all donors and implementers. However, AWATT was able to work in the high security risk area of Shindand District in Herat province, where communities were engaged in the development of 12 community prioritized activities of rehabilitation of karezes in Taliban areas of Shindand. The Governor of Shindand, a former Taliban Commander requested and approved these activities and provided security to AWATT staff and subcontractors. All of the twelve project activities in Taliban dominated Shindand district, were successfully completed without any security related incidents. The lesson learned therefore is that engagement of communities in activities that are demand driven and beneficial for local communities can contribute to the minimization of security risks.

   Having a majority of Afghan/Pakistan professionals on staff – plus Afghan drivers and guards – allowed AWATT personnel to go in the field thus creating a relatively secure environment. If any danger became evident, the local Afghan staff let the rest of the team know.

2. ***Human capacity is weak but improving***. Due to the decades of isolation of Afghans from educational institutions, AWATT encountered problems finding competent staff for the implementation of program activities. AWATT accepted this challenge by embracing Afghans as they are, opening their eyes and ears and grooming them as partners in the development of their own country by enhancing their skills through practical training in implementation of the AWATT program's field activities. The lesson learned therefore is that future development programs and projects must include capacity building components aimed at training Afghans at the degree levels as well as short-term technical training.

   Similarly, during the first years of the AWATT program, AWATT found it difficult to attract skilled expats to work long-term in Afghanistan. There were difficulties in finding personnel who were acceptable to both AWATT and to USAID. This changed over the course of the program as those who worked on the AWATT team conducted their work and reported their experiences to colleagues.

3. ***Sustainability of programs requires advocacy from government agencies or from invested users***. AWATT's experience with the engagement of Afghanistan's

Ministry of Agriculture, Irrigation and Livestock (MAIL) staff as partners in planning and implementation of the programs' activities proved very successful in terms of creating awareness, capacity building and confidence of the local communities in MAIL.

AWATT's effectiveness could have been enhanced had there been greater advocacy in MAIL. While AWATT had support in MAIL's Irrigation Department, advocacy was not as prevalent elsewhere in MAIL. MAIL must be actively involved in projects and overall program impacts are to be long reaching. Thus, programs must make investments in establishing relationships and building projects in cooperation with the Ministry.

Donors should concentrate on the development of effective agricultural institutions in the light of customs and traditions that favor institutional development that better serves the agricultural sector. This helps to build a sense of local ownership and sustainability.

4. ***AWATT's presence in cities outside of Kabul was responsible for many of the program's accomplishments***. In addition to the main office in Kabul, AWATT maintained offices in Jalalabad, Herat, and Mazari Sharif. The AWATT presence in these communities helped to establish and maintain important linkages as staff were able to reach out to the University Faculties of Agriculture, TVET Vocational Institutions, DAIL, PRT's and ADT's, NGO's, other USAID implementing partners, local and regional producer organizations, and farmers.

   The ability of AWATT specialists to work at the field level with farmers and Afghan Ministerial personnel, i.e., MAIL and MEW, as well as others at the provincial and district level, allowed AWATT to address irrigation, agronomic and natural resource management issues. AWATT brought knowledgeable specialists from the four partner Universities to Afghanistan to work directly with their Afghan counterparts at the field level to improve on-farm water management, more efficient water distribution among water users, incorporate forages into their crop rotations, and identify ways to rehabilitate forest and rangelands in the upstream watersheds.

5. ***Currently, infrastructure investments that increase on-farm productivity offer greater potential returns than those that improve water savings***. AWATT's primary focus related to agricultural water use. Afghanistan currently has no mechanisms in place for the pricing of water. Without a pricing structure, there are few incentives for farmers to engage in water savings methods. Thus, the incentives for farmers are to increase production (output) rather than reduce water use. In some cases, like the laser leveling promoted by AWATT, both improved production and water savings are the result – less water was used and improved efficiency resulted in increased yields.

