Food and Agriculture Organization of the United Nations

Final report

Development of water management in the Caza of Marjayoun

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Photo: Claude Chalhita

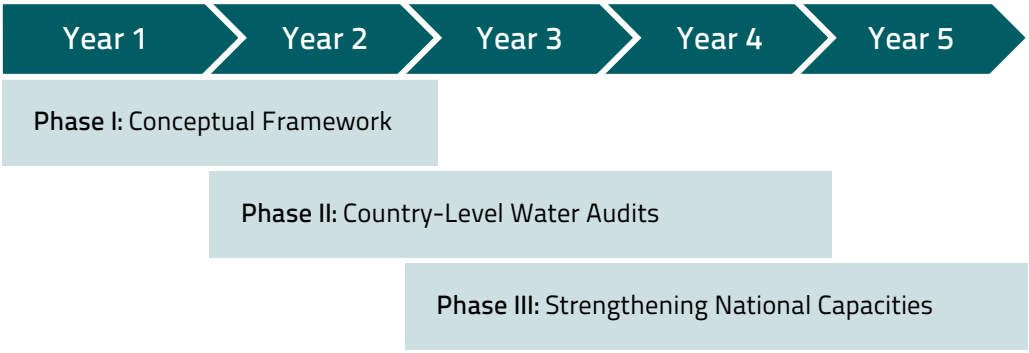
1. Introduction

Water use has been growing globally at more than twice the rate of population increase in the last century, and an increasing number of regions are reaching the limit at which reliable water services can be delivered. Demographic growth, rapidly growing urban areas and economic development are all putting unprecedented pressure on water, especially in dry regions. Growing scarcity and competition for water stand as a major threat to future advances in food security and poverty alleviation, especially in rural areas.

Lebanon, a country of 4.3 million, located on the eastern coast of the Mediterranean, is one of the countries facing water scarcity and the challenges this brings. Despite its relatively good precipitation levels, water deficits are expected in the near future, as demand from domestic, industrial and agricultural users increases. Because government policy gives priority to domestic needs, the agricultural sector, which uses 65-70 per cent of the country's water resources is likely to face severe water constraints. This will be exacerbated by higher temperatures, reduced precipitation and higher evapotranspiration rates over the next few decades as a result of climate change. The stress placed on the agricultural sector by water scarcity is a concern because although the sector only employs about 1.5 per cent of the total labour force, it provides an important source of income in less-populated rural areas, and is an important employer for poor, unskilled workers.

In this context, FAO, in collaboration with the Ministry of Agriculture and the Ministry of Water and Energy has been implementing a number of projects in Lebanon to cope with water scarcity to improve food security and the eradication of poverty. These projects come under the 'Coping with Water Scarcity – The Role of Agriculture' Programme of FAO that has been identified as one of the main flagship programmes of cooperation between the Government of Italy and FAO. The programmatic approach spans 5 years (2011 –2015) and has been organized in three phases as shown in Figure 1.

Figure 1: "Coping with water scarcity" programs' phases



Phase I: *'the comprehensive framework'* provided decision- and policy-making bodies with approaches and principles and a comprehensive framework to formulate development strategies and monitor their implementation.

Phase II: *'water auditing'.* A Water Audit is one of the tools recommended in the comprehensive framework and can be applied at either country or basin level. It provides a country administration or a river basin organization with a complete methodology for assessing, analysing and reporting of the use of scarce water resources. A detailed assessment of agricultural water use, including its productivity, its value-in-use, and its efficiency during the water use process, gives countries a basis for the adaptation of water policy and the improvement of water management plans for the future through strategic interventions to increase their capacity to cope with water scarcity.

Phase III: *'strengthening national capacities'* is the current and final phase of the programme. Together with national and regional counterparts, Phase III aims to strengthen national capacities to cope with water scarcity in Jordan, Lebanon and Egypt.

Building on this work, The 'Development of Water Management in the Caza of Marjayoun' project in Lebanon (hereafter Marjayoun Project) is closely linked to Phase 3, and focuses on the reinforcement of local and national capacities to cope with water scarcity in an irrigation system. The project was implemented with local, national and international counterparts in partnerships with the Region of Lombardy and AVSI Foundation under the Italy/FAO Decentralized Cooperation Program (IFDCP).

Photo: Dr. Marie Therese Abi Saab

2. Project background

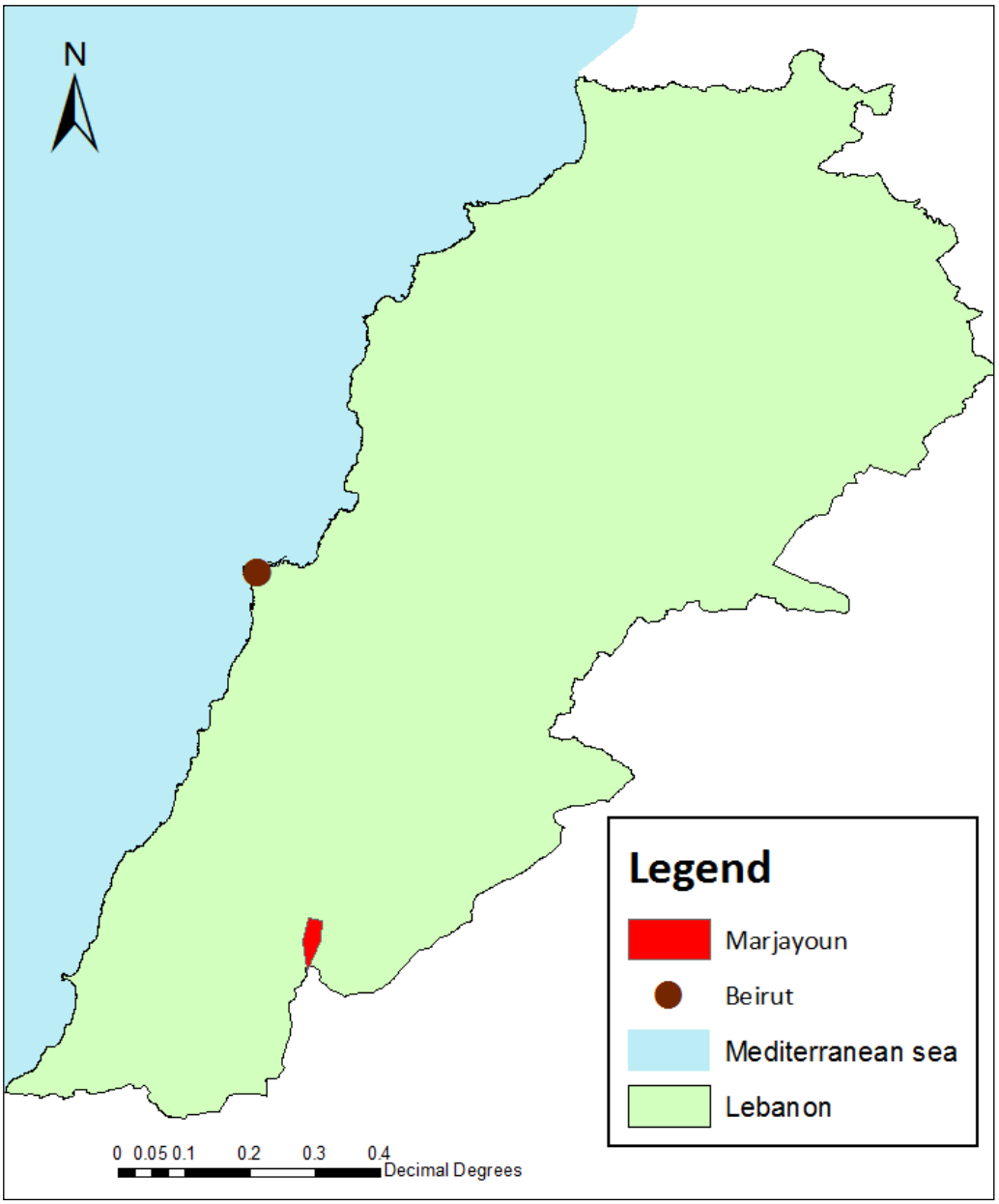
The Caza of Marjayoun - an administrative division of the Nabatyeh area of south-east Lebanon - lies in the fertile Plain of Marjayoun. The plain has an area of just over 30km^2 and is home to over 40,000 people. Two demographic trends exist in this region: a progressive 'ageing" phenomenon (as mostly young people migrate) and a decline in rural population, whose causes are complex and range from political insecurity to a general lack of employment opportunities. The main source of income in the area of Marjayoun is family-based agriculture.

While the land in the Plain of Marjayoun is ideally suited to agriculture, its irrigation infrastructure had deteriorated (particularly since the 2006 conflict in the region), leading to high water losses and poor irrigation efficiency. Moreover, the public maintenance budget allocated to irrigation was unable to meet the costs of rehabilitation, and farmers in the area had few incentives to save water.

