# TECHNICAL REPORT
# Optimization of on farm irrigation management

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## Introduction

The IrWa project (Improvement of Irrigation Management in Lebanon and Jordan) started in 2003, under the framework of the MEDA Water Programme, with the main objective of increasing crop production and farmer income in Lebanon and Jordan.
The MEDA Water Programme is part of the European Union support for the improvement of water management in Middle East and North African (MENA) countries through coo-operation between non-profit organizations from EU and countries MENA countries.

In the Jordan Valley the main activities of the project, in collaboration with the NCARE (National Centre for Agricultural Research and Extension), aimed at improving irrigation management at on-farm level, adopting an approach based on multiple components, including financial support to the improvement of farm assets and technical assistance for the management of fertilization and irrigation. Starting from the technical problems identified in the field, the project built a Pilot Extension Service to tackle two major topics: irrigation and fertilization practices.

The aim of this document is to present the grassroots approach developed by the project; from the field problematic to the extension agent capacity building and management.

## A STEP BY STEP APPROACH

### 1. ASSESSMENT OF TECHNICAL CONSTRAINS

30 farms in Jordan Valley were assessed by IrWa staff through open and close questionnaires and field measurements to identify critical points for improvement of irrigation and fertilization. These farms were selected by NCARE extension agents from three different regions in Jordan Valley: the northern part (Al Kraemeh), the middle (Ghor Kabed) and the southern part (Al Karamah) and were representative of the whole regional situation[1].

#### *1.1. Improper irrigation practices*

Despite the national water shortage, little attention is paid by the farmers to irrigation scheduling and irrigation management (e.g. none of the interviewed farmers could give reliable figures about their own consumption). Improper operation and maintenance

[1] Vegetable growers using open field and green houses, with a growing season starting from August/September and ending by May/June

practices, poor irrigation design and infective filtration systems induce critical financial losses for Jordanian farmers. This result in yield decrease due to the uneven water distribution, and production cost increase due to clogging problems (labour cost and material renewal). The evaluation of irrigation system uniformity, using the Low-Quarter Method, confirmed the previous observations. The uniformity coefficient, in fact, varied between 20.9% and 75%, which is low considering that most references present 80% as the minimum acceptable figure.

*1.2. A fertilization management based exclusively on empiric observations*

Farmers usually do not use any soil analysis to design their fertilization management planning and depend only on their own experience. The amount of fertilizer is fixed per area and per crop which results in excessive use of fertilizers. Fertilizer injection is done through the main pump, in a very short period of time, and without any control of the fertigation solution quality (EC and pH), producing an significant efficiency lost.

The analysis of soil samplings confirmed the existence of over fertilization, as a very high quantity of available N, P and K was found[2]. Additional field analysis using NITRACHEK tool displayed an excessive amount of $NO^3$ in the soil and in crop sap[3]. High soil and water EC were found in Karamah region, where treated mixed waste water is used, compared to the north of the Jordan Valley irrigated with the fresh water from Yarmouk River.

Soil pH is usually above 7.2 and should be reduced to improve element uptakes by the plant. Farmers mainly use organic matter (chicken manure / mixed chicken sheep / sheep / cow) to ameliorate soil structure without taking into account the elements provided through mineralization (N specially).

*1.3. Filtration*

Cheap screen filter is the most commonly adopted filtration system, but it has two disadvantages: the mesh is too large and it is easily damaged during manipulation. On the contrary, disc filters, much less frequently distributed in the Jordan Valley, are well adapted to rustic field conditions, easy to clean, cheap and functional with precise mesh size.

The traditional horizontal sand filter, with its current coarse media and improper design, does not prevent dripper clogging. Indeed, the bottom diffuser isn't suitable to uniformly back-flush the sand bed. The back-flushing water will clean vertically the central layer of sand only and not the layers closer to the curved container walls, resulting in bad back flushing (media is stuck on the side of the filter). In addition the media used is always oversized, which reduces the filtration capacity. Finally the low profile of the maintenance (no pressure gauge, no calibration of the filters…) may also increase the clogging problem.

[2] The fertilization assessment was based on data collected in the "Mémento fertilisation des cultures légumières" published by the French research station Ctifl (Centre technique interprofessionnel des fruits et légumes)

[3] Tomato, pepper and eggplant sap were interpreted according to the PILazo methodology

## 2. DEFINITION OF THE TECHNICAL PACKAGE

The following elements were considered, for the elaboration of the technical package to be proposed to the farmers:

*2.1. Irrigation system design*

- Use of EPANET software to optimize irrigation network design and management, with training of local engineers and extension agents.
- Use of PROSONIC tool to calculate the pump curve when old material without any reference is used.
- Enhancement of farmer operation and maintenance practices through training and field visits, paying special attention to fertilization injection that induces pipe clogging in the case of improper filtration system.