The greatest returns, however, appear to be from introducing technologies that store water so that it can be used at times when deficit situations occur or to create surpluses that can be diverted to areas that would otherwise not be irrigated. AWATT's work with kareze restoration allowed increased off-farm flows by reducing seepage and thereby allowing previously unirrigated lands access to water. However, reduced seepage may also impact replenishment of the aquifer and could impact access to water during dry periods.

AWATT trained MAIL personnel and Mirabs in water measurement methods. This is a key first step in developing a system for pricing water. Until pricing can be established, water use in Afghanistan will continue to be supply driven rather than based on a demand driven system.

6. ***Integrating projects leverages dollars and creates increased benefits to Afghans.*** Rather than funding separate project activities like more efficient water use, improved agronomic and livestock management practices, upstream watershed rehabilitation and technology transfer these activities should all be brought together at the level of a micro-catchment (i.e., sub watershed). In Afghanistan there are 5 river basins and 40 watersheds. For planning purposes, river basins are generally used at the international level for transnational treaties and for planning large irrigation / hydro-power dams. Watersheds are generally used at the national level for information needs like river flow monitoring and natural resource management planning and coordination. Micro-catchments are at a level below watersheds and are used at the community level for developing a participatory approach in natural resource planning and management. Land rights and land use issues are can better be addressed at this level. In Afghanistan there are an estimated 3,000 to 4,000 micro-catchments.

   The building blocks for comprehensive development should be at the micro-catchment level, working with associated villages to plan and implement needed development activities. The initial task is to show current land use in a given micro-catchment on a plot map in a watershed or Province that has been identified for comprehensive development. The next step (in participation with the local people) would be the development of a Master Plan for the micro-catchment, showing planned land use. Before the Master Plan is done, a local NGO group would have educated village leaders, farmers and other residents on the objectives of comprehensive watershed rehabilitation, and how they will be affected, clearly showing the timeline and impacts of proposed changes. Understanding the benefits of switching from a marginal farming enterprise with low productivity to an

integrated system that will increase crop yields and result in healthier livestock in two to four years requires a well formulated orientation program. Concerns and fears of village residents must be overcome, to ensure project sustainability.

Other inputs required for a micro-catchment development strategy are:

- Data needs at the watershed / provincial level like climate, slope composition, and socio-economic information;
- Applied research and Extension site-specific information for village farmers like soil test results, integrated pest and disease control, grass and forage management systems, livestock management practices;
- Land tenure guarantees for farmers explicitly stating the terms, land use rights and obligations under which farmer's interests would be protected.

In its second year AWATT began a concerted focus in three provinces at a micro-catchment level. AWATT projects targeted stabilization and restoration of the upper watershed; and off farm delivery system improvements and on-farm efficiency at the middle of the watershed. Concurrently, these projects worked toward improving overall watershed health, elevating farm productivity, and increasing the gross jeribs/hectares of irrigated land. By demonstrating technologies throughout micro-catchments, AWATT was also able to use these sites as vehicles for hands-on trainings of MAIL, water user associations, and TVET students.

In addition to gaining participation from villagers and DAIL personnel, this approach allowed for low-risk piloting and demonstration of new techniques or the introduction of new technologies that could be assessed before rolling them out elsewhere. Conducting research that confirms the value of technological innovation at this level, in concert with making that technology observable, is an important component to assuring success and sustainability.

7. ***Seek opportunities for innovative projects that create direct and secondary benefits.*** While AWATT primarily targeted water issues resulting in increasing farm output, it also sought to create short- and long-term employment opportunities for Afghans as well. Women were a focal point from the beginning of the project. AWATT offered trainings in food processing methods that taught women how to dry and can perishable crops thereby extending shelf life of these perishables. Many of the women who attended these trainings were able to capitalize on their learning and create enterprises that generated secondary sources of income for their families. Another highly successful project was the introduction of solar fruit and vegetable dryers. The dryers have now diffused across the country extending shelf life and improving health. Further, as demand has increased a new industry has been spawned to build the solar dryers.