In light of these challenges, the AVSI Foundation – an Italian NGO – began an intervention in the northern part of the Plain in 2008. The project aimed to replace two of the open irrigation canals from the Dardara Spring (the most important of the three sources of irrigation water in the plain) with covered pipelines[1], and to support the establishment of the Dardara Farmer Cooperative to manage the distribution of water to farmers. In 2011, FAO partnered with AVSI to extend this rehabilitation work to a greater area in the Dardara irrigation system, in a project area targeted at 5 villages located along three sides of the Plain: Bourj El Moulouk, Kfar Kila, Khiam, Marjayoun and Qlaiaa. The aim was to further strengthen the capacity of local farmers and institutions in irrigation water management to raise agricultural productivity.

[1] The third irrigation canal was to be rehabilitated as part of a project funded by the EU and managed by the Council for Development and Reconstruction (CDR).

Figure 2: Location of the Plain of Marjayoun and the Dardara Irrigation System



Map: Motasem Abukhalaf

Photo: Claude Chalita

3. Project goals and objectives

The project had two main objectives, which together contributed to its overall aim of strengthening local and national capacity to increase agricultural productivity through improved water management. These were:

Objective 1: Contribute to improved water management in irrigation.

Four main types of project activity helped to improve demand management in irrigation. The first project activity assessed the irrigation system by implementing several different types of study, including the application of FAO's MASSPRES approach; the second project acitivty, was to train and raise capacity by holding workshops to discuss options to improve operation practices and system design; the third, was the rehabilitation and modernization of the irrigation system to enhance performance; and lastly, the fourth, was piloting and expanding drip irrigation schemes.

Objective 2: Contribute to increased knowledge of farmers and institutional personnel with regard to new irrigation technology and management practices to enhance the efficiency and the productivity of water use.

Several different activities were undertaken to raise irrigation efficiency and crop-water productivity in the project area. These activities included:

- Assessing the potential for reducing water demand while increasing production by applying AquaCrop to simulate yield response to water
- Designing a capacity development plan through a learning-by-doing approach
- Designing a monitoring program to scrutinize the effectiveness of the capacity development plan;

- Organising training sessions for farmers;
- Establishing an 'Irrigation Service Unit" at plain level to transfer knowledge to farmers and information about up-to-date irrigation scheduling practices;
- Developing a business plan and constitution for the Dardara Cooperative.

Photo: Claude Chalita

4. The beginning of the project

The project agreement was signed by the Government of Lebanon and FAO in September 2011 and was declared operational in October 2011. In September 2013, and with the success of Phase I of the project, the Italian Cooperation agreed to provide additional financial support to the project to extend it to a 2nd Phase to October 2015.

The project was managed by a steering committee, a local committee and a coordination unit.

- The Steering Committee (SC) comprised: FAO; the Italian Cooperation; AVSI; the Ministry of Agriculture; the Ministry of Energy and Water; and the Dardara Cooperative. The SC met periodically to take important decisions regarding strategy and operation.
- The Local Consultative Committee comprised: FAO; AVSI; the Dardara Cooperative; and the five villages involved in the project (Khiam, Qlayaa, Marjayoun, Bourj El Moulouk and Kfarkila). Its role was to monitor project implementation and provide recommendations to the Steering Committee.
- The Coordination Unit was responsible for daily activities of the project and functioned as an executive body. It comprised an Overall Project Coordinator, a Project Technical Assistant and Administrative Support. Operational support to this unit was given by the FAO Representative in Lebanon, with additional technical support delivered by the Land and Water Division in FAO's Rome Headquarters (AGL-HQ).

Figure 3. A meeting of the Steering Committee

Photo: Claude Chalita

Figure 4. A meeting of the Local Consultative Committee

Photo: Claude Chalita

Figure: FAO

5. Understanding the Dardara irrigation system

Understanding the irrigation system was an important first-step towards its rehabilitation and modernization. This required several different physical and social studies of the plain and its irrigation system, including: a hydraulic study to help with the design of a gravity system of two pipelines (see Figure 5); a topographic study to identify target areas where improvements to drainage channels would have most effect (Figure 6); and a hydro-geological study to how much groundwater was available, the likely yield from pumping and groundwater quality. The hydrogeological study included surveys of wells and springs, analysis of precipitation data, geological mapping, sample collection and laboratory analysis. The results showed the groundwater potential of the plain and highlighted how the rising number of groundwater pumps had impacted groundwater flows and availability. Groundwater levels were found to decrease in response to seasonal variation but also as a result of over-abstraction in the summer (May-September).

5.1 MASSPRES and irrigation system analysis

The MASSPRES approach to understanding irrigation systems was also implemented. This approach requires many inputs including the wider characteristics of the plain, but also, farm level information. Thus, farm surveys were carried out to establish cropping patterns and to find out how much water each farmer was using to irrigate crops. The information gathered for MASSPRES helped to show how the Dardara irrigation system has changed over time. For example, the cropping pattern study showed how crops choices have changed since 2009 with the proportion of fruit crops rising gradually over time, the extent of cereal cropping (which represents over half of the cultivated area) gradually declining, and vegetable cultivation also slowing rising.

Figure 5: Map of pipelines in the Dardara Irrigation System

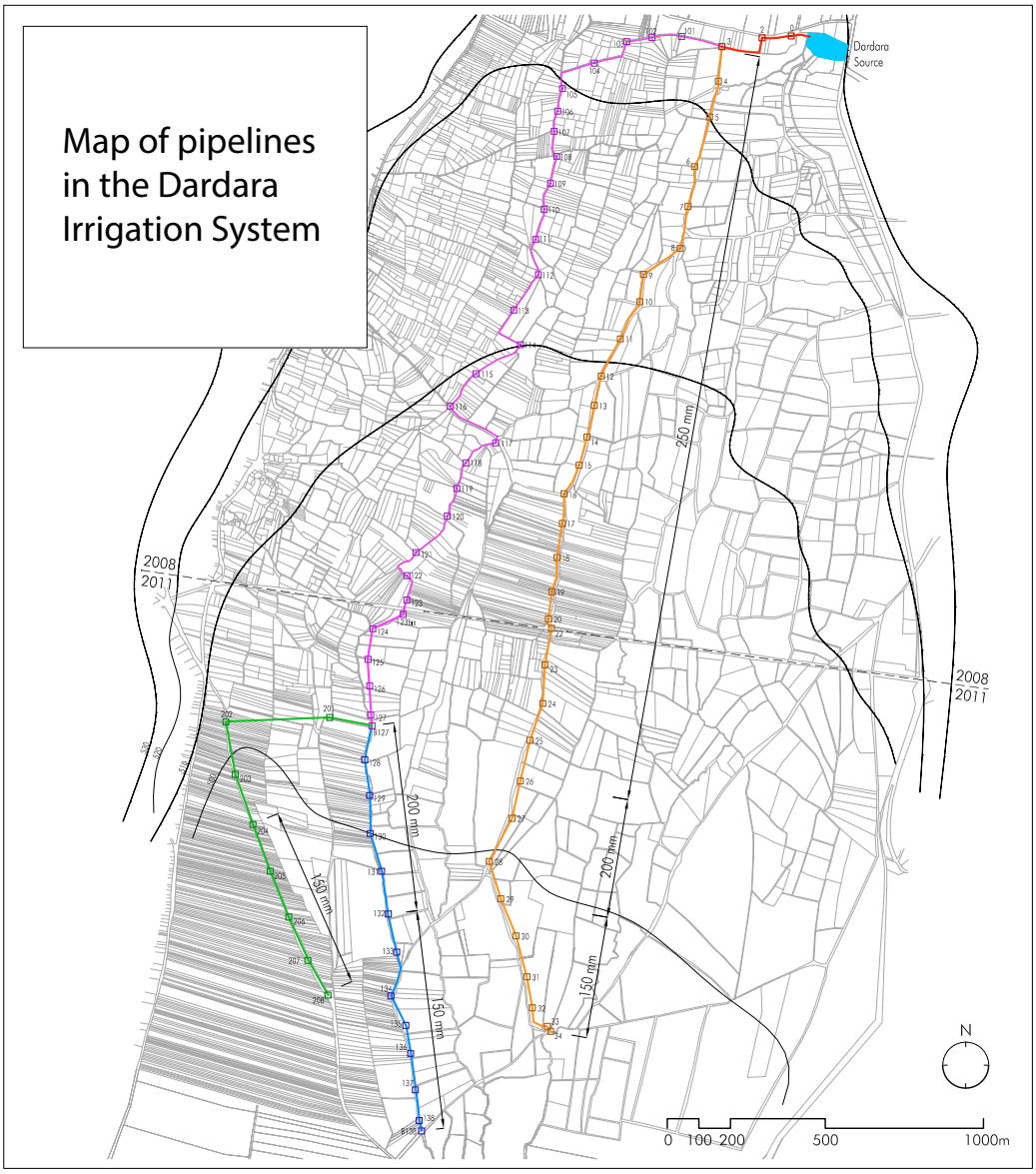


Figure: FAO

The results of these different studies were fed into a MASSPRES model and the results provided the framework to test options to improve the performance of the system.

