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

Jordan
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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 Jordan 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:

Year 1
- Phase I: Conceptual framework
- Phase II: Country-level water audits
- Phase III: Strengthening national capacities

Year 2

Year 3

Year 4

Year 5

**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.
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 Jordan

Increased capacity for water demand management in irrigation systems

Water demand in irrigation schemes in Jordan 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 capacity building workshop in the use of RAP (Rapid Appraisal Performance of large collective irrigation networks) and MASSCOTE (MApping System and Services for Canal Operation Technologies) took place from the 23rd to 26th of September 2012 on the topic of “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 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.

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 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.
Increased capacity to enhance water productivity in agriculture

Improve 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 Landmark Hotel in Amman from 30th June to 4th July 2013. The training was given by Dr. Dirk Raes, Professor at the Faculty of Bioscience Engineering (University of Leuven) and the National Centre for Agricultural Research and Extension (NCARE). In total, 20 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 Jordan. 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. Concrete case studies were developed and discussed in order to apply the topic presented by the consultants in the theoretical sessions.
Country specific output: Jordan

Water harvesting development for agriculture – Support to farming community establishment and livestock production increase in Al-Hashimiyeh village, Al-Husayniyeh district, Ma’an Governorate, Jordan

Water scarcity in Jordan is a well-known and alarming problem. Increasing water scarcity is threatening the economic development and the stability of many parts of Jordan. Moreover, opportunities for the significant capture of new water are now limited. While gains in efficiency are potentially available from improved distribution and use of water in fully irrigated agriculture, a great proportion of the region’s agricultural livelihoods are based on dry land farming systems where production is dependent on low and extremely variable rainfall. To ensure food security and better livelihoods in these areas, more food should be produced with less water; this means increasing agricultural water productivity and improved water management technologies.

Water harvesting provides a means for making water more available to the plants in drier environments. Through controlled concentration of runoff into target areas, water harvesting increases water availability to plants, controls soil erosion, reduces the impact of drought and increases rainwater productivity.

Water Harvesting (WH) refers to the collection of rainfall for application to a cropping area, either stored in the soil profile for immediate uptake by the crop or stored in a reservoir for future productive use. The basic concept is to capture water falling on one part of the landscape, either on the farm or upstream, and redirect it to a storage mean. There are many forms of WH with some measures stemming from the local agricultural practice while others have been introduced from other regions or countries. WH yields best results when associated with agronomic practices and biological measures such as planting trees to stabilize the structures and to improve infiltration.

In recent years, low rainfall and successive drought waves in Jordan have jeopardized the livelihoods of many rural communities who depend on rainfed agriculture, especially livestock breeders. Currently livestock breeders travel all over the country in the search for enough feed and water for their animals. Livestock breeders are among the most vulnerable groups in the country and due to increased competition for available water resources it is becoming increasingly difficult to make a living out of their activities. Water harvesting structures like small check dams can give them more security with regard to drinking water for their animals and also help to irrigate fodder crops.
The project, therefore, aimed at contributing to the development of water harvesting in Jordan. In particular, it aimed at:

- **Develop** a fully operational pilot area, with appropriate water harvesting equipment for agricultural production in general and livestock production in particular, selected with the participation and contribution of beneficiary farmers, to be used for demonstration and training purposes.

- **Carry out** training program on water harvesting technology for capacity building of all stakeholders involved in the implementation and use of water harvesting schemes.

- **Prepare** a strategy framework for the development of water harvesting in the project region, to serve as input in the national water resources strategy and pilot for other regions.

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 Water Harvesting Directorate at 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.

In addition, other government institutions involved in water resources management, such as the National Centre for Agricultural Research and Extension (NCARE) and the Jordanian Hashemite Fund for Human Development (JOHUD), were also brought on board to conduct a number of activities and collaborate in the research, monitoring and training part of the project.