Several other AWATT projects also created jobs for women. As part of meeting the need for trees to help stabilize the upper watersheds, AWATT worked to develop Foster Mums. The Foster Mums program employed women by having them grow sapling trees at their homes that were later purchased for replanting in denuded and eroded upper watershed areas.

Likewise, the forage related work in Balkh and Herat provinces, was in part, targeted at helping women develop skills to better manage livestock and increase production. Both the kareze restoration and the upper watershed restitution provided short-term employment. Local companies and workers were employed in the kareze rebuilding and in the building of terraces in the upper watersheds. Hence, in addition to their primary objectives, these projects also provided short-term employment and an infusion of new funds into these local economies. Also, the completed structures represent well-designed models (and trained personnel) that can be visited by others in the future.

The lessons here are that well planned projects can reap multiple benefits for the Afghan people.

8. ***Work to build both human capital and institutional knowledge***. Institutions in Afghanistan, such as MAIL, were totally collapsed after the war. The newly established Irrigation Department within the MAIL lacked the capability of a full-fledged functioning department such that it was without competent staff, organizational management capabilities and lack of financial and administrative resources and absence of rules and regulations that govern a good institution. Implementing partners therefore should concentrate on the development of effective agricultural institutions in the light of customs and traditions that favor institutional development that better serves the agriculture.

9. ***Deliver programs to the level of the audience***. Because of the many years of war, literacy is low across all groups – farmers, women, even extension and university personnel. It is important to realize this when developing the media and delivery of training. The use of participatory demonstration as experiential learning has higher retention and is less abstract.

   As indicated in the report prepared by RSI, AWATT trainings were well received by Afghan farmers and government officials. These trainings acted as conduit to carry new ideas into the communities. In the future, more attention should be given to associations and farmer groups within communities to facilitate diffusion of methods and to assure that teaching is retained and perpetuated.

Conducting comprehensive trainings in cohorts that meet many time over the course of a program leverages investments in instruction. Several AWATT programs involved cohorts of the same people who met for trainings multiple times over the three years of the AWATT program. Thus, those being trained could be given project-based assignments to conduct and report on at the next training event. The trainings were conducted as a broader curriculum rather than as single episodic events. Finally, relationships were built across these cohorts that will perpetuate the sharing of experiences and new learning in the future.

10. ***Utilize MAIL as conduit for delivering and diffusing knowledge.*** Well trained local level extension staffs are critical to Afghanistan's recovery and the credibility of the central government. They must earn the confidence and respect of farmers and villagers because they ARE the government's representatives. A train-the-trainer model should be emphasized for broader capacity building and efforts should be focused on human capital building with the people who can see it continue. However, extension staff needs additional resources to take programs to villagers and farmers. Funding only extension salaries limits their effectiveness.

11. ***View the problem systemically***. As with anywhere, agencies are siloed and tend to focus on their designated turf. When viewed at a systems level, these silos can create longer term problems. Specifically noted by AWATT is that the Vocational Agricultural Schools (TVET) is under the jurisdiction of the Ministry of Education. However, TVET is the pipeline for the supply of MAIL extension personnel. This requires making contacts across Ministries and gaining cooperation (MOU's).

    Linkages and connections are hugely important. While on a study tour in Egypt, TVET principals listed linkages in the agricultural sector as one of their primary objectives. AWATT was uniquely positioned to help them establish these linkages by playing a liaison role and being the catalyst. AWATT helped to facilitate a dialogue between their primary employer (MAIL) and the Ministry of Education / TVET. This type of community building should be a focus of new and existing programs.