Figure 6: The drainage, topographic and cropping pattern surveys

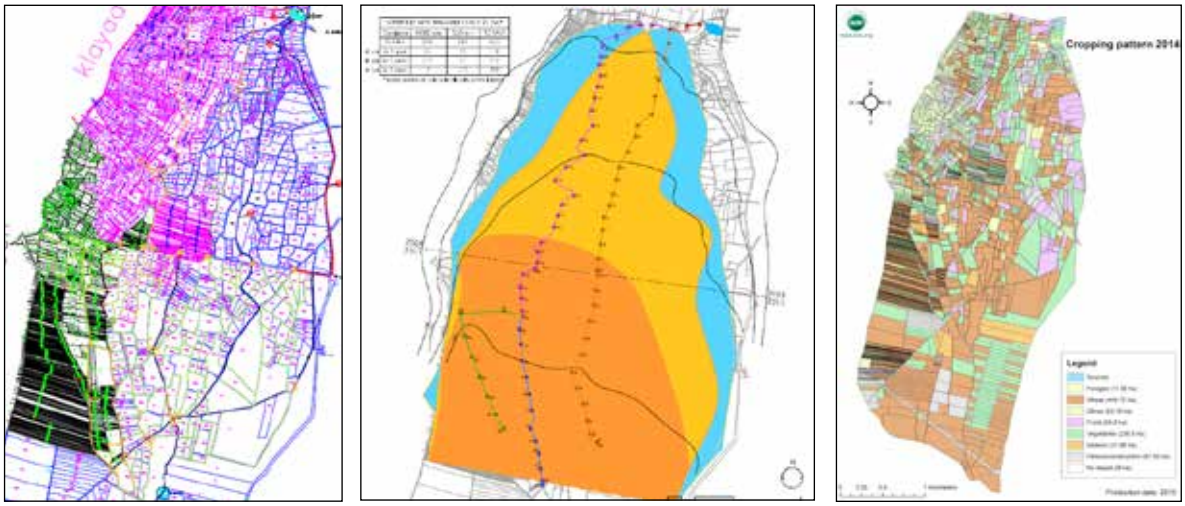


Figure: FAO

What is MASSPRES?

MASSPRES stands for: Mapping System and Services for Pressurized Irrigation. It is an approach developed by FAO to understand irrigation systems and is derived from the wider MASSCOTE approach used in different types of irrigation systems. By following a stepwise approach, MASSPRES helps to audit the performance of irrigation systems and allows the development of planning options. Results from MASSPRES can be used as the basis for training and workshops to build capacity.

What is MASSCOTE?

MASSCOTE is a step-wise procedure for auditing performance of irrigation management, analyzing and evaluating the different elements of an irrigation system in order to develop a modernization plan. The modernization plan consists of physical, institutional, and managerial innovations to improve water delivery services to all users and cost effectiveness of operation and management.

Masscote is founded on a rigorous onsite approach of the physical water infrastructure (canals and networks) and introduces service oriented management as a normal practice.

Photo: Claude Chalhita

6. Building capacity through training with MASSPRES

A key component of the project was to build capacity through training from the farm-level up to the expert-level. This was achieved by holding training workshops, including one where the MASSPRES approach was used. The workshop's aim was to develop capacity and encourage evaluation of the Dardara Irrigation System. The training was conducted in Beirut in the summer of 2012. Almost 20 irrigation and agriculture engineers participated in the training workshop, which focused on the application of MASSPRES to irrigation in the Plain of Marjayoun. The training workshop had four objectives:

- Introduce the MASSPRES and MASSCOTE methodologies to participants through real-case applications;
- Increase capacity on techniques and modern approaches to irrigation management and operation;
- Produce insights into the performance of the Dardara irrigation scheme;
- Produce recommendations for the concluding regional workshop on irrigation modernization.

The workshop was a success and the participants, through guided group work sessions, identified several options to improve irrigation in Marjayoun. Among these varied suggestions, several hardware and operational changes were selected as priority improvements. These included:

Options to improve water delivery services:

- A water filtering/water treatment at the network inlet;

- Flow and Pressure control;
- Water distribution – implementing a rotation system.

Structural improvements:

- Increase water storage by intercepting, collecting and conveying drainage water to the Dardara reservoir from the surrounding areas;
- Construction of a stilling basin at inlet of pipe network;
- Construction of multiple water filtering stages to remove algae and other suspended materials before the inlet of pipe network;
- Installation of pumps (preferably variable-speed pumping units) at network inlet;
- Installation of flow limiters and flow meters at hydrants for better control of flows in the network, as well as for implementation of transparent water billing procedures;
- Installation of safety devices (drain valves or spillways, air release valves, pressure regulators, flow limiters, air chambers, shut-off devices, etc.) at key points in the network.

Operational improvements:

- Setting flow limiters at hydrants based on cropped areas, actual crops and irrigation methods;
- Enforcement of frequency restrictions to hydrants with high sensitivity;
- Enforcement of an adjustable rotation delivery schedule, or restricted frequency demand based on adequate network partitioning;
- Implementation of incremental volumetric water tariffs;
- Estimation of peak flow requirement in the pipe network based on cropped areas and irrigation methods;
- Assessment of field level irrigation efficiency;
- Better definition and monitoring of water delivery services;
- Irrigation Advisory Service to Farmers;
- Capacity Development of the operation staff, managers, cooperatives;
- Crop intensification and diversification;
- Implementation of a monitoring program.and operation;

These suggestions formed the basis of the rehabilitation and modernization detailed below as well as the additional training provided to improve capacity.

Photo: Claude Chalhita

7. Rehabilitating and modernizing irrigation in Marjayoun

The rehabilitation and modernization of the irrigation system was a critical element of the project in Marjayoun. The scope and design of rehabilitation was informed by the technical studies of the irrigation system, but also by the options identified during the MASSPRES workshop listed above. Rehabilitation and modernization interventions included an extension to the piped irrigation system, the installation of flow meters, improvements to drainage to ameliorate the impacts of flooding on productive land and lastly the rehabilitation of the main water source.

7.1 Extending the piped irrigation system

In 2008, AVSI Foundation rehabilitated the old open canals in the North-West part of the Plain by replacing them with 2 irrigation pipelines, shown in blue in Figure 7. These two pipelines supply a potential irrigated area of 157 hectares (1039 fields or almost 17% percent of the total area).

The third pipeline, shown in red, is located in the Eastern part of the Plain and was built as part of a project funded by the EU and managed by the Council for Development and Reconstruction in Lebanon (CDR). This third pipeline has been beset by problems, yet supplies a potential irrigated area of 99 hectares (10.5 percent of the total area of the Plain). During the second phase of the project, pipelines were extended to replace two irrigation canals with the potential to irrigate 200 hectares in the southern part of the plain. The evolution of pipeline extension is shown in Figure 7.

Figure 7. Previous pipelines

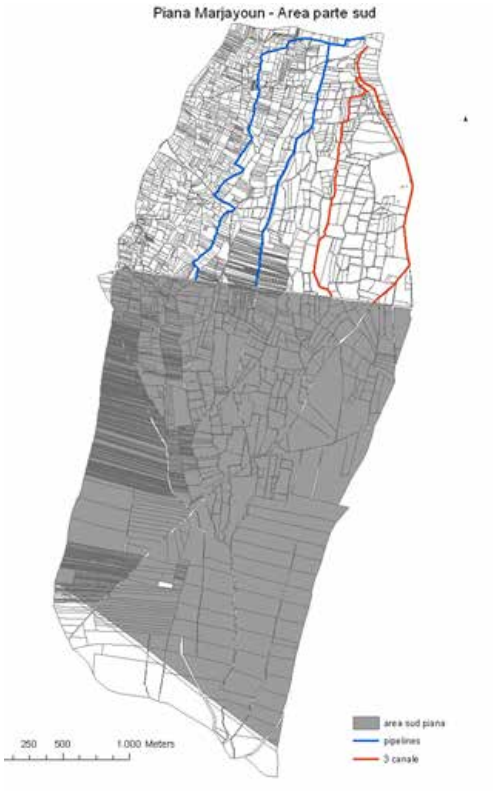


Figure: FAO

7.2 Flowmeter installation

A further intervention to modernize the Dardara Irrigation Scheme and optimize its operation, was the installation of 158 flowmeters. These allow the monitoring of water across the system and show the volumes of water being being delivered by the system. This information enables more efficient water management, for example, the data from flowmeters informs irrigation scheduling thereby allowing farmers to maximize profit and minimize water use.

