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Strengthening Armenian Irrigation Capability through Extension Education and Mentoring

Kevin Heaton
Extension Professor
Utah State University
Garfield, Kane and Washington Counties
P.O. Box 77
Panguitch, UT 84759
435-676-1117
Fax: 435-676-8239
kevin.heaton@usu.edu

James Barnhill
Extension Professor
Utah State University
Weber County
1181 North Fairgrounds Drive
Ogden, UT 84404
801-399-8205
Fax: 801-399-8208
james.barnhill@usu.edu

Robert W. Hill
Irrigation Extension Specialist
Utah State University
Old Main Hill 4105,
Logan, UT 84322-4105
435-797-1248
Fax: 435-797-2791
robert.hill@usu.edu

Abstract

The disintegration of the Soviet Union in the early 1990s led to the creation of 440,000 small, privately owned farms in the country of Armenia. Armenian farmers, largely untrained in crop production, needed education and experience in all aspects of agriculture production, including irrigation management. In order to provide irrigation information and resources to individual farmers, the Armenian extension system itself was in need of mentoring by qualified individuals. Utah State University (USU) extension irrigation specialists trained Armenian extension personnel in irrigation fundamentals, implemented a soil moisture monitoring program and conducted on-farm irrigation research. Between 2001 and 2005, USU Extension trained Armenian extension specialists and agents in over 25 in-country irrigation management workshops. The mentoring team monitored soil water in on-farm demonstrations and reduced the number of irrigation water events on many fields through scientific irrigation scheduling.

They also conducted impact interviews each fall and found that 54–61% of farmers saved irrigation water and farmers averaged $41–$159 USD per hectare in net benefits from the program. Prior to 2003, Armenian flood irrigation management was perceived as "inefficient." The irrigation specialists conducted 60 in-field efficiency evaluations and found that Armenian farmers achieved above average efficiency. This multi-year project suggests that education and mentoring efforts improved irrigation management, which in turn could reduce the demand for irrigation water and improve the economic and agricultural sustainability of Armenia.

Keywords: Armenia, Soil Moisture, Irrigation Fundamentals, Irrigation Management, Irrigation Efficiency

Introduction

Armenia is a small, historic country landlocked by Turkey, Georgia, Azerbaijan and Iran. Towards the end of the 69 years of Soviet rule (1922–1991), production agriculture consisted of 840 large, highly subsidized and centrally managed collective farms (Bledsoe, et al. 2006). Farms were normally several hundred hectares in size with farm machinery, storage facilities, cement canals, and irrigation systems. The Soviets managed these farms with specialized labor. One person's responsibility was planting; another's irrigation or weed control. Few Armenians understood or participated in all aspects of crop production: planting, growing, and harvesting. Under this system, incentives to share knowledge of improved management practices did not exist. In fact, knowledge was power, highly guarded and quite often used for personal gain.

After independence, Armenian villages and cities divided the nearby collective farms amongst the local citizens. The 840 large farms were divided up into 440,000 small, privately owned, unsubsidized farms, varying in size from 0.4–2 hectares (Bledsoe, et al. 2006). This drastic change almost collapsed the system, but failure was not an option. Now, Armenia required self-sufficiency in agriculture production not only for subsistence as a nation, but also for economic growth. Private citizens inheriting small farms were inexperienced and uneducated in the various aspects of crop production. Additionally, personnel in the newly created extension system were not adequately trained or experienced to meet the needs of the agricultural community, and the mentality of guarding information still persisted. The irrigation infrastructure, designed for large collective farms, was inadequate for delivering water to small farms.

In 1996, the United States Department of Agriculture (USDA) initiated an economic development program called the Marketing Assistance Program for Armenia (MAP). This program solicited crop production specialists to work with Armenian Universities, the extension system, government officials and local farmers to improve crop production practices. In the late 1990s, regional droughts highlighted the importance of irrigation management for Armenia's agriculture production system. Over the last several decades, excessive water withdrawal from Lake Sevan, Armenia's largest lake, had led to a water level drawdown of 60 to 80 meters. Sustainable use of Armenia irrigation resources needed to be addressed.

An estimated 85% of Armenian farms utilize irrigation for sustainable crop production. Yet most extension agents and farmers lacked understanding of irrigation fundamentals, soil–water–plant interactions, crop water use, and crop rooting depth. The USDA/MAP recruited Utah State University's International Irrigation Center in early 2001 to provide education on

irrigation management. Utah's climate and topography are similar to Armenia's. Although Utah's crops and cropping practices are different, Utah's and Armenia's reliance on irrigation is similar. Thus, Utah State University (USU) Extension was well suited to spearhead this irrigation educational effort. Under the direction of USU Extension Specialists, the program ran from 2001 to 2006, when it was placed under the umbrella of the Armenian Center for Agribusiness and Rural Development (CARD).