One of the project’s main activities was to implement an operational demonstration area with appropriate water harvesting equipment for agricultural production in general and livestock production. The main objectives of the project are:

- Increase capacity to enhance water productivity in Agriculture;
- Contribute to water harvesting development in Jordan (in Al-Hashimiyeh watershed);
- Increase households’ income to improve the quality of life, and enhance women’s participation in Al-Hashimiyeh village;
- Encourage families to adopt fodder production to cope with the deterioration of natural rangelands;
- Use water harvesting techniques for fodder production to cope with water scarcity; and
- Develop institutional capacity to improve water harvesting and farming skills.
The main activity was divided into eleven sub-activities:

1. Select the Pilot Area;
2. Conduct a baseline, socioeconomic need assessment studies and evaluation;
3. Support agriculture and water management cooperatives;
4. Conduct a hydrological study;
5. Conduct a biophysical characterization study;
6. Conduct a topographic study;
7. Prepare the land for the pilot area;
8. Design appropriate irrigation systems;
9. Purchase the materials and install the complete system;
10. Plant and promote zero tillage technique;
11. Maintain and increase the pond capacity; and
12. Conduct culturing seeds of green forage for households.

Selection of the pilot area

The PSC decided that the Al- Da’janiyeh Pond, which is located in Al-Husayniyeh District north to Ma’an Governorate was the most adequate option for the pilot project. Al-Husayniyeh district was selected in this project according to the following criteria:

- Existence of a water harvesting structure;
- High poverty rates;
- High vulnerability to climate change; and
- Natural grassland degradation that affects fodder availability.

Al-Husayniyeh district is located about 50 km north to the center of the Ma’an Governorate and has the total area of 9,306 Km². The province includes the following districts: Al-Husayniyeh, Al-Hashimiyeh, Prince Hashim Park, Prince Raghd Park, Al Fajij, Hadira, and Aniza.

Ma’an region is the largest governorate and one of the driest areas of Jordan, as temperature exceeds (42) ° C in summer and rainfall around 86 mm per year. These harsh climatic conditions provide little opportunities for short-term grazing, except where groundwater is available, which helps in the occurrence of pockets of irrigated agriculture. It is located at an elevation of 683 meters above sea level.
Conducting a baseline study

During the second half of 2012, the second sub-activity, a socioeconomic and agricultural baseline study and evaluation of Al-Hashimiyeh village was conducted with the objectives to recognize the socio-economic conditions within the village and all the related data and basic indicators and to identify the post-implementation effects of the project on the targeted groups through the various subsequent operations during the life of the project. The questionnaire covered a sample of 162 families which represented 39% of the overall families within the village. The village was divided into blocks and random sampling was applied in the selection of families within each block to avoid bias. The household questionnaire consisted of five sections on: household information; water use; agriculture; livestock; labour; and income. The study aimed to identify the basic data and indicators within the study area, including the following information: social aspects; water resources and their uses; agricultural production; livestock production; local institutional environment; jobs and employment patterns; and income rate and quality of life in the village.

Main conclusions of the baseline study:

<table>
<thead>
<tr>
<th>Household information</th>
<th>24.8% of heads of households have a secondary activity and 47.5% of them work in livestock breeding.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water use</td>
<td>None of the households received any training regarding water harvesting systems;</td>
</tr>
<tr>
<td></td>
<td>93% of respondents would use water harvesting in the future for fodder irrigation and livestock watering this result may be linked to the desire of families to benefit from the project to adapt water scarcity within the region; and</td>
</tr>
<tr>
<td></td>
<td>81% of families that want to use water harvesting are willing to contribute to the operating costs but the remaining families are not willing to do so due to extreme poverty.</td>
</tr>
<tr>
<td>Agriculture</td>
<td>18.6% of households that own livestock adopted nomadic life system, while 81.4% of them adopt a system of settling life style and have hungers for livestock around their houses; and</td>
</tr>
<tr>
<td></td>
<td>All households do not produce fodder such as barley, wheat bran, alfalfa or hay.</td>
</tr>
<tr>
<td>Labour</td>
<td>79% of households that own livestock use permanent family employment of women with an average of 1.65 women' employments per family and they do not pay them wages.</td>
</tr>
<tr>
<td>Income</td>
<td>The poverty rate in Al-Hashimiyeh village is 37% of the total households.</td>
</tr>
</tbody>
</table>
Based on data analysis, results, evaluation and discussion, the study team recommended the following:

- Al-Hashimiyeh village should be targeted by the ‘copying with water scarcity project’ due to their high vulnerability to climate change and high poverty rate.
- The project should focus on the production of fodder through the use of water harvesting and artesian wells to provide fodder throughout the year and decrease the load in natural pastures.
- The economic and financial feasibility study for the production of fodder using water harvesting techniques should estimate the actual cost of the project. This will ensure the positive economic effects of the project on families suffering from poverty.
- The project should use focus groups method to determine the criteria of families benefiting from the project and the form of the local institutional framework who will manage the system of water harvesting facilities and mechanisms to ensure sustainability and maintenance.
- Implement training programmes, at both level of families and community institutions regarding water harvesting techniques.