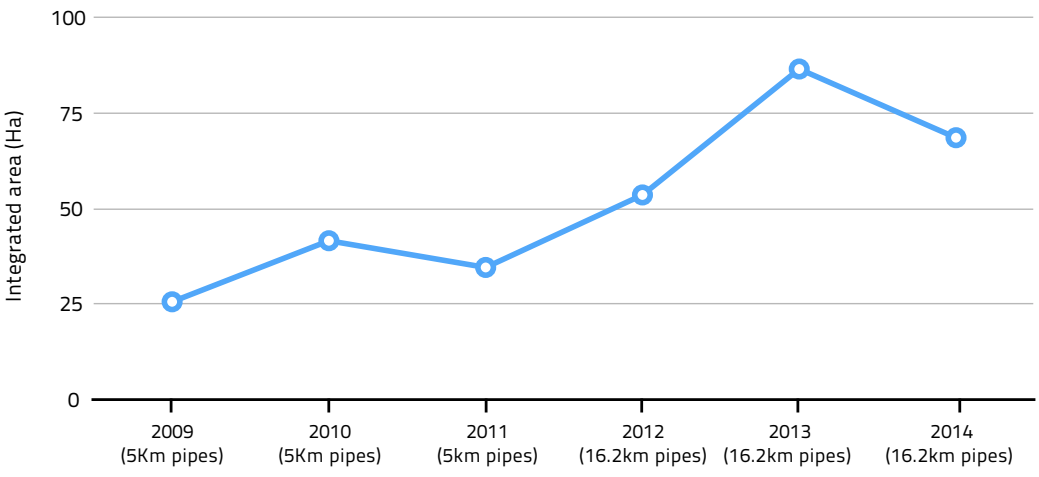
The flowmeters were installed in two phases.

Phase 1: June-July 2012
Installation of 90 Flow meters

Phase 2: April-May-2014
Installation of 68 flowmeters.

The pictures (Figure 9) show the installation of the flowmeters and checks to ensure their smooth operation.

Figure 8: Irrigation evolution since 2009



Source: FAO

7.3 Minimizing flooding through drainage channel maintenance

To control the effects of annual winter flooding on productive land, the drainage system was rehabilitated. The 'intervention zones', where drainage could best be improved, were

Figure 9: Figures showing the installation of flowmeters

Photos: Claude Challita

Figure 10: Waterway design (left) and construction (right)

Photo: Claude Challita

identified using the topographic study. This strategic improvement of targeted drainage channels resulted in the rehabilitation and cleaning of over 12, 000 m of primary and secondary, and the construction of nearly 300 m of new water-ways.

The pictures in Figure 11 show how the rehabilitated drainage channels improved flooding close to water channels in the Plain. Images to the left show the situation before the rehabilitation, and images to the right show the improvement.

Figure 11: Pictures showing drainage before (left) and after (right) the intervention

Photos: Claude Challita

7.4 Rehabilitating the irrigation source: The Dardara pond

The Dardara pond is the main water source for a substantial part of the irrigation system, however, it has suffered from poor outflow and its water storing capacity had reduced over time. To overcome these problems, the walls of the pond were reinforced in September 2013. This infrastructural work included concreting, water-proofing and fashioning a stone-cladding 'jacket'. The resulting improvements are shown in Figure 12. While these interventions have improved the pond, there remain problems with algae. A recent study by the irrigation service unit (introduced later in this report), suggest that adding filters to the outlet of the pond could reduce the clogging of pipelines and improve the system performance.

Figure 12: Results of Dardara pond rehabilitation

Photos: Claude Chalhita

Photo: Claude Challita

8. Extending pilot areas under drip and sprinkler irrigation

Drip irrigation systems can both improve water use efficiency and lead to more productive yields. This is because crop water demand can be met more precisely through drip systems, and less water is delivered to the field thereby reducing non-beneficial evaporation and waste. To raise efficiency and productivity in Marjayoun, the project piloted the use of drip irrigation systems by providing irrigation equipment to 18 farmers between 2012 and 2014. Farmers were selected on the basis of a socio-economic study, which sought to identify those who were less able to make the investment in modern irrigation systems themselves. For this group of farmers, the project purchased and installed the equipment and gave training on the use of the new system.

Figure 13: Delivery of the equipment

Photos: Claude Challita

Figure 14: Installing with farmers

Photos: Claude Challita

Figure 15: Inspection and operating

Photos: Claude Challita

This piloting of drip irrigation, in tandem with maintenance of the irrigation system and modernization, not only helped the farmers selected to take part in the pilot scheme, but also encouraged the wider uptake of drip irrigation by other farmers in the Plain. This finding was confirmed by a socio-economic survey conducted in late 2013 and early 2014. This revealed that while farmer investment in drip irrigation had decreased due to the local conflict in 2006, that now farmers have increased confidence. This has led to more farmers investing in their own drip irrigation systems and in other cases. Many of these investments have occurred since 2008, when the rehabilitation and piloting of drip irrigation systems began in the Plain. Furthermore, the survey also showed that the wider rehabilitation of the irrigation system and the increased use of drip irrigation technology has led to an increase in the irrigated area in the Plain.

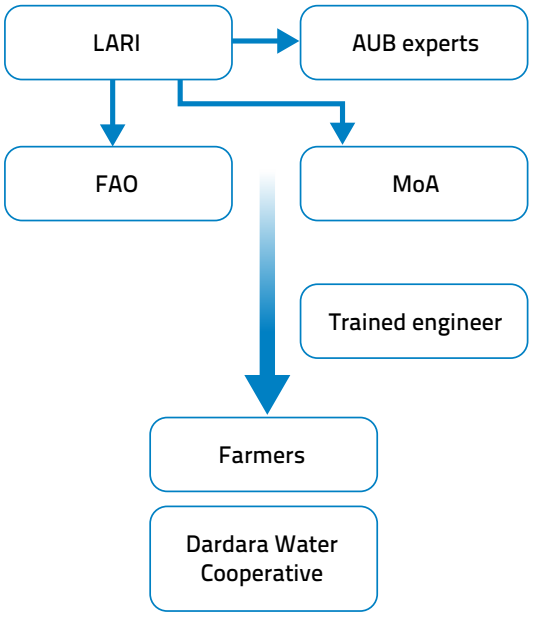
Nevertheless, further work remains to train farmers in the appropriate use of drip systems and build technical capacity. A more recent study by the irrigation service unit in 2015 highlighted that more than half of the fruit tree growers were irrigating under capacity, and that more drip irrigation equipment was required at the field level. This finding highlights the on-going requirement for the farmer cooperative to continue to train farmers in the best use of water resources.

Photo: Dr. Marie Therese Abi Saab

9. Irrigation service unit

Supporting farmers is a key element of efforts to build capacity in the Plain of Marjayoun and specifically for farmers in the Dardara Cooperative. On the ground support was provided by the irrigation service unit, whose main focus was to transfer up-to-date irrigation scheduling technology and to develop an irrigation schedule to help farmers maximize yields and minimize water use. The irrigation service unit formed from the Lebanese Agricultural Research Institute (LARI) and the American University of Beirut (AUB) experts worked with a trained engineer to support farmers and the Dardara Cooperative, as shown in Figure 16.

Figure 16: Organisational structure of the Irrigation Service Unit



Source: Lebanese Agricultural Research Institute

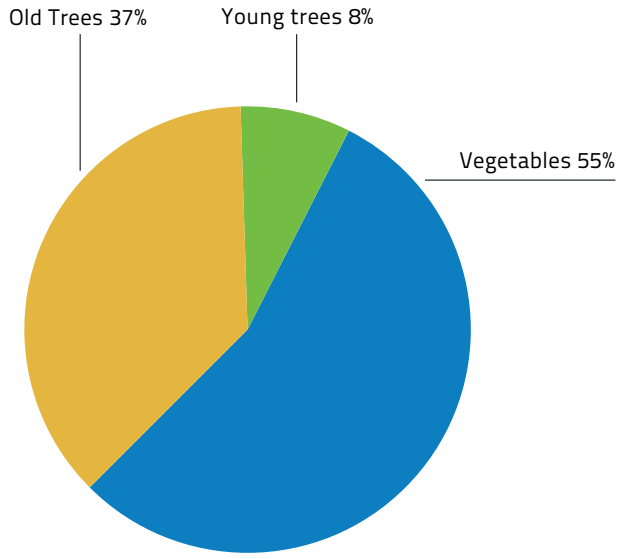
9.1 Irrigation scheduling

Irrigation scheduling helps farmers to decide when and how much water to apply in order to maximize profit. Setting a schedule requires a large amount of data and technical knowledge. The data required includes, estimates of crop water requirements, understanding the limitations of different irrigation methods and irrigation equipment, as well as being aware of the limitations relative to the water supply system. Farmers may also be cautious of irrigation scheduling, particularly in cases where schedules recommend a reduction in the amount of water that farmers have applied in the past. In this scenario, farmers

often fall back on business as usual practices and are reluctant to make changes to their irrigation practices. So, the challenge of irrigation scheduling combines both the technical complexity of understanding the system, but also helping to support farmers move to more effective farming practices.