Purpose and Objectives

Irrigation training is key to gaining maximum crop yield from a limited quantity of water (Ratnakar & Das, 2006). In order to realize this impact, farmers and extension personnel must understand soil–water interactions, crop rooting depth, crop water use, and irrigation efficiency. Learning irrigation fundamentals and gaining experience in irrigation management will best conserve limited water resources and improve sustainability of crop production. Utah State mentors desired to develop a team of Armenian irrigation specialists and agents who were recognized as experts in irrigation management and who understood the importance of on-farm research and dissemination of science-based information to individual farmers. In order to accomplish this objective, USU implemented the following programs: (a) Irrigation fundamentals, workshops and trainings for Armenian extension personnel, (b) Soil moisture monitoring program with local farmers in every marze (similar to a state in the United States), and (c) On-farm irrigation efficiency research. The expectation was not only that Armenian extension personnel would become more knowledgeable in irrigation water management but also that Armenian farmers would improve management and sustainability of irrigation water nationwide.

Methods

In collaboration with USDA/MAP and the Armenian Agricultural University, USU Extension established the Small Farm Water Management Research Center (SFWMR or Center), consisting of the Center staff, Armenian natives, included a director, an irrigation engineer, an irrigation technician, and a secretary. Over the course of the program, USU Extension provided mentoring support with in-country visits from two irrigation extension specialists (multiple in-country visits), two county extension faculty (summers of 2003 and 2004), a vegetable specialist, and a soils specialist (multiple in-country visits). The project remodeled the Center's laboratory and supplied it with simple testing and research equipment such as pH and conductivity meters, hand held global positioning systems (GPS) units, soil augers and probes, drying ovens, and scales. USU Extension specialists trained the Center staff on the use of laboratory equipment. On every field visit, specialists used the pH/conductivity meter to determine irrigation water quality throughout the country of Armenia. They used GPS units to identify soil moisture monitoring fields, water quality testing sites and field research sites. They trained Center staff to proficiently use scales and the drying oven during irrigation efficiency research.

An on-farm water management project in Pakistan focused on providing technology and improvements in efficiency with minor emphasis on education of the local farmers and extension personnel. Evaluations of random Pakistani farmers showed an emphasized need for demonstrations, training sessions, and workshop/seminars (Mirani, et al, 2003). Successful implementation of an irrigation

technology program requires extension workers and local farmers to participate and support the project (Noruzi and Chizari 2006). Without local farmer participation in the irrigation management process, farmers will be less likely to adopt sustainable practices (Drost, et al, 1996). USU Extension focused on teaching native extension personnel to develop on-farm irrigation programming and irrigation research activities.

Mentoring effectively helps inexperienced individuals develop and progress in their profession (Byington, 2010). This irrigation program developed trained and knowledgeable Armenian extension workers in each marze. In 2003, Armenian extension and Center staff attended a three-week training and mentoring program coordinated by faculty and staff at the USU International Irrigation Center. Armenian short course participants experienced irrigation systems management and training that would have been impossible to create in their own country. From 2001 to 2005, USU Extension and Center staff conducted over twenty-five in-country training seminars ranging in length from four hours to two and a half days in length. USU specialists focused workshops on soil–plant–water relationships, irrigation scheduling concepts, determining soil moisture by feel, water measurement, irrigation efficiency evaluations, and crop production. At least one workshop or training was held in each of Armenia's ten marzes, and 9 to over 25 extension agents and farmers participated in each event. Workshop participants evaluated selected workshops with a written anonymous survey prepared by USU. Evaluations were intended to teach Armenian extension personal the value of constituents' feedback, ensure relevancy in the material being taught, and improve the quality of future workshops. Additionally, the evaluations indicated knowledge gained by the participants.

Important mentoring occurred through the soil moisture monitoring program. The center staff, with help from USU Extension, initiated a soil moisture monitoring program throughout the country. In 2001, 30 farms participated in monitoring soil moisture in five marzes using resistance blocks and hand held meters (WaterMark©, purchased from Irrometer Company, Riverside, CA). At each farm, the USU mentor, the Armenian extension specialist and agent and the farmer placed soil moisture sensors in the field at the following depths: 30 cm, 60 cm, and 90 cm. The local extension agent used a hand-held meter to determine soil moisture levels, which he recorded and also reported to the farmer. Center staff and USU Extension mentors visited each field location twice during the growing season with the local Armenian extension worker and the farmer. At the end of each season, center staff removed the soil moisture sensors from the field, stored them during the winter and reinstalled them in a new field the following year. Due to the success of these initial efforts, the soil moisture monitoring program expanded to 107 farms in 2002, 150 farms in 2003 and 111 in 2004. Over 30% of Armenia's villages had at least one soil moisture monitoring data collection site involving the local extension personnel and a farmer. In all total, 398 farmers participated in the soil moisture program. In 2003, at the height of the program, soil moisture was monitored in 15 fields in each of the ten marzes. Farmers utilized the soil moisture data to answer two questions, prior to irrigation water application, "Is it time to irrigate?" and after irrigation water application, "Was the proper amount of irrigation water applied?" The soil moisture monitoring program continued under the direction of USU Extension until 2005.

