Food and Agriculture Organization of the United Nations

Coping with water scarcity - The role of agriculture
Phase III: Strengthening national capacities

Lebanon

Cover photo
Maher Salman

Photos
Maher Salman
Antoun Maacaroun
Elie Choueiri
Salim Roukoz
Elisa Lorenzon

Maps
Antoun Maacaroun

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Acknowledgements

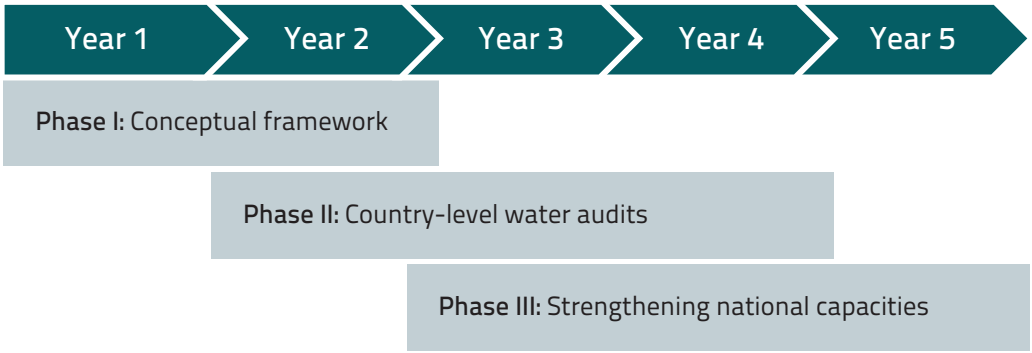
Antoun Maacaroun,
Musa Nimah
Issam Bashour
Elie Choueiri
Marie Therese Abi Saab
Salim Roukoz
Leonora PiresLorena

Introduction

Coping with water scarcity – The role of agriculture

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. Essentially, demographic growth, rapidly growing urban areas and economic development are 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.

FAO, in collaboration with the Ministry of Agriculture and the Ministry of Water and Energy is 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 has the duration of 5 years (2011 – 2015) and, has been organized in three 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: *'the development of water audits in Africa'* was a logical continuation of the earlier mentioned phase. A Water Audit is one of the tools recommended in the comprehensive framework that can be applied on 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 handles to adapt water policies and improve 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. Since most of the Near East and North Africa (NENA) Region countries have already reached or even gone beyond water scarcity levels, this region is a good starting point to invest in national capacities to cope with water scarcity. Together with national and regional counterparts, phase III aims to strengthen national capacities to cope with water scarcity in Jordan, Lebanon and Egypt[1].

[1] Initially the project country was Syria, but due to escalated political situation, the share of the funds allocated to Syria was shifted to Egypt to pilot solar-powered water lifting for irrigation.

Project Phase III: Strengthening national capacities

Near East and North Africa region

The NENA Region faces the challenge of addressing a wide range of complex and inter-twined issues associated with the management of natural resources, particularly land and water, and to securing food supply for a growing population. Growing scarcity and competition for water stand as a major threat to future advances in food security and poverty alleviation in the region. It is, therefore, urgent for countries in the region to improve agriculture water management and to strongly investigate the best practices and the successful solutions necessary to use water resources in the most efficient and sustainable manner.

'Coping with water scarcity – the role of agriculture – Phase III: Strengthening national capacities' focuses on strengthening national capacities in Lebanon, Jordan and Egypt regarding possible interventions for improved water management in general, and dealing with the agricultural component of water scarcity in particular. The project aims at strengthening national capacities by following both a regional and a national approach. The project provides a detailed assessment of agricultural water use, including its productivity, its value-in-use, and its efficiency during the water use process, giving the countries handles to adapt their water policy and improve their water management in the future through strategic interventions to increase their capacity to cope with water scarcity.

The ultimate beneficiaries of the project are the communities, who will benefit from development programmes and interventions utilizing water for agricultural production more efficiently. The primary beneficiaries are national government institutions who will benefit, through a set of decision support instruments, of improved ability to manage available water resources.

Other beneficiaries are donors, international and local NGOs, educational institutions and the private sector, all of whom will have access to improved decision support instruments for planning, programming and implementing their response to water scarcity.

The **regional outputs** common to the three countries are the following:

- Increased capacity for water demand management in irrigation systems; and
- Increased capacity to enhance water productivity in agriculture.