Engaging agriculture and livestock cooperative

On February 2012, a letter of agreement with Al Safra Cooperative was signed to establish a partnership with the farmers’ association and community in the area. In order to enhance the capacities of the cooperative, FAO and NCARE conducted an on-job training for some selected members of the farmers’ cooperative to carry out the irrigation and field practices. The aim of this training was to support the cooperative the transfer of management to users (ex: planting, irrigation and harvesting) so that farmers are able to manage the pilot area during and after the end of the project. After the termination of the project in 2015, the farmers’ cooperative will have the full control and management responsibility on the project site.

Under the supervision of NCARE and FAO, the trained farmers irrigated the area according to a fixed schedule, and field practices in the pilot area for the three crops...
grown (Barely, Vetches and Safflower). In addition, the trained farmers, under the super-
vision of NCARE staff, carried out the planting and harvesting process during the last
seasons 2013/14 and 2014/15.

Conducting a hydrological, biophysical and topographic studies

The third, fourth and fifth sub-activities consisted of conducting a Hydrological, Biophys-
cical and Topographic studies of the selected site. The full Hydrological Study contained
information on precipitation, runoff volumes and topography of the area and runoff
volumes. Regarding the biophysical characterization two profiles have been investigated
and tested in the Area: Al- Da’janiyeh Pond and Al-Hashimiyeh Dam.
Jordan is characterized by severe weather conditions, therefore, great temporal and spatial variations in rainfall, runoff and evaporation amounts are expected. Water harvesting has been practiced in Jordan throughout history for both irrigation and household purposes. The study area was divided into three catchments and hydrologic parameters for the targeted catchments and the estimated runoff volumes calculated were:

<table>
<thead>
<tr>
<th>Catchment number</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment area (km$^2$)</td>
<td>46.7</td>
<td>60.03</td>
<td>17.1</td>
</tr>
<tr>
<td>Highest elevation (m)</td>
<td>1300</td>
<td>1334.6</td>
<td>1164.3</td>
</tr>
<tr>
<td>Lowest elevation (m)</td>
<td>1122</td>
<td>1224.9</td>
<td>1107.8</td>
</tr>
<tr>
<td>Average elevation (m)</td>
<td>1211</td>
<td>1279.7</td>
<td>1136</td>
</tr>
<tr>
<td>Average slope (%)</td>
<td>3.6</td>
<td>6.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Average rainfall (mm)</td>
<td>211.5</td>
<td>200</td>
<td>162.5</td>
</tr>
<tr>
<td>Runoff volume (MCM) infiltration rate</td>
<td>1.21</td>
<td>1.48</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Regarding the biophysical characterization, two profiles were investigated and tested in the pilot area: Al- Da’janiyeh pond and Al-Hashimiyeh dam.
The results of the biophysical characterization are resumed in the following table:

| Soil properties and units | A total of 51 soil samples were collected for chemical analysis such as: pH, salinity, organic matter content, total calcium carbonate, sodium percent, exchangeable sodium percent and sodium absorption ratio. The physical soil properties investigated included infiltration rate, bulk density, and water holding capacity. The two sites (Al- Da’janiyeh, and Al-Hashimiyeh) were visited and with several testing and sampling points selected. Soil core samples (13 soil samples) with undisturbed soil were collected from different points covering the two sites and later taken to the laboratory for bulk density and water holding capacity analysis. |
| Water analysis | Two water samples were collected from Al- Da’janiyeh Hafeer and Al-Hashimiyeh Dam. |
| Geology | Parent material is primarily Alluvium derived from limestone associated with chert. |
| Relief | The topography of the study area is gently sloping flow filed with very stony and gravelly surface and thin Aeolian deposition with a slope of 1 to 10 %, and altitude of 950 to 1250 meter above sea level. |
| Vegetation and Land use | The blocks are aridic. The pilot area has a low density cover of Artemisia, ‘Ado’ and ‘Hamd’, but the eastern areas are bare without any vegetation. Rainfall varies from 50 to 150 mm. |
| Topography | An area of about 140 Donums around the Pond was selected and delineated, and all the surrounding targeted plots were delineated and surveyed. A detailed map for the whole area includes contour terraces and basins was prepared. |