At the end of each field season, Center staff and the USU mentor conducted impact interviews with individual farmers. Farmers were selected based on the region and the logistics of being able to travel to the farm, meet with the farmer, and conduct the interview. The USU Extension mentor, Center personnel, and the local extension agent met with the farmer at his field or home. Due to the lingering mentality of guarding information, the USU Extension mentor initiated and directed the interview. Local farmers opened up to a foreigner during field conversations, and Armenian extension personnel learned interviewing and data collection skills. USU recorded all responses in a field note book and later summarized them in a spreadsheet. Each farmer responded to the following questions: (a) How did you utilize the soil moisture monitoring data? (b) Did the information improve your irrigation management? (c) What benefits did you receive by participating in this program, i.e. water savings, cost savings, yield increases, labor savings? (d) Was there anything that you would have changed with the program? (e) Did you share the information and knowledge with neighbors? The interview ended by the farmer or extension agent providing any final comments, concerns or suggestions. Due to limited time and resources, and challenging road conditions, USU Extension and the Center Staff could not interview every farmer who participated in the soil moisture monitoring program. The first year of the program in 2001, 16 farmers participated in impact interviews. The number of interviewed farmers increased annually, with 31 interviewed in 2002, 63 in 2003, and 75 in 2004.

The Center staff and USU Extension faculty set a goal to conduct surface irrigation efficiency research on two farms in each marze annually for 3 years. Simply put, an irrigation efficiency evaluation measures the amount of water entering the field, the amount of water leaving the field, and the amount of water stored in the crop's root zone. Utah State Extension trained Center staff to measure incoming and outgoing water with portable flumes. Center staff collected soil samples pre and post irrigation at multiple depths and calculated the amount of irrigation water delivered to the root zone. Center staff measured furrow length, slope, and advance rate of the irrigation water at each field. From this data, center staff calculated irrigation efficiency on more than sixty irrigated fields utilizing modern farm irrigation evaluation principles (Merriam and Keller, 1978).

Findings and Results

The Armenia Small Farm Water Management Research Center organization created a key mentoring and educational irrigation program for Armenia's small farms. The Center and USU Extension mentors identified water management issues, coordinated training, and implemented research efforts nationwide. These efforts provided a forum for collaboration, cooperation, and advancement in irrigation management. Most importantly, USU Extension trained and provided real world irrigation experience for the Center Staff, which enabled them to become known as Armenia's "irrigation experts."

Investing in irrigation water management infrastructure is thought to be the most effective way to improve irrigation management. At the present time, improving irrigation infrastructure is simply infeasible for Armenian farmers. Armenian agriculture will always utilize surface irrigation, due in part to the existing surface water supply infrastructure and also to the prevalence of the numerous small farms with limited access to credit for financing irrigation technology advancements. The current need for Armenian farmers is knowledge and

training in irrigation water management. USU Extension provided important knowledge transfer to the Armenian extension specialists and agents regarding irrigation principles and management. This training and information provided another useful extension tool for the agent's portfolios. Both extension personnel and farmers enthusiastically received irrigation water fundamentals and management workshops and felt the information was "valuable and timely" (Hill, et al. 2006). Evaluations of the evapotranspiration/ irrigation training held in Tavush (2003) rated the program very high. The relevance of the topics, quality of teaching materials, presenter's knowledge of the subject, and preparation of the presenters were rated "excellent" by 84% of participants. One participant stated, "the workshop was conducted in an excellent way and was very educational." Regarding the irrigation training held in the western United States, Armenian participants rated the three-week training session as "very good." One Armenian extension personnel member expressed that he "learned more about irrigation methods and research in three and a half weeks than he would have learned in six years," otherwise. Some of the extension agents commented that they were not "irrigation specialists," and the knowledge obtained in the irrigation training was new and particularly useful. They applied to the training in soil moisture monitoring, furrow irrigation evaluations, visits with farmers, and field seminars (Hill, et al. 2006).