While the three country specific outputs are:

Lebanon: Improved use of treated wastewater for irrigation at Iaat Wastewater Treatment Plant

Jordan: Contribution to water harvesting development

Egypt: Improved agriculture water management in the Delta by providing a more sustainable source of energy for water lifting for irrigation – solar energy

Regional outputs in Lebanon

Increased capacity for water demand management in irrigation systems

Water demand in irrigation schemes in Lebanon often exceeds water supply. Water demand management should be developed to increase the economic return of irrigation water. Optimizing the economic return of water can be done by focusing on growing high value crops under irrigation.

There is a need to control water at secondary and more importantly at tertiary levels to make water allocation demand driven. Modern and flexible irrigation systems with reliable irrigation water delivery services gives farmers and water managers more options to reduce water losses and invest in modern irrigation techniques.

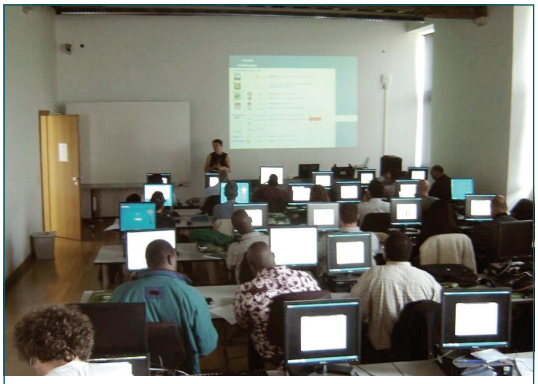
A regional training workshop in the use of RAP (Rapid Appraisal Performance of large collective irrigation networks) and MASSCOTE (MApping System and Services for Canal Operation TEchniques) methodologies took place in Beirut from 28th of May to 4th of June 2012 for professional participants from the Ministry of Energy and Water, Ministry of Agriculture, Lebanese water establishments, and the green plan to evaluate and analyze the performance of large scale irrigation systems. Also RAP and MASSCOTE techniques were applied for concrete case studies to evaluate and analyze large scale irrigation systems, and test possible improvements in water management practices in pilot areas.

In the same year, 23rd to 26th of September a regional capacity building workshop on "Irrigation modernization in the NENA region: Current status and future trends" was organized by FAO in collaboration with L'Istituto Agronomico Mediterraneo di Bari (IAMB), in Italy. The objective of the workshop was to develop, test and disseminate tools for modernization of irrigation system operation and

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 on site approach of the **physical water infrastructure** (canals and networks) and introduces **service oriented management** as a normal practice.

The participants of the NENA workshop analyze the performance of irrigation systems on the ground

The **Rapid Appraisal Process** (RAP) for irrigation projects is a 1-2 week process of collection and analysis of data both in the office and in the field. The process examines external inputs such as water supplies, and outputs such as water destinations (ET, surface runoff, etc.). It provides a systematic examination of the hardware and processes used to convey and distribute water internally to all levels within the project (from the source to the fields). External indicators and internal indicators are developed to provide (i) a baseline of information for comparison against future performance after modernization, (ii) benchmarking for comparison against other irrigation projects, and (iii) a basis for making specific recommendations for modernization and improvement of water delivery service.



AquaCrop practical classes in Leuven

AquaCrop theoretical classes in Leuven

Group picture of participants, organizers and trainers

management and it focused on the application of 7 selected irrigation systems in the NENA region (Morocco, Syria, Egypt, Jordan, Iran, Tunisia and Lebanon) emphasizing on both the commonalities and the differences of the lessons learnt on these systems.

Increased capacity to enhance water productivity in agriculture

Improving water productivity requires an increase in crop yields, which can be obtained by changing crop, soil and water management. In rainfed agriculture, bridging crop water deficits during dry spells through supplementary irrigation stabilizes production and increases water productivity dramatically. In irrigated agriculture, water productivity can be increased by reducing water losses from drainage, seepage and non-productive evaporation. Another possibility to increase water productivity in agriculture is the re-use of treated wastewater for irrigation.