12. ***Assure that the introduced technologies are available and affordable***. The appropriateness of technologies for transfer is dependent on many factors. Readiness and availability for adoption can also be impacted by location. Just because a technology has been introduced successfully elsewhere does not guarantee its successful transfer. In general, high tech solutions with subsistence level farmers can't be sustained because of affordability and accessibility. When

planning, all aspects of the introduction of a technology should be assessed, including its economic viability. Lower tech solutions, while perhaps not generating yield increases comparable to higher tech solutions, may result in greater benefits to farmers in the long-term as they are sustainable and likely to be implemented by others.

13. ***A short project horizon makes measuring success difficult.*** The short, three-year time frame of AWATT makes it difficult to assess ultimate program effectiveness. New technologies introduced by AWATT such as laser leveling, SRI, turnouts, and water measurement methods could substantially improve the livelihoods of rural Afghans. Many of these innovations, if they become pervasive, could result in meaningful water savings and potentially result in new lands being irrigated. The full effect will reach beyond the agreement period.

    Likewise, the trainings of agents in extension methods, engineers in CAD/CAM, Mirabs in water measurement techniques, farm women in food processing, university personnel in soil and pest assessment methods are activities that may not show results for many years but that could have long-term, positive ramifications.

    Another area of success for AWATT that may have continuity depending on continued support is the Foster Mums program. To the degree that Afghan policy supports restoration of the upper watershed, this program could provide continuous employment and income for Afghan women throughout the country.

    Other impacts will be created by the AWATT infrastructure work such as ditch lining. There will be obvious long-term impacts in the regions where these programs were instituted as the result is more available water for agriculture. Unseen as of yet is if the skills that were taught to those who worked supervising these projects will transfer to future projects or if entrepreneurial Afghans might be able to leverage these skills to start new businesses.

    Another area of outreach by AWATT was in the working with the vocational agriculture schools (TVET). The degree that these school supervisors are able to transfer what they learned from their study trip to Egypt could have long-run implications for the capacity and quality of the Afghan agricultural workforce.

Unfortunately, many of these projects were just starting to build advocates as AWATT concluded. The lesson here is that the short timeframe of the projects does not allow the program team to track and truly gain an understanding of the effectiveness of implemented projects.

14. ***Working with the USG (PRTs and ADTs) extends diffusion of knowledge into areas that may be otherwise inaccessible.*** The work AWATT conducted in the upper watershed areas in some of the eastern provinces could not have been conducted had it not been with the cooperation of the US Military.

15. ***Be nimble and fluid.*** Throughout AWATT's duration there were many shifts in programmatic approaches. These changes required modifications or redesign of existing implementations. AWATT consistently received requests from USAID and MAIL for new activities to further the strategic objectives of the USG and GIRoA. While being responsive to on-the-ground changes, these modifications also impacted the ability to assess the true impacts of knowledge and technology transfer programs in a three-year time frame.

16. ***Communicate results more regularly and effectively.*** One of AWATT's early challenges was in communicating with donor agencies and the GIRoA the impacts of its projects and trainings. USAID was looking for specific presentation formats expected by its stakeholders. These communications formats are different than those typically used by land grant university faculty. Once AWATT became more familiar with vehicles valued by USAID, the word of AWATT successes was distributed more quickly. The AWATT website was not the preferred mechanism for telling the story. New projects should work directly with the AOTR in determining how to best deliver the message.

17. ***Administration of projects in Afghanistan requires special considerations.*** Effective administration of a project such as AWATT is compounded by several challenges and factors such as; distance, time and environment; experience in managing a complex project with several demanding stakeholders; accounting systems in place to account for the unique requirements of the Afghan First policies of the US Government; risk of placing valued faculty assets in Afghanistan; and using universities as resources to assess, design and implement activities that can alleviate the degradation of land and water resources and develop the agricultural sector to the point where the entire economy can "take off." Doing all of these things in a country at war can be termed a supreme challenge. AWATT laid the foundation and paved the way for similar projects that are currently underway or are being contemplated for implementation by various donor agencies.