Preparing the land of the pilot area and designing the irrigation systems

An area of about 140 Donums (14 ha) around the pond was selected and delineated, and all the surrounding targeted plots were delineated and surveyed. A detailed map for the whole area including contour terraces and basins was prepared. Based on the detailed topographic study, the land preparation and levelling works over the delineated area around was conducted and level-basin terraces were constructed.

After the completion of the land preparation process, detailed survey maps with the irrigation system for the whole area were designed accompanied with the table specifying the necessary materials quantities and costs.
Purchasing the materials and installing the complete system

Based on the irrigation system design and bill of quantities presented by the irrigation expert, FAO called for tenders to purchase the required equipment for the irrigation networks and the best offers were chosen by an official joint committee. All the materials were bought from the different contractors and the irrigation system was fully installed, the official joint committee operated and tested the installed irrigation system, and fully checked: the pumping system; the pressure of water line by line (main, sub main and lateral) until the most far points; and the valves among all lines and other finishes. The committee concluded that the installed irrigation system was in accordance with the conditions and plans submitted to the contractor, and the system was operating adequately.
Planting and promoting the zero tillage technique

The crop selection for the pilot area took into consideration the suitability, sustainability and available varieties of the crops in Jordan. The selected crops to be planted in area equivalent to 100 Donums (10 ha) during three seasons were: Barely, Vetch and Safflower.

Based on the expert’s report, the prepared basins were planted with 800 kg of seeds included:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Quantity</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barely</td>
<td>600 kg of three different local types</td>
<td>75 donums</td>
</tr>
<tr>
<td>Vetch</td>
<td>100 kg</td>
<td>12.5 donums</td>
</tr>
<tr>
<td>Safflower</td>
<td>100 kg</td>
<td>12.5 donums</td>
</tr>
</tbody>
</table>

For the harvesting in season 2013/14, hired labor (which included members of the cooperative including females) harvested the Barley. After threshing, the Barley collected was considered of low productivity. The reasons for the low productivity were: a long dry period; low soil fertility; and lack of fertilizers.
As for the Vetch crop, the late heavy rainfall events during the month of May 2014 and the resultant floods affected the crop that was in the harvesting stage. Together with the cooperative, it was decided to leave the Vetch without harvest so that the seeds would be in the ground for the coming season. The harvesting of the Safflower crop occurred at the end of July 2014.

During the plantation of the season 2014/2015, different measures were taken to overcome the problems and obstacles mentioned in the earlier season, such as: the improvement of the levelling of the land in some locations to improve water distribution; deep ploughing of the soil to prepare a good seed bed for the Barley; the addition of an appropriate dose of fertilizer during the planting of Barley; and addition of manure to improve soil quality.

Land preparation started at the end of October and the beginning of November 2014. The levelling of certain areas was also done to ensure better water distribution within the planted plots. Both the chemical and organic fertilizers were added to the planted area prior to planting and the soil was ploughed for the second time just to incorporate the fertilizers.

In the 2014/2015 season, the system will be operated in a better way to supplement the rainfall at the location, thus, avoiding long dry periods, and will be in better amounts since the full volume of water from the pond will be utilized and the soil fertility will be improved using fertilizers.
Maintenance and increasing the pond capacity

Full maintenance work was carried out in the second half of 2014. The work included:

1) Removal of sediments and full cleaning of the cement pond;
2) Rehabilitation of the damaged front and back walls of the pond and the entrance cement canal of the pond;
3) Construction of a shelter for the installed pump; and
4) Restoration and adjustment of the spillway of the pond.