In July 2012, an AquaCrop workshop was organized by FAO, the Department of Earth and Environmental Sciences of the KU Leuven University and the Graduate School on Environmental sciences, Technologies and Management (ENVITAM), in Leuven, Belgium. 27 Participants from 12 countries (Algeria, Belgium, Burundi, Democratic Republic of Congo, Ethiopia, Greece, Iran, Italy, Jordan, Lebanon, Tanzania and Uganda) attended the 5-day workshop. The participants ranged from lecturers and PhD students from the KU Leuven, Ghent and Louvain La Neuve Universities (Belgium), as well

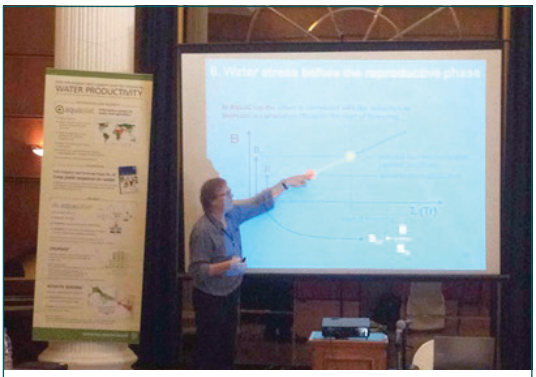
as PhD students from Italy, staff from FAO, and members from FAO projects at Lebanon and Jordan.

Another workshop on 'Capacity development for farm management strategies to improve crop-water productivity using AquaCrop' was held at the Riviera Hotel in Beirut from 27th May to 31st May 2013. The training was given by Dr. Dirk Raes, Professor at the Faculty of Bioscience Engineering (University of Leuven) and the Lebanese Agriculture Research Institute (LARI). In total, 25 professionals from various institutes, organizations and research institutes participated in workshop.

The main objective of the workshop was to build local capacity through the application of FAO crop-model in order to develop participants' skills in strategic farm management toward increasing crop-water productivity in Lebanon. 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.

Two case studies were developed and discussed in order to apply the topic presented by the consultants in the theoretical sessions:

1. Yield prediction under climate change for two strategic crops wheat and potato, grown in the central Bekaa plain; and
2. Assessing irrigation requirements of crops grown in Marjayoun plain that benefit from the Dardara spring.



Theoretical session

Distribution of certificates at the closing ceremony

Group picture of participants, organizers and trainers

Results of the AquaCrop application: Yield prediction under climate change for two strategic crops wheat and potato, grown in the central Bekaa plain

The AquaCrop model was tested for the first time under the semi-arid conditions of the Bekaa Valley of Lebanon, located between 850 m and 1000 m above sea level. In the Bekaa valley, improving the efficient use of available water is a strategic line to address the issue of water shortage. Water is by far the major constraint to crop production because rainfall is extremely irregular and it is concentrated during winter months. Moreover, high temperature and evapotranspiration rates, in combination with limited water storage capacity of soils during winter, reduce water availability for crops during summer time.

In addition, climate change projections for Lebanon indicate that the Bekaa region will experience the highest rates of temperature rise, precipitation decrease and humidity decrease as compared to the rest of the country. This region, home of some of Lebanon's most vulnerable population whose source of livelihood comes from agriculture and on which Lebanon's food security depends, will be significantly affected.

Wheat and potato are two strategic crops for Lebanon. According to the recent Agricultural Census (2010), wheat constitutes almost 70% of the area cropped with cereals in Lebanon and most of the cultivated lands are in the Bekaa Valley that account for 54% of the total wheat area. Similarly, potato crop is mostly grown in the Bekaa representing 71% of the total cropped area.

AquaCrop was evaluated for its performance for each crop separately by modeling each treatment within each growing season. It was concluded that AquaCrop model is a valid model for wheat and potato production under the semi-arid conditions of the Central plains of Bekaa valley.

AquaCrop model was applied under different scenarios of climate change in order to predict crop yields in the near and far future and test possible adaptation measures to the impact of climate change on wheat and potato systems under the dry and hot conditions of the central plains of Bekaa Valley. There are several uncertainties concerning the climatic data generated from PRECIS climate model simulation that were used as input to AquaCrop.

Safe solutions for the re-use of treated wastewater for irrigation

A regional capacity building workshop on the safe use of treated wastewater and good agricultural practices was held at the LARI Institute in Bekaa area from 26th May to 28st May 2014. The training was given by Marie Therese Abi Saab, LARI Researcher, Dr. Musa Nimah and Dr. Issam Bashour, both from the American University of Beirut. In total, 20 farmers and extension service staff from the Bekaa Region participated in training.