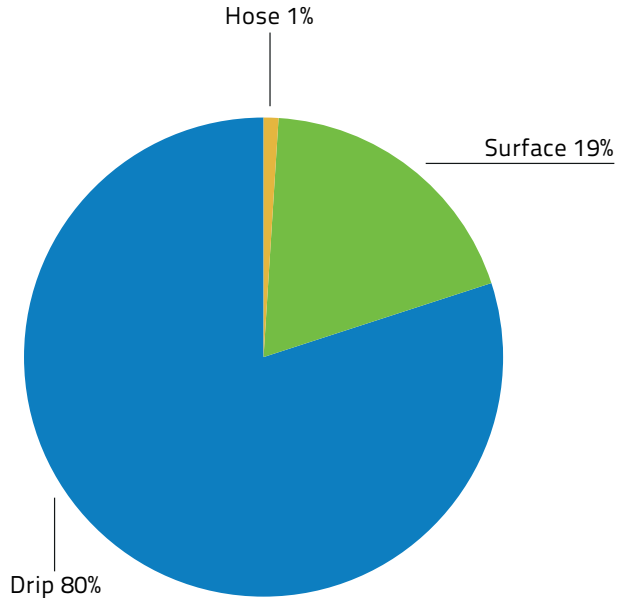
To develop an irrigation schedule for farmers, an irrigation scheduling study was carried out for the 2015 cropping season (the 2014 season was affected by acute water scarcity and research could not be effectively carried out because farmers were forced to restrict water delivery due to limited supply). The study, was undertaken by LARI, who collected data relative each irrigated parcel (farmer area of land). This included: parcel number, farmer name, identifying the hydrant used for irrigation, crop type, irrigation method, emitter flow and spacing, soil analysis, and lateral flow. In addition, data was collected related to the volume of water registered by flow meters at both the reservoir outlet and at the irrigation parcel, and hydrant flow measurements before hydrant operation (often in the early morning). The study considered the three main crop types of old fruit trees, young fruit trees and vegetables for the 79 farmers opting to irrigate during the period of the study. The majority of these farmers irrigated using drip-systems; see Figure 17 and Figure 18 respectively.

Figure 17: Main crop types for the 2015 cropping season



Source: Lebanese Agricultural Research Institute

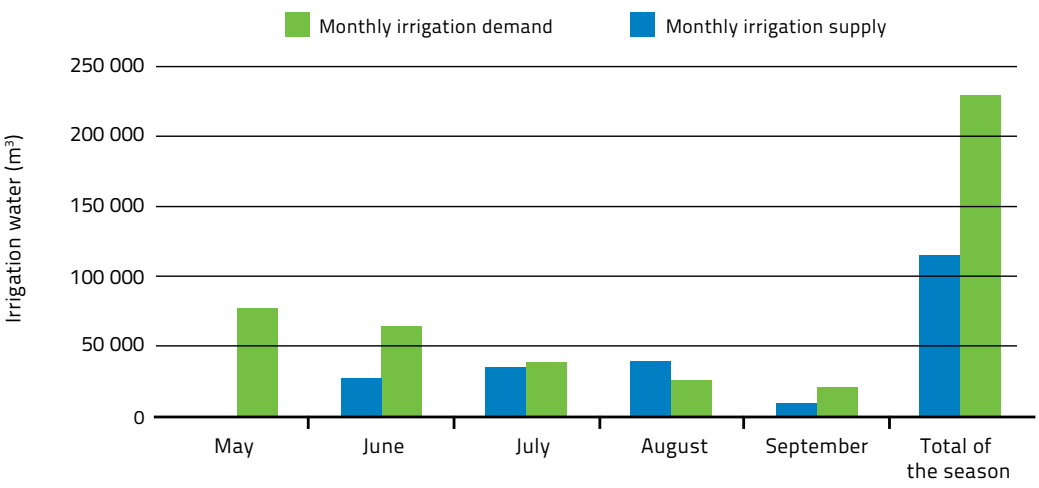
Figure 18: Main irrigation types used by farmers in the 2015 cropping season



Source: Lebanese Agricultural Research Institute

Despite gaps in data availability, the scheduling study was able to show that many farmers are over-irrigating and wasting water. This result is shown clearly in the analysis of irrigation water demand versus irrigation supply in Figure 19. Therefore, there is a scope for further training and capacity development in the irrigation, and an important role for the Dardara Cooperative to help farmers to better manage water resources. A first step could be the adoption of the irrigation schedule shown in Figure 20, and the implementation of a demonstration plot where farmers can be shown the relationship between the irrigation schedule and yields.

Figure 19: Irrigation demand versus irrigation supply



Source: Lebanese Agricultural Research Institute

Figure 20: A simplified irrigation schedule for vegetables and fruit trees

	Irrigation schedule for 1 dunum of vegetables			
	June	**July**	**August**	**September**
Irrigation frequency (days)	6	6	6	6
GIR (m^3)	8	12	12	10
	Irrigation schedule for 1 dunum of young fruit trees			
	June	**July**	**August**	**September**
Irrigation frequency (days)	20	15	6	6
GIR (m^3)	12	12	12	12
	Irrigation schedule for 1 dunum of old fruit trees			
	June	**July**	**August**	**September**
Irrigation frequency (days)	20	20	15	15
GIR (m^3)	21	21	22	22

Source: Lebanese Agricultural Research Institute

Moreover, the work of the Irrigation Service Unit, revealed several further areas where improvements could be made to reduce operational inefficiencies in the management of the piped irrigation system. Simple steps for improvement to system performance include technical and management interventions, many of which could be undertaken with little additional cost:

- Maintenance and cleaning of flowmeters, particularly the flowmeter on the outlet from the Dardara Pond;
- Installing filters in the Dardara pond to reduce clogging in the main irrigation pipelines;
- Installing a booster pump to improve system pressure for downstream farmers;
- Encouraging data collection and information management to improve data reliability
- Encouraging farmers to provide reliable data on water use;

- Improving irrigation management at the field level through capacity building;
- Encouraging and enforcing the organised allocation of water between hydrants;
- Encouraging more effective hydrant management by the Cooperative to prevent falling system pressure.

The irrigation service also provided guidance on irrigation design. This involved providing farmers with necessary support to design and implement a drip irrigation system. For example, issues related to appropriate equipment, the purchasing of the correct fittings and how to maintain the equipment in the field.

Figure 21: Irrigation unit

Photos: Dr. Marie Therese Abi Saab

Soil sampling and analysis is another service provided by the Irrigation Service Unit. In the photographs, researchers are shown helping farmers to collect soil samples and send them for analysis and delivery of appropriate soil fertility program.

Figure 22: Soil sampling

Photos: Dr. Marie Therese Abi Saab

Lastly, the irrigation service also provides advice on effective management on plant disease, for example management of aphid populations on okra crops. To date, this service has not been widely used by the farmers

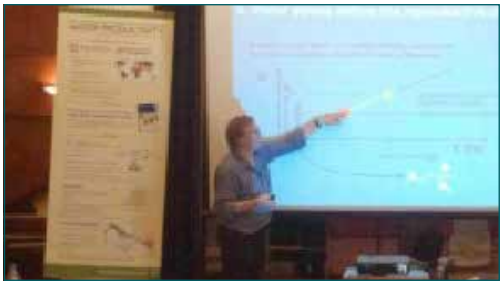
Photo: Claude Challita

10. Building capacity through Aquacrop training sessions

Training sessions on Aquacrop were also conducted by the project team. Aquacrop is a crop-model which can help to improve irrigation efficiency and crop water management. A training workshop was help in 2013 on the application of this tool. The main objective was to build local capacity and develop participants' skills in strategic on-farm management toward increasing crop-water productivity in Lebanon. The workshop took place over 5 days and included both theoretical and practical sessions. In total, 22 participants, from several Lebanese institutes, attended the 5-day workshop.

> The AquaCrop model is designed to balance simplicity, accuracy and robustness, and is particularly suited to address conditions where water is a key limiting factor in crop production. It is a companion tool for a wide range of users and applications including yield prediction under climate change scenarios.

Figure 23: Pictures from the workshop



Photos: Claude Challita

Photo: Claude Challita

11. Building capacity by training farmers on modern techniques

Workshops were also held with farmers, to train them in modern irrigation techniques. The focus of these workshops was on soil and irrigation management and the facilitation of discussion on soil management practices, irrigation scheduling and design/management. Staff from the Ministry of Agriculture also took part in the workshops, which lasted 3 days and included both theoretical training and field visits where demonstrations of irrigation equipment and steps to maintain them were given. Overall, the farmers received the following information:

- Fertilization programs specific to common regional crops.
- Irrigation scheduling programs for specific vegetables and fruit trees grown in the plain.
- Information on designing irrigation systems (including components).
- Information on the maintenance of drip irrigation systems.