Conduct culturing seeds of green forage for households in Al-Hashimiyeh village

The idea of conducting the experiment of culturing seeds of green forage for households in Al-Hashimiyeh village came as a result of the actual need of farmers for green fodder to feed their animals all year round, and due to the lack of agricultural land in the area. Due to rainfall scarcity, scarce natural pastures and climate change, there is a clear need to find appropriate solutions for the farmers. As a result, FAO collaborated with agricultural associations and individual livestock breeders that aimed to teach and train the farmers on this new technique to ensure a balanced supply of green fodder all the year round.
Based on the results of socio-economic study that was conducted in 2012, and in cooperation with the local community, several nominated houses in different zones in Al-Hashimiyeh village were interviewed and investigated. A list of sixteen beneficiary households was created based on the following criteria: poverty and low income; acceptance and willingness to operate and follow up the installed system; availability of place, space and light; and social aspects (balance in the selection between the main two big families).

The benefits of culturing green fodder:
- The increase in green weight of the crop;
- The increase of the quality of protein;
- The high level of protein, essential fatty acids, vitamins and antioxidants;
- The Reduction of Anti-Nutritional Factors.
- The increase Plant Enzyme content.
- The increase of coefficient of digestive of poor diets.

In each selected house a full unit was installed in the proper space, a general presentation and training on operation and maintenance of the system was carried out with the attendance of all the beneficiaries. In addition, each household received 500 kg of fodder and was taught separately during the installation of each single unit. A periodical check out and follow up for the installed units was carried out by the specialized NCARE staff.

FAO and NCARE staff looked for the perfect location of each unit
The farmers learned how to prepare each tray with culturing seeds of green forage
The removal of green forage from the tray

The installation of a unit in one of the households

Women and children of each household also learned about the management of the unit

The livestock benefits from the higher quality of green forage
Develop a public awareness and training program on water harvesting

One of the project’s main activities was to develop a training program on water harvesting technology for capacity building of all stakeholders involved in the implementation and use of water harvesting schemes. The main activity was divided into four sub-activities:

1. Assess the level and capacity needs of the target stakeholders related to water harvesting aspects and irrigation design and scheduling;
2. Design a training program;
3. Conduct training programs; and
4. Conduct an awareness campaign.

The first sub-activity of assessing the level and capacity needs of the target stakeholders related to water harvesting aspect and irrigation design and scheduling was achieved through the socioeconomic baseline study and several meetings with the Al-Safra Cooperative at Al-Husayniyeh district. Based on the identified needs, a training program was designed and conducted by the Jordanian Hashemite Fund for Human Development (JOHUD) from November 2013 until January 2014. JOHUD worked in close collaboration with FAO and the Country Project Coordination Unit. The target group was 25 members of Al-Safra Cooperative at Al-Husayniyeh district Cooperative and the training program focused on:

<table>
<thead>
<tr>
<th>Type of skills</th>
<th>Duration</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>soft skills for project management</td>
<td>3 days</td>
<td>bookkeeping, project planning, and leadership skills</td>
</tr>
<tr>
<td>technical skills for water management</td>
<td>5 days</td>
<td>irrigation techniques and scheduling, crop water requirements, maintenance of excavated dams, and on farm practices</td>
</tr>
</tbody>
</table>

As part of the fourth sub-activity which focused on an awareness campaign, the last training day included a field visit to the Project Pilot Area, in order for the participants to observe and learn how to manage the Al-Dajaniyeh Pond and the equipped area with the fully installed irrigation system.
Practical session I
Group picture of participants, organizers and trainers
Contributing for the development of a sub-sector strategy for water harvesting

Water harvesting has greater potential to contribute to agriculture in Jordan than what is currently being achieved. While water harvesting has been practiced in the country for centuries, modern development of water harvesting has been ad hoc. As noted in both Jordan’s Agricultural Strategy and National Environment Strategy, there is no integrated national plan to make greater use of water harvesting for supplemental irrigation – despite the additional water that it can contribute. A sub-sector strategy for water harvesting is needed to ensure the continued development of this alternative in a way that is effective and sustainable.

As a result, one of the main activities of the project was to contribute to a sub-strategy for the development of water harvesting, to serve as input in the national water resources strategy. The main activity was divided into five sub-activities:

1. Review and evaluate previous strategies;
2. Identify the policy gaps and develop policy options;
3. Discuss and test policy options with stakeholders;
4. Develop the sub-strategy framework; and
5. Validate the sub-strategy framework.

The first sub-activity consisted of reviewing and evaluating previous strategies, and led to an in-depth assessment of the current status of water harvesting sector in Jordan, with a focus on the Al-Mafraq region. This assessment will subsequently serve as an important input into the development of a sub-sector strategy for water harvesting and pilot for other regions.