The four themes and outputs of the training were:

Themes	Outputs
1. Safe use of treated wastewater	Understand wastewater treatment procedure as well as different issues related to the safe reuse of treated effluent.
2. Good irrigation practices	Learn how to irrigate with treated wastewater and how to adopt good agricultural practices.
3. Soil fertility management	Understand how to add fertilizers and manage their soil.
4. Field visit	Observe the wastewater treatment process and the irrigated area downstream the plant.

During the training farmers received theoretical input from FAO, LARI and AUB

Dissemination material was distributed among the farmers

Country specific output: Lebanon

The reuse of treated wastewater for agriculture from the Iaat Wastewater Treatment Plant, Bekaa Valley, Lebanon

When there is a lack of water for agriculture, many urban and peri-urban farmers find alternative solutions, such as, the use of wastewater. That is precisely what farmers are doing in the Beqaa valley, the most important farming region in Lebanon.

There are many compelling reasons why farmers use wastewater for irrigation. Firstly, it is a reliable supply of water that allows them to irrigate their crops throughout the year. Secondly, it also contains nutrients that can improve crop growth and lead to higher productivity. Lastly, it is often the only water available, so they have no other choice.

But there are also risks associated with the use of wastewater, especially if it is applied directly and untreated. Wastewater can be heavily contaminated with pollutants and disease-causing organisms that are harmful for farmers, consumers and the environment. Therefore, it is important for farmers to be aware of the health-risks associated with the use of wastewater for irrigation and to know which measures should be taken to reduce these risks.

Wastewater reuse in agriculture presents both technical and institutional challenges which need to be addressed to optimize use of such water for irrigation. One of the important measures is to use wastewater that has been treated properly by sewage treatment plants.

The beginning of the project

The kickoff of the pilot project began in November 2011 with an inception workshop, organized by FAO in collaboration with the Ministry of Agriculture to introduce the project, activities and coordination structure to all stakeholders and also decide in the pilot area.

A Project Steering Committee (PSC), composed of members of different Ministry departments involved in the project, farmers, the private sector, FAO experts and all authority levels, going from national to local actors was established. The PSC's role is to coordinate and ensure timely government inputs from all national parties involved in the implementation of the project. A National Project Coordinator was assigned by the Ministry of Agriculture and entrusted with the overall day-to-day responsibility for the implementation of the project, as well as for mobilizing the PSC and acting as its secretary.

Wastewater guidelines in Lebanon

From 2009 to 2011, FAO, through a project addressing wastewater reuse and sludge, assisted the Lebanese government in the development of guidelines and in building national capacities so as to maximize the benefits and minimize the risks of the re-use of treated effluent and sludge. The project focussed mainly on the development of guidelines on how to treat the waste water to produce a safe effluent. However, the treated wastewater is also a relevant source of water for agriculture that is currently not used in an optimal way.

Table 1 - Lebanese guideline for wastewater reuse (FAO, 2011)

Class	I	II	III
Restrictions	Produce eaten cooked; irrigation of greens with public access	Fruit trees, irrigation of greens and with limited public access; impoundments with no public water contact	Cereals, oil plants, fiber and seed crops, canned crops, industrial crops, fruit trees (no sprinkler irrigation), nurseries, greens and wooden areas without public access
Proposed treatment	Secondary + filtration + desinfection	Secondary + storage or maturation ponds or infiltration percolation	Secondary + storage/oxidation ponds
BOD^5 (mg/L)	25	100	100
COD (mg/L)	125	250	250
TSS (mg/L)	60 (200 WSP)	200	200
pH	6 - 9	6 - 9	6 - 9
Residual Cl_2 (mg/L)	0.5 - 2	0.5	0.5
NO3-N (mg/L)	30	30	30
FC(/100ml)	<200	<1000	None required
Helminth eggs (/1L)	<1	<1	<1

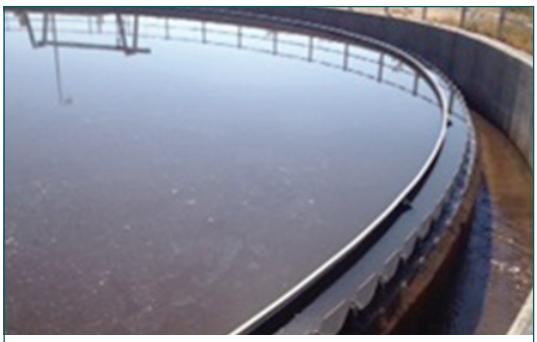
Note: Irrigation of vegetables eaten raw is not allowed

In addition, other government institutions involved in water resources management, such as the Lebanese Agricultural Research Institute (LARI) and the American University of Beirut, were also brought on board to collaborate in the research, monitoring and training part of the project.