Figure 24. Building farmer capacity through training

Photos: Claude Challita

Photo: Dr. Marie Therese Abi Saab

12. A business plan for the Dardara cooperative

The Dardara farmer cooperative operates the newly rehabilitated irrigation system and aims to ensure a reliable supply of irrigation water to its members at price which balances affordability for farmers with the long-term sustainability of the organisation. The Dardara Cooperative, which is registered with the Ministry of Agriculture, has a hierarchical structure. This includes: a president, a director, an elected board of directors, an oversight committee, two salaried staff (fountain-men) and the farmer members.

Continued water distribution relies on several strategic activities, the most important of which is the continued operation and maintenance of the Dardara Irrigation System. This includes the payment of the salary for the foundation men, and regular cleaning and maintenance of filters, hydrants and flow meters to ensure the system is run optimally. In addition, the Cooperative plays a role in supporting the continued training and capacity development of the farmers using the water.

The cooperative is funded largely by the fees paid to farmers to for their irrigation water, with initial costs being met by grants from FAO and AVSI. The aim of the Business Plan developed for the Cooperative is to ensure the financial sustainability of the organisation in to the future by setting out appropriate fees for farmers and outlining possible strategies to reduce costs and generate income. The main findings of the Business Plan are given in Appendix 1.

Photo: Claude Challita

13. Project impacts

Project impacts have been evaluated by combining the results of a socio-economic assessment in late 2013 and early 2014, with technical insights on system operation arising from the work of the irrigation service unit. Overall, the Marjayoun project sought to increase agricultural productivity, improve the livelihoods of beneficiaries, and strengthen local and national capacities for water resource management. Findings from the socio-economic survey reveal broadly positive impacts on many variables related to increasing agricultural productivity. For example, access to improved irrigation has led to a shift away from rain-fed crops towards higher-value fruits and vegetables– although the shift was neither uniformly observed across the Plain, nor always permanent. The increased use of drip irrigation appears to have positively influenced crop yields, particularly for vegetables.

However, it is also clear from the results of the socio-economic study, that there are many other factors influencing farmer production decisions besides the availability of irrigation water. For example, the expected market demand and price for crops plays a particularly import role. In addition, many farmers prefer to keep their cultivation diversified to reduce risk, meaning that there is unlikely to ever be a wide-scale comprehensive shift towards only irrigated high-value crops. There are also some natural constraints to this imposed by the soil fertility in parts of the Plain.

The project has also had a clear positive impact on the net income of many farming households. This is largely the result of the higher yields and lower labour costs associated with the greater use of drip irrigation (whether funded directly by the project or not). However, while many farmers reported an increase in income, they still felt that this was a volatile increase that may not be permanent – still citing the unpredictability of yields as a major source of instability.

The broader impact of the project on the local economy is mixed. With respect to labour, the introduction of drip irrigation typically led to a reduced demand for farm labour, which was not offset by any increased labour demand due to more land being cultivated or greater cropping intensity. This may have a negative impact on the livelihoods of agricultural workers, depending on their mobility and ability to find work elsewhere. The project has also had wider impacts on the local economy. For example, it appears to have contributed to a lower use of fertilizers for some farmers. The trend towards lower fertilizer use should have a positive environmental impact; however, it may negatively affect the local industries from which fertilizers are sourced. This may be countered by greater demand for food processing services, although whether this can be provided in the local economy is uncertain.

Photo: Dr. Marie Therese Abi Saab

14. The way forward

Future interventions in the plain of Marjayoun should consolidate and strengthen the assistance given to existing beneficiaries. There are many challenges that these farmers still face before the full benefits of the improved irrigation systems can be realised. These include blockages and reduced efficiency of the irrigation tubes, limited farmer expertise when it comes to increasing cropping intensity (even in circumstances where improvements are feasible), and a lack of leverage in the markets for agricultural produce. Future projects could assist farmers to meet these challenges, through capacity development at both the individual level and within the Dardara Cooperative.

Specific areas for improvement, as reported by the irrigation service unit, focus on improving the operation and maintenance of the system, in which the Dardara Cooperative can play the central role, and in the continued development of technical capacity within the farming community.

15. Project resume

Location	Caza of Marjayoun, Lebanon
Duration	2011-2015
Executing Agency	Food and Agriculture Organization of the United Nations (FAO)
Problems	▪ Water Scarce Country ▪ Lack of capacities at national and regional level to cope with water scarcity ▪ Poor irrigation management and infrastructure in the Plain of Marjayoun
Main objective	Strengthening local and national capacities to increase agricultural productivity through improved water demand management.
Objectives	▪ Contribute to improved water demand management in irrigation ▪ Contribute to increased knowledge of farmers and institutional personnel with regard to new irrigation technology and management practices to enhance the efficiency and productivity of water use
Direct Impact	Local communities in the Plain of Marjayoun benefit from improved water demand management and increased water use efficiency in agriculture
Indirect Impacts	Government and water management institutions improve their capacity to efficiently manage water resources for agriculture. Secondly, the risk of conflict over the distribution of water resources is reduced in the project area
Budget	The total budget amounts to USD 1 197 665. Contributions from the Region of Lombardy (USD 243 000) and AVSI Foundation (USD 348 165) managed by AVSI plus a contribution from the Ministry of Foreign Affairs of Italy through the Trust Fund for the Italy/ FAO Decentralized Cooperation Programme (USD 300 000 initial + 306 500 extension) managed by the FAO Representative in Lebanon (separate administration of funds)
Contact	**Land and Water Division (AGL)** Maher Salman, Technical Adviser Maher.Salman@fao.org **FAO Lebanon** Maurice Emile Saade, FAO Representative Maurice.Saade@fao.org

16. Appendix: Dardara Business Plan

16.1 Introduction

The Dardara Cooperative is a farmer organization in south-east Lebanon, which distributes irrigation water to its members. This appendix sets out a business and financial plan for the cooperative to achieve water distribution in a sustainable and transparent manner. The Business Plan provides a framework, which addresses the financial sustainability of the organization and proposes options for income generation beyond the collection of farmer fees. As part of this Business Planning assessment, the plan considers the Cooperative's activities and their costs, and highlights the main challenges faced by the Cooperative. The data supporting this business plan includes interviews with the Lebanese Agricultural Research Institute (LARI), the President of the Dardara Cooperative and project staff, in addition to analysis of the Cooperative accounts for 2014 and a socio-economic assessment of farmers in the Plain, conducted in 2013-14.

16.2 Description of irrigation system and assets

The Dardara Farmer Cooperative operates a newly rehabilitated irrigation system in the Plain of Marjayoun. The land in the Plain of Marjayoun is ideally suited to agriculture, but prior to recent project interventions, its irrigation infrastructure had deteriorated (particularly since the 2006 conflict in the region), leading to high water losses and poor irrigation efficiency. In light of the poor condition of the system, the AVSI Foundation – an Italian NGO – began an intervention in the northern part of the Plain in 2008. The project aimed to replace two of the open irrigation canals from the Dardara Spring (the most important of three sources of irrigation water in the plain) with covered pipelines, and to support the establishment of the Dardara Cooperative. In 2011, FAO partnered with AVSI to extend this rehabilitation work to a greater area in the Dardara irrigation system, in a project targeted at 5 villages. The aim was to further strengthen the capacity of local farmers and institutions in irrigation water management to raise agricultural productivity.

The projects undertaken by AVSI and FAO resulted in the rehabilitation of large parts of the irrigation system including the installation of a piped irrigation system, improvements to drainage and the piloting of drip irrigation with several farmers. Since the overall improvements to the system and piloting of more efficient technologies, many additional farmers have invested their own money in drip irrigation equipment, which is now commonplace across the Cooperative area. In 2015, the Cooperative was responsible for an area of approximately 60 hectares, and 82 farmer members who cultivate a variety of cereal crops, vegetables and fruit trees.

While the project interventions, which have included training and capacity building elements, have resulted in improvements to the irrigation system, there remain operational and technical changes that could significantly improve performance. Many of these

improvements could be overseen by the Cooperative and include improved maintenance, more effective operational practices and the installation of filters and booster pumps.

16.3 Technical details of the irrigation system

The irrigation system is composed of infrastructure assets which collect and distribute water to farmer members of the Cooperative. These include the newly rehabilitated Dardara Pond (the source of irrigation water for much of the Plain), 27km of irrigation pipe (between different irrigation 5 lines) plus 17km of the CDR pipeline, 12km of winter drainage channels, 158 flow meters, 72 manholes, and 2 filters.

16.4 Organization structure

The structure of Farmer Cooperatives affects their ability to sustainably manage water resources and facilitate equitable decision-making. Organization structures with transparent rules and procedures for voting, election of representatives and conflict management are favoured. The Dardara Cooperative, which is registered with the Lebanese Ministry of Agriculture (see Figure 25), has a hierarchical structure comprised of:

- a President
- a Director
- an elected Board of Directors
- an Oversight Committee
- Two salaried staff (fountain-men)
- Farmer members

The Cooperative has a constitution which details its role and the rules of membership, voting procedures and the obligations of the farmer membership.