As first step of the assessment process, FAO collected available national water harvesting data online and on the ground during the entire year of 2012. This involved, a comprehensive review of all data and publications relating to water harvesting in Jordan, produced by governmental agencies, national universities, national research institutes, and international organizations.

Based on the revision of the different national strategies and the existing data, a database was constructed to capture the main characteristics of water harvesting structures in Jordan (ex: name, coordinates, design capacity, current capacity, water use, construction material, height, estimated sediments, cost of construction, year of construction, and expected potential).
Subsequently, FAO collaborated with the Jordanian Ministry of Agriculture (MoA), Ministry of Water and Irrigation (MWI), Natural Resources Authority, Jordan Valley Authority (JVA), and local municipalities in order to fill in any data gaps and add relevant information. Data on the other criteria (e.g., relating to water supply, water demand, and contribution to agriculture) were collected from a wide variety of governmental sources.

The data collected for the various criteria were subsequently represented in Geographical Information System (GIS) maps. GIS techniques are useful for such a sub-sectoral assessment, due to their capabilities for storing, analyzing and displaying spatially distributed data according to user defined specifications. They allow for a broad overview of the important characteristics of the existing water harvesting sub-sector.

A GIS file was created based on the database developed by FAO in cooperation with MoA and JVA. A total of 347 out of 362 existing and future water harvesting structures have defined coordinates that were able to be mapped. The linking of the mapped sites to the database allows for easy editing and updating as soon as any new data becomes available.

**Conclusions drawn from Al Mafraq**

Considering the selected example from the Al-Mafraq governorate, a number of initial conclusions can be drawn based on the data available. The distribution of water harvesting structures relative to rainfall variability suggests that in areas where precipitation makes water harvesting feasible, such structures are preferred to groundwater wells. Alternatively, it may be that the official abstraction limit for groundwater has been reached for this area, and that no new wells can be built – meaning that water harvesting provides an essential alternative water source. A comparison of the existing and planned water harvesting structures relative to the distribution of wadis suggests that perhaps the planning of water harvesting structures has improved in recent years, as the future planned structures are located in places that are more efficient for capturing scarce rainfall and/or preventing erosion (compared to those constructed in the past).
Population density in the selected area is low, suggesting a primarily nomadic population reliant on water harvesting to support livestock production. With respect to land use, the data shows that there is potential to expand cultivation in the areas surround water harvesting structures in the sample area. Given that the structures will mostly be empty during the warmest months when irrigation is most needed, they could instead provide supplemental irrigation for winter crops – as has been tested in the pilot for the “Coping with Water Scarcity” project. Water harvesting could be particularly useful for supporting the cultivation of fodder crops, given the existing importance of livestock in the area.

Conclusions drawn from the assessment report

The assessment describes the rationale for further investment in the water harvesting sub-sector in Jordan, in particular through the development of a sub-sectoral strategy. It provides an overview of the data available for assessing the water harvesting sub-sector, and an example of how this might be done at the sub-national level. The assessment was undertaken based on a set of criteria relating to supply and demand for harvested water. The report is intended to provide the basis for the development of a sub-sector strategy on water harvesting. However, several factors must be taken into consideration in developing such a strategy. These are:

Land rights

The impact of the allocation of land rights on the location and use of water harvesting structures. The land tenure system can influence the success of water harvesting in various ways. If land rights are unclear, farmers may be unwilling to invest in water harvesting structures on land that they do not formally own; the same may also be true for communal or state-owned land. The land tenure system in Jordan is complex. There are three main types of land tenure: private ownership (land that is registered and documented), tribal ownership (historically distributed by the sheikhs), and state land (free access to resources). There is often overlap and a lack of clarity between state land and customary tribal systems, frequently leading to unsustainable land use practices; there is also substantial fragmentation of land rights over subsequent generations. Land rights cannot be measured using a simple indicator such as those shown in the proposed matrix. Nonetheless, the land tenure regime, both formal and informal, must be taken into consideration when designing a national sub-sector water harvesting strategy for Jordan.
Equity issues
As with any development strategy, the national sub-sector strategy on water harvesting should ensure that the promotion of this approach is not particularly advantageous to one group of people while excluding others. To some extent, the indicator on poverty levels allows for an assessment of those areas where the need for water harvesting is the greatest. Due consideration should be given to equity issues, particularly given that while state law in Jordan does not differentiate between men and women in terms of rights to natural resources, customary law typically does not allow for women to have ownership or use rights over land or water.