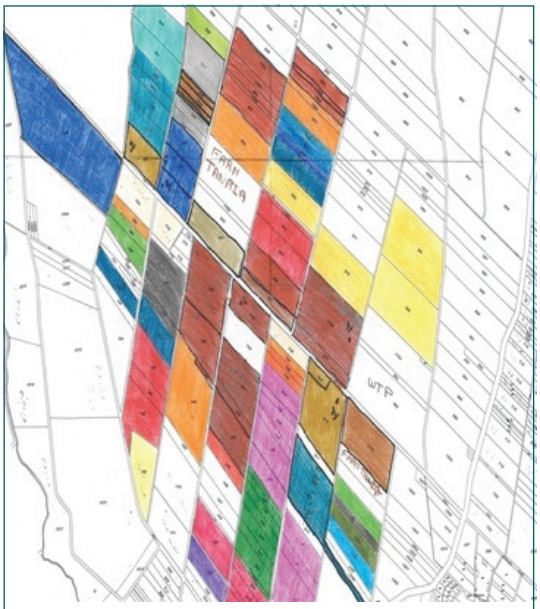
Selection of the pilot area

The PSC decided that the Iaat Wastewater Treatment Plant (WWTP) was the most adequate option among 15 different other possibilities within the Bekaa valley based on a selection of criteria (e.g. location; number of farmers; and capacity). The Iaat WWTP is a

The filtration phase in Iaat treatment plant



The settlement tank of the Iaat treatment Plant



Map of the farms surrounding Iaat wastewater treatment plant

secondary treatment plant with a design capacity of 12 000 m^3 inflow per day intended to serve a population of 88 000 inhabitants.

The wastewater flows by gravity through a sewer network of around 100 km from from five surrounding villages: Baalbeck, Iaat, Douris, Ain Bourdai, and Haouch Tell Safiyé. The plant was constructed in 2007 by the Council for development and reconstruction (CDR), with funds from the World Bank, and is managed by the Bekaa Water Establishment that has hired a private contractor Farhat Group to run it on a daily basis.

The water that reaches the Iaat WWTP varies according to season. In the winter 2012, due to heavy rains and road canalization directly linked to the treatment plant, it reaches values up to 16 500 m^3 per day, which is even more than the capacity of the treatment plant. In summer months, the inflow can reach below 1 000 m^3 per day because some farmers, when faced with water scarcity, break sewage lines to have direct access to raw wastewater.

Conducting a baseline study

A socioeconomic and agricultural baseline study was conducted with the objective to collect data on current livelihoods and agricultural practices, and gain a greater knowledge about the impacts of the use of treated wastewater among farmers in the project area. The household questionnaire consisted of 148 questions divided into five sections on: 1) household information; 2) Agriculture; 3) Treated wastewater use; 4) Labour; and 5) Income. In total, 45 households were visited by two enumerators in the village of Iaat, but only 22 agreed to fill the questionnaire. The visited households were selected and are representative only of the farms surrounding the Iaat Wastewater treatment plant.

Main conclusions of the baseline study:

Household Information	▪ The majority of all interviewees are married and the man is considered as head of the household (over 90 percent). ▪ The age range of the household head varies from 35 to 80 years and the average age is 54 years. ▪ 68% of the sample have primary education, 22% have secondary and tertiary education.
Agriculture	▪ Most of the farmers put into production all their land, the average area owned is 100.3 dunam (10.03 ha) and the average cultivated area is 97.8 dunam (9.78 ha). ▪ Due to the location of laat in the bekaa valley, in a very fertile area too many crops are cultivated in its lands especially vegetables and cereals. ▪ The farmers are following a crop rotation cycle is planned on 3 years basis out of which the first two years the farmers are growing winter crops (mainly Barley 64.4 % and Wheat 7.4%) and in the third year they are planting cash crops mainly potatoes 11.7% and onions 6.1 %. ▪ Barley is the most cultivated crop due to the fact that this crop is resistant to drought. ▪ The fresh water sources are very limited in the area and also it is very expensive to use it due to fact that the water comes from deep boreholes. ▪ 36% of the lands included in the studied sample are irrigated.
Treated wastewater use	▪ 23% of the farmers are already using treated wastewater for irrigating their fields and more than 90% of the remaining farmers are willing to use it in the future. ▪ Most of the interviewees stated that they want to use the treated waste water as an alternative source for irrigation to decrease their cost of production by decreasing the cost of pumping the underground water from borehole for irrigation. ▪ The main reasons for not using wastewater are health risks, colour and smell of wastewater. ▪ Most of the respondents report drought as the main problem affecting their water sources ▪ Also lowering of the groundwater table, power failures, and financial constraints are perceived as problematic ▪ Also the farmers using groundwater report the same problems as for other source but include competition and quarrels among users as well as contamination of the source.