16.5 Roles and responsibilities

The constitution details the roles and responsibilities of the president and the board. The main responsibilities of the President are to:

- Invite members of the Board for meetings;
- Organise the meeting schedule in collaboration with other members;
- Represent the Cooperative in meetings, workshops, local & central authorities and international organizations (based on decisions taken at the council level);
- Prepare the annual budget with the accountant and review it with members of the council;
- Ensure that the irrigation process operates smoothly during the summer months.

Figure 25: Registration certificate of the Dardara cooperative

الجمهورية اللبنانية
وزارة الزراعة
المديرية العامة للتعاونيات

قرار رقم ١٠/أ/

انشاء جمعية تعاونية لادارة مياه الري في محافظة البيطية

ان المدير العام للتعاونيات
بناء على المرسوم رقم ٢٥١٤ تاريخ ٢٠٠٠/٢/٢٣ (تعيين المدير العام)
بناء على المادة التاسعة من مشروع القانون الموضوع موضع التنفيذ بالمرسوم١٧١٩٩
تاريخ ١٩٦٤/٨/١٨ المعدلة بالمادة الرابعة من مشروع القانون الموضوع موضع
التنفيذ بالمرسوم رقم ٣٥٠٨ تاريخ ١٩٧٢/٦/٢٩
بناء على المرسوم التطبيقي رقم ٢٩٨٩ تاريخ ١٩٧٢/٣/١٧
بناء على طلب الانشاء المقدم الى المديرية العامة للتعاونيات
بناء على مقررات الجمعية التأسيسية المنعقدة بتاريخ ٢٠٠٩/٤/٢٣

يقرر ما يأتي

المادة الاولى : تؤسس في قضاء مرجعيون جمعية تعاونية تدعى:
"الجمعية التعاونية لادارة مياه نبع الدردارة م.م / قضاء مرجعيون ."
مدتها : /٩٩/سنة. تسع وتسعون سنة.
نطاق عملها : الخيام / القليعة وبرج الملوك .
مركزها : الخيام / العقار رقم ١٨ .
مسؤوليتها : محدودة بقيمة الاسهم المكتتب بها.
رأسمالها الاساسي :/١,١٠٠,٠٠٠/ ل.ل. مليون ومئة ألف ليرة لبنانية.

الجمهورية اللبنانية
المديرية العامة للتعاونيات

The Director's role is to assist the President. The main responsibilities include managing the work of the two fountain-men who operate different pipelines across the irrigation system. The fountain-men are responsible for operating the hydrants, system maintenance, collection of data and the collection of farmer fees.

16.5.1 Obligations of cooperative members

Cooperative members also have responsibilities and obligations to support the functioning and maintenance of the irrigation system. These obligations extend beyond the payment of fees. Several different member obligations typically adopted by Water Users Associations and Farmer Cooperatives across the world are given below:

1. Comply with the provisions and rules of the Cooperative;
2. Provide the Cooperative with information on land and water use.
3. Allow the Cooperative staff access to land when carrying out Operation and Maintenance;
4. Ensure careful treatment of Cooperative equipment;
5. Comply with irrigation schedules;
6. Pay for the costs of repairing Cooperative equipment damaged as a result of intended or neglectful action.

Given that a considerable challenge for the smooth operation of the Dardara Cooperative is the collection of data (see Section 5.2), a strong recommendation of this business plan is that the Cooperative formally adopts these member guidelines, particularly those related to the provision of data and information by the farmers who benefit from the system.

16.6 Objectives

The key objective for the Dardara Cooperative is to ensure a reliable supply of irrigation water to its members at price, which balances affordability for farmers with the long-term sustainability of the organization. Continued water distribution relies on strategic activities, the most important of which is the continued operation and maintenance of the Dardara Irrigation System. The Cooperative has a secondary objective to preserve the natural environment of the region and improvement of agricultural production. The Cooperative is also involved in the continued capacity development of its farmer members through the support of the Irrigation Service Unit (funded in the short-term by the FAO Project in its extended phase).

The strategic activities supporting these objectives are given below.

16.6.1 Operation and maintenance

To ensure the reliable supply of its irrigation water, the Dardara Cooperative's funds must meet the costs of operation and maintenance of the system. Currently there are concerns that maintenance is not being carried out to the level required and this is having a detrimental impact on the performance of the system. For example the majority of the flow-meters are clogged, which is having a negative impact because it prevents both the smooth operation of the system and also means that essential data required for irrigation scheduling is not available.

Operational costs include salaries for the fountain-men who operate the system, and meeting the cost of energy for pumping. Maintenance costs are also on-going and should include provision for continued inspection, cleaning and repair of the irrigation assets operated by Cooperative. For example, the Dardara Pond, filters, the piped network, canals, drainage system, flow-meters and hydrants all need regular cleaning and inspection. Effective operation and maintenance can best be achieved if the capacity of the fountain-men is improved through training. This would enable these staff to better attend to the needs of the irrigation system, in terms of operation, collection of data and maintenance.

16.6.2 Investing in infrastructure

The Cooperative may also wish to invest in improvements to the irrigation system. Current requirements include equipment to improve the performance of the system such as a booster pump and appropriate measures to reduce clogging and therefore reduce cleaning and maintenance across the system. Investment in further efficiency gains for water and energy use may also be of interest to the Cooperative, for example, water harvesting infrastructure, to reduce reliance on the Dardara pond and solar pumps to reduce operating costs in the irrigation system.

16.6.3 Continuation of the irrigation service unit to support capacity building

The Irrigation Service Unit which provides advice to farmers on irrigation scheduling, soil fertility issues, and on-farm irrigation techniques, is funded for the duration of the FAO project. Thus, cooperative funds might be used in the future to support the continuation of the Irrigation Service Unit. This option requires costing of the service and consultation with cooperative members to decide whether they feel that the services provided by the unity represent value for money.

16.7 Challenges facing the cooperative

The Cooperative faces several challenges to its work of ensuring a reliable water distribution system. These relate to management, operational practices, the need for additional infrastructure and farmer capacity at the field-level.

16.7.1 Management and conflict resolution

A significant management challenge, is that the Cooperative is not the sole water-using stakeholder in the Plain of Marjayoun. There are a number of other water users who access resources, thereby increasing the potential for conflict, particularly during times of drought. Thus one option for the Cooperative is to ensure the effective engagement of other stakeholders in dialogue processes. This could promote conflict resolution and ensure the continued sustainability of the Dardara Spring as a source of water for multiple users.

16.7.2 Operation

An irrigation scheduling study was undertaken in 2015. This found that the performance of the system is often poor with low pressure being a significant problem. One cause of low pressure in the system is the sub-optimal operation of hydrants, without due attention to the effects of opening hydrants on the wider system. The scheduling study recommends that an operational plan is developed and adhered to by those managing the opening and closing of hydrants. This will require further research to understand the system and the delivery of training and capacity-building for the staff who work on and manage the system. Moreover, to support the development of better irrigation scheduling and to better understand the system, emphasis should be placed on the importance of data collection carried out by operating staff and farmers.
Further problems with the operation of the system are arising due to clogging and poor maintenance. Therefore, a more appropriate maintenance schedule is required to remedy these issues.

16.7.3 Infrastructure

The poor performance of the system is also related to the need for additional equipment. The two most important purchases for the Cooperative should be a booster pump to better maintain system pressure, and measure to reduce clogging in the piped system.

16.7.4 Capacity

Low levels of training and capacity remains a challenge to the operation of the system. To solve this, the Cooperative should target farmers who are irrigating under capacity, and encourage the installation of additional drippers. The study also identified that many farmers are over-irrigating their crops, thus greater training should be given to reduce inefficient use of water. If the Cooperative invested in training for farmers, system efficiencies could be made and the pressure on water resources reduced.

Training and capacity development is also essential for the staff who operate the system.

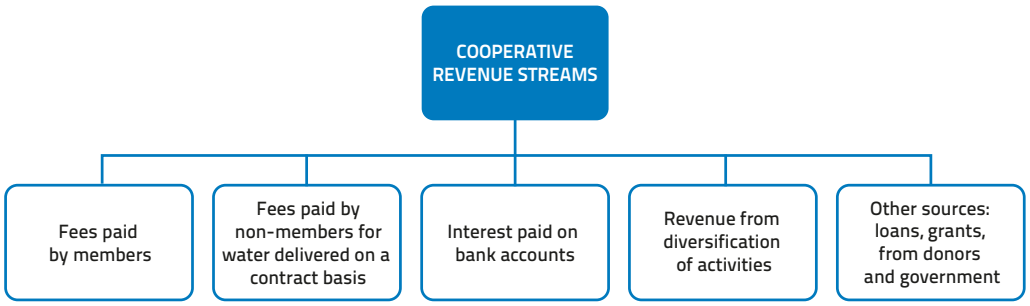
16.8 Financial plan

Financial planning allows an assessment of whether the Cooperative can meet its obligations with regard to distributing water to members in a sustainable fashion. This section reviews the revenue streams of the Cooperative; proposes options for additional revenue generation; presents an overview of operation and maintenance costs; and summarises the processes to collect of levies from members in a transparent manner.