Other physical features
The assessment has not considered all physical features that may be relevant to the future direction of the water harvesting strategy: partly because the assessment does not seek to determine site selection for water harvesting structures, but also due to a lack of data. Other features that could be considered in future analysis are temporal rainfall variability (rather than only spatial), slope gradients, and the soil profile.

Water tariffs
The question of water tariffs – Jordan’s National Water Strategy envisages the introduction of appropriate water tariffs in order to promote water efficiency in irrigation. The more rigorous application of tariffs to irrigation water particularly that sourced from groundwater may create incentives to invest more in water harvesting.

The second sub-activity consisted of identifying the policy gaps and developing policy options, were consulted with different stakeholders to agree on specific methodology in which water harvesting can complement existing strategies, in particular the new Agricultural Strategy. Based on the results of the stakeholder consultation were incorporated into a final assessment report that was published in June 2014.

The third sub-activity consisted of discussing and testing policy options with stakeholders from different backgrounds and institutions through a workshop on water harvesting in Jordan that was held in Amman on 25 November 2013. The stakeholders that participated were:

| Government                              | Ministry of agriculture |
|                                        | Ministry of Water and Irrigation |
|                                        | Jordan Valley Authority (JVA) |
|                                        | Ministry of Environment |
|                                        | National Center for Agricultural Research and Extension (NCARE) |
| Civil Society                          | Jordanian Hashemite Fund for Human Development (JOHUD) |
|                                        | Farmers Cooperative (AL-Safra) |
| Donors                              | United States Agency for International Development (USAID) |
|                                    | Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) |
|                                    | World Bank (WB)                                             |
|                                    | French Development Agency (AFD)                             |
| Universities                       | University of Jordan                                        |
|                                    | Al al-Bayt University                                        |
|                                    | The Hashemite University                                    |
| Others                             | International Center for Agricultural Research in the Dry Areas (ICARDA) |

The presentations and discussions of the workshop covered the following topics:

1) Overview of agriculture, energy and water strategies in Jordan;
2) Presentation of Water Harvesting assessment report and the proposal for national WH sub-sector strategy;
3) Overview of data collection and compilation;
4) Set of criteria for assessment;
5) Results (including some map examples);
6) Setting the foundation for the strategy and the validation of the proposed criteria;
7) Brief recapitulation of the indicators and Summary of conclusions;
8) Brief overview of gaps and needs;
9) Discussion of the inclusion of socio-economic considerations in the strategy;
10) Summary of conclusions; and
11) Next steps for strategy framework setting.
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 Al-Hashimiyeh 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.

The project contributed to the development and validation of a water harvesting sub-strategy for Jordan. The strategy will contribute to the achievement of a number of existing national strategies relating to water, agriculture, environmental management and desertification, and will complement in particular the new Agricultural Strategy for 2014-2020. The next step for development of the sub-sector strategy is to form a steering committee to lead the drafting process, and an agreed workplan. The drafting of the strategy will be led by the Government of Jordan with inputs from FAO and other stakeholders as appropriate.
## Project resume

<table>
<thead>
<tr>
<th>Location</th>
<th>Al-Hashimiyyeh area, Ma'an Governorate, Jordan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>March 2011 – March 2015</td>
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<tr>
<td>Donor</td>
<td>Government of Italy</td>
</tr>
<tr>
<td>Executing Agency</td>
<td>Food and Agriculture Organization of the United Nations (FAO)</td>
</tr>
</tbody>
</table>

### Problems
- Water scarce country
- Lack of capacities at national and regional level to cope with water scarcity
- Lack of information on water harvesting techniques and management

### Main objective
To strengthen national and regional capacities to cope with water scarcity in Jordan

### Objectives
- Increase water productivity
- Contribute to water harvesting development in Jordan
- Implement an operational demonstration area with appropriate water harvesting equipment for agricultural production in general and livestock production
- Develop a public awareness and training program on water harvesting technology for capacity building of all stakeholders

### 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

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