Labour	▪ The main occupation of the household head is farming which represent nearly 90% of the sample.
Income	▪ Most farmers refused to answer any question related to their income.

Selection of the farmers

With the results obtained in the baseline study, six farmers for the pilot project were selected, with three using solely freshwater and the other three applying treated waste-water with total pilot area of 3.5 hectares (5 plots with an area of 0.5 ha each, one plot with an area of 1 ha). The selection of the pilot farmers and plots was based on the following criteria:

- Agriculture as main occupation;
- Willingness and enthusiasm to be part of the project;
- Demographic distribution of the laat;
- The location of farmers' plots (e.g. easy access for the follow-up and soil sampling; and sufficient distance between selected plots to eliminate the possibility of mixing freshwater and treated wastewater); and
- Availability of water (i.e. treated wastewater and freshwater).

Distribution of the selected plots, in blue irrigated with fresh water and in brown those irrigated with treated wastewater

The selected farmers were:

Farm	Farmer	Irrigation water	Size
Farm A	Mehdi Zeaiter	Freshwater	0.5 ha
Farm B	Joseph Hajj Moussa	Freshwater	0.5 ha
Farm C	Ali Abdel Sater	Freshwater	0.5 ha
Farm D	Faysal Abdel Sater	Treated wastewater	1 ha
Farm E	Jamal Abdel Sater	Treated wastewater	0.5 ha
Farm F	Saado Abdel Sater	Treated wastewater	0.5 ha

Monitoring the wastewater and soil

In collaboration with LARI and the AUB, the quality of both raw wastewater that arrived at Iaat Treatment Plant and the treated effluent to be used for irrigation by farmers in the region was monitored. Water samples of raw and treated wastewater (Inlet and Outlet of Iaat treatment plant) were collected on a two-week basis during an entire year and analyzed for physic-chemical parameters, pathogens and heavy metals. The obtained results confirmed that the treated water from Iaat WWTP is of category III as proposed by the Lebanese guidelines. However, this water could easily reach category II or I if well treated.

Although the treated wastewater from Iaat Plant is of category III, it is unrealistic to insist that vegetables cannot be grown there. Farmers in the region have been since a long time irrigating and growing vegetables even with untreated wastewater. Therefore the project integrated a livelihood-based approach focusing on farmers and emphasizing on how to provide them the necessary support and information on good irrigation practices in order to grow vegetables. As part of the project, an experimental trial was established in the premises of Iaat treatment plant for the use of treated effluent for vegetable production (Eggplant) that can be eaten cooked.

Non treated wastewater was also collected and tested

Different water samples were collected and brought back to the Laboratory

Soil samples were collected and analyzed from the 6 pilot fields that were irrigated with treated effluent and freshwater. Samples were taken before planting and after harvesting at 2 (two) different depths (0-15cm) and (15-30cm). All soil samples were analyzed for physic-chemical, heavy metals and nematodes levels.

Collection of soil samples

Numbering of soil samples

Crop Selection and new irrigation systems

Several meetings were held between the project experts and the farmers in order to select crops based on the following criteria:

- Respecting the proposed Lebanese treated wastewater re-use for irrigation purposes;
- Crops that farmers are familiar with; and
- Growing the same crop for all the farmers with the exception of one farm that cultivated poplar tree.

Based on the above criteria and on the water and soil analysis it was decided to grow the following crops mentioned in Table 2.