The soil moisture monitoring program created a venue for mentoring, engagement, and professional development of Armenian extension agents and specialists. To maintain good political relations, the Armenian government employs as many people as possible. Extension personnel typically have an office with a chair and a desk but do not have any equipment, be it phones, pencils, paper, computers or printers. Lack of resources greatly reduced extension programming and hindered extension personnel from providing science-based knowledge to the people. During the Soviet years, personnel collected data but rarely shared it with the "on-the-ground" manager, resulting in mismanagement of irrigation resources. The soil moisture monitoring program provided equipment, travel, and office supplies, which allowed the Extension personnel to do their job and share information with the farmer, in many cases for the first time. By sharing knowledge and skills, the Armenian extension workers empowered farmers with decision-making skills, resulting in improved production and lifestyle.

Annual fall interviews by the Center staff and USU Extension showed farmers benefited greatly from the soil moisture monitoring program. Table 1 summarizes the impacts of the program. Armenian farmers utilized the soil moisture data collected on their farms to adapt their irrigation water practices. This often improved their crop production in comparison to neighboring farms and historic production levels. Not every farmer reported an economic benefit from the soil moisture monitoring program, but the average benefits were significant in comparison to average monthly wages (average wage of an Armenia government employee is $40.00 USD/month). A majority of farmers reported applying less irrigation water. When farmers reduce irrigation frequency, they have less labor associated with crop production and they conserve water, which is the objective. Farmer-to-farmer mentoring increased throughout the program as farmers participating in the soil moisture program began sharing their newly gained knowledge of irrigation management with their neighbors.

Table 1. Soil Moisture Monitoring Impact Summary from 2001–2004

Year	Fields monitored	Farmers interviewed	US$ per ha benefit[a]	Irrigation water savings[b]	Production increase[c]	Farmers who shared knowledge[d]
2001	30	52%	$41	54%	38%	1
2002	107	29%	$159	61%	55%	2
2003	150	42%	$105	56%	49%	4
2004	111	68%	$137	57%	43%	6

[a]The average economic benefit received from utilizing recommendations from the soil moisture monitoring program.
[b]The percent of farmers reducing the number of irrigations applied.
[c]The percent of farmers who reported production increases as a result of following the recommendations of the Soil Moisture Monitoring program.
[d]The number of farmers who shared soil moisture information with neighboring farmers.

During the last several decades, Lake Sevan, a natural fresh water lake that contributes a significant amount of irrigation water to the country of Armenia, has been drawn down 60 to 80 meters. Obviously, such continued use is not sustainable and the cause of the drawdown must be slowed or stopped. The majority of Armenian irrigation systems are flood systems. A few sprinkler systems with risers on a fixed grid pattern exist in some areas of Armenia. In the United States, poorly managed flood irrigation systems are typically 25 to 35% efficient, and sprinkler irrigation systems are 65% efficient (Draper, 2010 and Morris & Lynne 2006). Modern irrigation thought suggests that Armenian farms should upgrade the efficiency of their irrigation systems, thus saving substantial amounts of water. After evaluating more than 60 irrigation efficiency studies, specialists discovered many extremes in irrigation application efficiencies, ranging from 20 to 100%. Surprisingly, the average application efficiency was 60%, much higher than in typical U.S. flood systems. The more efficient Armenian irrigation systems tend to utilize short furrows (<10 meters in length) or small level basins (<30 meters in length). Farmers captured the tail water (water leaving the field) and distributed to lower lying fields, which also improved average irrigation efficiency. By managing irrigation intensively, farmers achieve better efficiencies. Generally speaking, when the Armenian farmer had the water, he or she was in the field tending it. In some of the fields where irrigation efficiencies were high, the farmer applied a large amount of water for a short amount of time.

Conclusions, Recommendations, and Implications

Over 440,000 Armenian farmers needed fundamental irrigation water management training. The most efficient way to train these farmers was through the Armenian extension personnel, who themselves required mentoring, educational training and experiences in irrigation management. USU Extension had the necessary expertise to meet these needs.

USU Extension created a venue for training and mentoring extension personnel by formal irrigation trainings, on-farm soil moisture monitoring, and irrigation field research. Additionally, this venue provided 398 individual farmers, representing 30% of

Armenia's villages, with on-farm, applied learning experiences. Armenia irrigators quickly adopted the soil moisture monitoring program and received benefits in water savings, reduced labor, and production increases. Over 60 irrigation efficiency studies revealed that Armenian irrigators intensively manage flood irrigation systems to receive above-average efficiency results. The soil moisture monitoring program and irrigation efficiency studies suggested that irrigation system upgrades are not the solution to sustaining Armenia's water resources. Local farmers, through extension personnel, were better prepared to conserve water by improving irrigation management because of education, research, and mentoring.

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