16.8.1 Revenue streams

Cooperatives and Water User Associations have several options for revenue generation. These include member fees, grants, loans, and interest on bank accounts as shown in Figure 26.

Figure 26: Options for revenue generation



However, the Dardara Cooperative limits its revenue to only farmer fees and ad-hoc grants from AVSI and FAO. This is demonstrated by the accounts for 2014 which show monies from only subscriptions and grants (see Table 1). Given the demands on its financial reserves, limiting income in this way is not sustainable. Thus, to increase its income, the Cooperative should focus on two areas. Firstly, income diversification and secondly, raising farmer fees.

Table 1. Annual revenue for Daradara cooperative (2014)

Revenue Stream	Lebanese Lira
Grants from AVSI and FAO	7200000
Subscription from Farmers	17085000
Interest Paid on Bank Account	0
Revenue from Diversification	0
Total	**24285000**

16.8.2 Diversifying revenue generation

Additional income streams could be generated for the Cooperative by considering diversifying the activities it manages and takes part in. Two main possibilities are presented below: business oriented strategies and the sale of water. However, these suggestions do not constitute an exhaustive list and consultation with farmer members may give rise to further options for the Cooperative to consider.

Business oriented strategies

There are several possible business strategies that could be developed by the Cooperative to diversify income. For example, renting the use of tractors or other heavy farming equipment to members or non-members of the Cooperative. While this option is likely to bring in additional funds, care must be taken to ensure that rules and procedures for rental are clear to avoid conflict within as to the allocation of resources. A second option proposed by the Cooperative is the implementation of a farmer-led direct sales business, where farmers sell their goods to market. This would require equipment such as a refrigeration unit, however there are drawbacks in terms of the management of this operation to ensure that all farmers benefit; in addition to increased costs in terms of maintaining a direct sales business.

Water sales

The sale of water on a contract basis to non-cooperative members also provides an opportunity to diversify income. While this is a revenue model seen in Water User Associations in other parts of the world, it may not be suitable to the local context of the Plain

of Marjayoun and the Dardara Cooperative, due to water scarcity. However, there is scope to reduce current irrigation water demand through better irrigation scheduling thus, the potential for water sales to deliver a modest revenue.

16.8.3 Increasing farmer fees

Income for the Cooperative could also be increased by raising the fees that farmers are charged for water and also by ensuring that all farmers pay for the water they use. To do this, the Cooperative must ensure that all farmers who receive irrigation water are formally declared and pay their fees to the Cooperative. Secondly, and most importantly, the Cooperative should consider raising the fee for irrigation water services.
Currently the fees paid by the farmers are extremely low. Farmers pay a flat rate of approximately USD 200 per hectare (USD 20 per donum) plus approximately USD 5 yearly membership fee. This is below the suggested government guidelines and furthermore, the flat rate does not reflect the differences in water demand of the different crops grown in the irrigation system.

A more sustainable fee should be discussed with the Board and farmers, which reflects the expenses of the Cooperative. Whilst there is understandable reticence to raise fees, an analysis of the financial position of the average farmer in the Cooperative suggests that there is scope to increase them without placing an undue burden on farmers.
See for example the farmer income self-assessment carried out for a recent socio-economic survey, presented in Table 2 below. The same survey highlighted the importance of irrigation water for farmers and the positive impact this made on their income. Equally, many farmers in the Plain have invested in drip-irrigation equipment and thus have a vested interest in the sustainable provision of irrigation water to their farms.

Table 2: Farmer self-assessment of standard of living (2013-2014)

The majority of the sample of farmers interviewed in 2013-2014 believe that their income is sufficient to meet everyday needs as shown in the table of responses to the income self-assessment given below. Amongst the farmers who live under difficult circumstances or with many restrictions, 71% obtain half or more of their income from agriculture. However, the primary reasons given for insufficient income are unrelated to agriculture (and beyond the control of the Marjayoun project): many farmers complained that the prices of goods in general are too high, while others have insufficient income due to school/university fees for their children, medical fees, and/or debt.

Farmers' self-assessment of standard of living (income sufficiency)

Self-assessment	Irrigator	Non-irrigator	Total	% of 84 respondents
I live under difficult circumstances	7	2	**9**	11%
I get by but with many restrictions	16	6	**22**	26%
I get by (income meets needs)	14	3	**17**	20%
I live fine	25	10	**35**	42%
No comment	0	1	**1**	1%

16.8.4 Expenses

The running of the irrigation system entails expenses related to operation and maintenance of the piped system and also expenses related to the smooth running of the Coop-

erative management structure. Typically, the expenses include, the costs of administration, depreciation of assets, energy for pumping (electricity tariffs, running diesel pumps, maintenance (inspection and upkeep costs for system assets such as drainage channels, pipes, filters, hydrants and flowmeters), and costs of repairs. Table 3 presents the typical expenses that a farmer cooperative or water user association may incur.

Table 3: Example expenses for the Dardara Cooperative

Type of Expense	Item	Lebanese Lira (2014)
Office Expenses	Office Rental	0
	Accounting Fees	500,000
	Bank Charges	0
	Computer Expenses	0
	Insurance	0
	Telephone Charges	0
	Printing and Stationary	0
	Refreshments for Meetings	0
Salaries	Salary for 2 Fountain-Men	13,200,000
Operation	Electricity/Fuel/Petrol	2,357,000
Maintenance of Assets and Repairs		5,683,185
Total		**21740185**

The summary of expenses for 2014 reveals that the main cost for the Cooperative is the salary paid to its staff, primarily to the two fountain-men who undertake much of the inspection work on the irrigation system.

16.8.5 Revenue collection policy and record keeping

Money from farmers is collected by the fountain-men and stamped receipts are issued. The money is deposited in to a single bank account which is managed by the accountant and the President. Withdrawals from the bank account require a counter-signature and the accounts are audited monthly.

16.8.6 Financial sustainability

Assessment of the financial sustainability of the Cooperative can be made by comparing income against expenses and contrasting this with requirements for future maintenance and investment. The analysis shows that once ad-hoc donations of cash from grants are deducted, the income generated from farmer fees is not sufficient to meet the running costs of the irrigation system. Furthermore, this precarious position is exacerbated by recent research by LARI which highlights the poor performance of the system. LARI recommend that greater attention should be paid towards maintenance, operational procedures, and investment in equipment such as a booster pump and filters. Given the relatively low levels of income invested in maintenance by the cooperative, a recommendation of this plan is that maintenance spending should rise to enable the Cooperative to meet the minimum maintenance standards suggested by LARI.

16.9 Conclusions and recommendations

This business plan has outlined the objectives and challenges for the Dardara Cooperative alongside an assessment of the financial sustainability of the organization. The plan shows that to meet the minimum requirements of maintaining the system, greater emphasis should be placed on the proper maintenance and operation of the system. The main recommendations are for the Cooperative are summarised here:

Increase income

The financial assessment suggests that in the absence of continued support from FAO and AVSI, the Cooperative spends more than receives from farmers. To increase income generation, the Cooperative should raise its fees in line with government recommendations, and charge farmers a more appropriate price for the distribution of water through the irrigation system. It should also consider income diversification strategies.

Improve operational performance

Attention should be given to the recommendations for improved system performance outlined in the recent Irrigation Service Unite report from LARI. Encouraging more effective system operation and reducing irrigation water use by farmers are likely to improve the performance of the system with little additional cost. These measures would improve the wider sustainability of the system and reduce water demand thereby increasing the resilience of the system to water scarcity.

Spend more on maintenance

The financial accounts reveal that too little of the Cooperative's income is spent on maintenance. This finding is supported by the LARI study which highlighted the impacts of insufficient maintenance on the performance of the irrigation system.

Encourage data collection

The availability of data is critical for the management of the irrigation system. Data allows assessment of the system performance and enables the calculation of irrigation schedules. At present, not enough emphasis is given to the importance of data and the need for both farmers and system operators to facilitate the collection of hydrological information. The Cooperative should emphasise the requirement for its members to assist in the timely and accurate collection of basic hydrological data and should aim to explain to its members why data is required, and the system wide benefits that can accrue from the availability of accurate hydrological information.

Focus on capacity building

An important prerequisite for improved operation, maintenance, and data collection, is the continued capacity development and training of the staff operating the irrigation system and the farmers who use it. This plan strongly recommends that the Cooperative focuses on training to help its staff to operate the irrigation system in a more effective manner.

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