Table 2 - Selected crops for all the project length

Field	Fall 2012	Summer 2013	Fall 2013	Summer 2014
Farm A	Poplar trees	Poplar trees	Poplar trees	Poplar trees
Farm B	Barley	Sweet corn	Mixture Barley + vetch	Sweet corn
Farm C	Barley	Sweet corn	Mixture Barley + vetch	Sweet corn
Farm D	Barley	Sweet corn	Mixture Barley + vetch	Sweet corn
Farm E	Barley	Sweet corn	Mixture Barley + vetch	Sweet corn
Farm F	Barley	Sweet corn	Mixture Barley + vetch	Sweet corn

Farmers' needs were assessed to select the most suitable equipment according to the characteristics of each area. For each plot, new modern irrigation equipment was selected according to the mentioned crops and also adapted for the treated wastewater users (Table 3).

Table 3 - The irrigation equipment delivered to the farms

Fresh Water users	Treated wastewater users
Electrical generator	Pumping stations
Fertilizers injector	Fertilizers injector
Disc filters	Disc filters
Pressure Gauges	Pressure Gauges
Polyethylene pipes	Polyethylene pipes
In-line Drip Laterals	In-line Drip Laterals
Polyethylene compression fittings	Polyethylene compression fittings
Polyethylene fittings	Polyethylene fittings
	Sand filters

Disc filter and fertigation system

Sand filters

Drip lines

Drip lines

The delivery of the irrigation materials was done in accordance with a commitment signed by the farmer in the presence of representatives from the ministry of agriculture and the FAO.

Ali Abdel Sater signing the contract

Joseph Hajj Moussa signing

Planting and harvesting

Fall 2012

The sowing took place in the beginning of December. Approximately 25 kg of Barley were planted per dunum and using local variety named Baladi. The sowing was made using old agricultural techniques.

Sowing of Barley using old agricultural techniques, Fall 2012

Summer 2013

During this season the "no till technique" a new sowing techniques to laat's farmers was introduced. Specific agricultural machinery was rented from the American University of Beirut. The objective of introducing this new technique is to show to the farmers that the cost of plantation by minimizing the number of agricultural intervention and in this way they can have higher profit. The sowing took place on the 22nd of July 2013 .The used variety was Merkur origin from Hungary at a ratio of 1.4 kg/ dunum, in addition 30 Kg of fertilizer was added. The planted area was 5 dunums. The corn was not able to reach maturity stage due to the very low temperatures (reaching -10°C) in the Bekaa valley, described by Director of LARI as " unprecedented phenomenon" at this period of the year. The result of cold weather was that the total loss of the yield.

The sowing of corn using the no tillage technique, Summer 2013

Fall 2013	A mixture of barley (10 kg/*dunum*) and vetch (10 kg/*dunum*) was planted. The plantation took place on 27th of December 2013 and the planted area was 5 dunums.

Plantation of the Barley and Vetch, Fall 2013

Summer 2014	The plantation of the corn took place on the 22nd of June 2014 using the conservation agriculture technique of no tillage. 1.4 Kg of the same variety Merkur was sown and 30 Kg of Fertlizer was added. The planted area decreased to 1 dunum due to the fact that this year Lebanon passed by a drought period so the borehole yield decreased.

Working with researchers and farmers

This project encourages research cooperation between researchers from the American University of Beirut and the Lebanese Agricultural Research Institute (L.A.R.I). The researchers are actively involved in several activities of the project and are fostering on job training with farmers. As an example, farmers are working together with researchers to monitor and evaluate the use of different systems, crops and vegetables. This provides an interactive learning process for both sides and helps build a bridge between research and practice, through experience sharing.

Conducting innovative research: experimental trial on vegetable irrigation with treated wastewater

As part of the project LARI established an experimental trial in the premises of laat treatment plant to conduct a pioneering research in Lebanon on the potential use of treated effluent for vegetable of high value such as, Eggplant. The experiment was carried out to assess the response of drip irrigated eggplant grown under two water quality regimes (Freshwater and treated wastewater) and two agronomic practices (no mulch and use of plastic mulch). Experiment was carried out to investigate the effect of treated wastewater irrigation on eggplant yield and quality attributes and to check if the presence of plastic mulch could constitute a protection measure against the microbial contamination of fruits by preventing them from being in direct contact with irrigation water.
The study showed that an integrated planning approach that takes into account the technological aspects of the irrigation system as well as the production and contamination issues is essential for the safe irrigation of vegetable crops. The microbiological quality of the products also needs to be maintained. As suggested by the World Health Organization (WHO) in 2006, the levels of microbial contamination can be reduced by applying post-treatment health-protection control measures to reduce the risk of microbial contamination to acceptable levels.

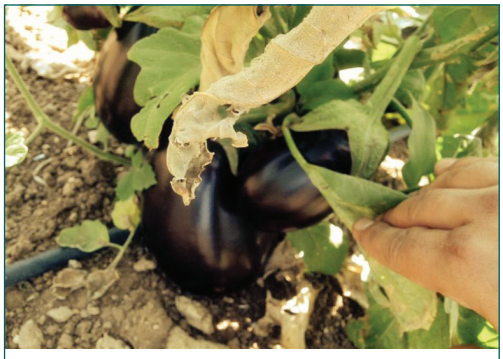
From the agronomical point of view, the study concluded that eggplant was grown successfully under treated wastewater, resulting in 19% yield increase when compared to yield from crops under fresh water irrigation. In addition that research indicated that several elements must be considered when treated wastewater is used in agriculture, including the presence of pathogens and chemical contaminants on the irrigated products as well as the impact of treated wastewater on soil properties and on the irrigation system equipment. Continued research and development will help improve and increase the use of treated wastewater for irrigation and will address the concerns of the general public. The results of this experiment will have a major influence regarding policies related to the use of treated wastewater for agricultural production in Lebanon.

Recommendations for farmers using treated wastewater for irrigation of Eggplant:

- Use sand media filter (gravel filter);
- Conduct analysis of soil once per year;
- Irrigate eggplant each 2 to 3 days not more than 20 mm;
- Wear protective clothes and gloves when dealing with low quality water;
- Allow at least one to two days, as a die-off period for bacteria, before sending harvested fruits to market; and
- Follow protective post-harvest measures as recommended by the WHO.

Experimental field in laat

Researcher and farmer working together to test the performance of emitters' system



Eggplant without mulch

Collected Eggplants at harvest time

In Lebanon there is still limited regulation on the reuse of wastewater for irrigation. FAO and the Ministry of Agriculture of Lebanon are working together with farmers on a pilot project on the reuse of treated wastewater for irrigation from the Iaat plant. The project is not only, focused on reducing risks and providing farmers with water, but also, actively involving them in the entire process.

The way forward

The project has helped improve the national, regional and local capacity to cope with water scarcity, as a result of an improved knowledge on how water is being used in the agricultural sector. The ultimate beneficiaries of the project were the communities of the Bekaa area, who benefited from development programme, the pilot project and interventions utilizing water for agriculture and more efficiently. Other direct beneficiaries were the government and water management institutions who benefited, through capacity strengthening, of an improved capacity to manage available water resources and wastewater.

Based on the lessons learned with the use of treated wastewater for irrigation at Iaat wastewater treatment plant the next step will be to replicate this project in other areas in Lebanon and benefit more farmers that are using or wish to use wastewater for agricultural purposes. The pioneering research developed within the context of this project will continue and support policy makers regarding the development of new policies and strategies on the reuse of wastewater for agriculture.

Project resume

Location	Beqaa Valley, Lebanon
Duration	March 2011 – March 2015
Donor	Government of Italy
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 ▪ Lack of information on reuse of wastewater for irrigation
Main objective	To strengthen national and regional capacities to cope with water scarcity in Lebanon
Objectives	▪ Increase knowledge in reuse of wastewater for irrigation ▪ Increase water productivity ▪ Improve use of treated wastewater for irrigation at Iaat WWTP
Direct Impact	Improved water management skills to cope with water scarcity for communities in project areas as well as government officials and institutions.
Indirect Impact	Educational institutions, NGOs, the private sector, UN agencies and donors will also benefit from strengthened capacities.
Budget	2 373 000$ USD
Contact	**Natural resources and environment department:** **Land and Water Division (AGL)** Maher Salman, Technical Adviser Maher.Salman@fao.org **FAO Lebanon** Maurice Emile Saade, FAO Representative Maurice.Saade@fao.org

Contact

Maher Salman, Technical Adviser
Maher.Salman@fao.org
Land and Water Division (AGL)
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

FAO Lebanon
Maurice Emile Saade, FAO Representative
Maurice.Saade@fao.org

DEVELOPMENT COOPERATION

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