*2.1. Appropriate filtration and fertigation system*

*Vertical sand filters*

To address this problem MREA has developed, in collaboration with the Association Canal de Provence (ACP) a vertical sand filter which fits the filtration requirements of a pressurized system in the Jordan Valley[4]. This filter is locally manufactured and has already been tested in combination with the disc filter by MREA. It should be promoted in the Jordan Valley to encourage farmer to switch from their traditional system. The model installed is characterized by vertical tanks, horizontal diffusers of appropriate number, proper media (silica or 0.5-1.2 mm quartzite), pressure gauge at inlet and outlet in order to determine the back-flushing whenever the in/out pressure differential reaches 0.5 bar, an extra valve for control of pressure at black flushing, and on extra opening at the bottom to facilitate the extraction of media and cleaning operations.

*Fertigation devices*

Fertigation optimization is in fact strictly related to irrigation management, as high water distribution uniformity is required to ensure a proper fertilizer application.

The improvement in dosage, distribution and scheduling of fertilizers leads to a reduction in the amount of fertilizers used while obtaining high yields at the same time.

Fertigation tanks as a first step and water-driven proportional injectors (Dosatron) as advanced systems for the rationalization of fertigation practices were installed in the pilot farms and farmers were trained to use them.

*Disk filters*

Disc filter could be proposed to substitute for a screen filter, but it cannot be the only on farm filtration system used due the poor physical quality of water stored in the farm reservoir Disk filters are installed after the fertigation devices; they ensure the filtration of possible suspended particles of fertilizer and enhance the level of filtration provided by the sand filters. This model substitutes the screen filter more commonly used in the

[4] Luc Armand, 2005

Jordan valley, as it is easier to clean, more durable and more reliable in the results of filtration..

*2.2. Support to fertilization management*

Fertilization application may be reduced, decreasing input expenses and reducing environmental impact, using the following methodology:

- Plan fertilization using soil analysis and regular monitoring of $NO^3$ available in the soil and uptake by the plants;
- Adapt fertilization practices to crop stages and weather;
- Use acidifying fertilizers (MAP, Ammonium sulphate, ammonium nitrate, urea, nitric or phosphoric acids);
- Promote adapted injection material (fertigation tanks and Dosatron) to control injection rate and fertigation solution concentration.

## 3. A GRASSROOTS APPROACH

*3.1. A field work based on farmer collaboration*

The new design and material purchase was discussed and approved by each farmer. The terms of the collaboration have been defined in a signed agreement, on the basis of which the farmers engage in provide the equipment and tools necessary to complete the installation of the optimized design, in following the management indications provided by IrWa technicians, in contributing to organize field days for other farmers in the area and to return 20% of the value of the equipment received by the project to the association of reference.

*3.2. Partnership with farmers' associations and other stakeholders*

All the IrWa support was given though farmers' associations to encourage membership, enhance participation, increase visibility and ensuring sustainability to the project activities. Furthermore, the payment to the association of 20% of the value of the equipment received by the pilot farmers contributes to the sustainability of the associated activities and a sharing of the benefits with other association members.

On the basis of the new design, the project equipped the 30 pilot farms in Jordan Valley with advanced tools and materials.

## 3. TRANSFER OF KNOWLEDGE: SET UP OF PILOT EXTENSION SERVICE FOR IRRIGATION AND FERTILIZATION MANAGEMENT

*3.1. Current situation of Extension service*

In Jordan, the private sector appears to be the most reliable source of information for farmers concerning new agricultural technologies and technical services. Its tendency is to favour capitalist intensive enterprises and to induce over use of agricultural inputs. In

Jordan, the public extension service is subject to major bottle necks that limit its service reliability: low skills of Extension Staff, insufficient logistic facilities, lack of working methodologies for on-farm assessment and low motivation of extension agents resulting in the promotion of a top-down approach where farmers are expected to contact extension agents rather than vice versa.

Since recently the technical assistance to farmers was under the overlapping responsibility of MoA and NCARTT. In July 2007, the NCARTT mission extended to include the extension services previously attributed to MoA becoming NCARE (National Center for Agricultural Research and Extension). As the expansion of the NCARE mission implies stronger focus on extension services, the centre will have to reorient professional and financial means from academic research to applied research activities in order to answer technical constrains met by local farmers. During the last 3 years, IrWa has developed, in collaboration with NCARE, a pilot project of extension services following the methodology presented below.

*3.2. Extension agents capacity building*

To accomplish the IrWa mission, six extension agents were at the disposal of the project for two days/weeks. Only two extension agents were specialized in fertilization and irrigation, the rest of the group did not have the skills to provide technical assistance. Specialisation of extension agents is one of the main limiting factors in the success of their work, so as a first step the project devoted some efforts on their capacity building through:

- Theoretical training in class rooms;
- Field days;
- Learning by doing process directly in contact with farmers.

*3.2.1. Training content*

Training on irrigation design, good operation and maintenance practices and optimization of filtration was provided mainly by IrWa irrigation engineers. Additional training sessions were organised in collaboration with the MREA and a local expert for specific technical topics.

*Irrigation*

The extension agents were taught:

- How to calibrate a pump using PROSONIC
- How to design adapted irrigation network using EPANET
- How to provide farmers with adapted operation and maintenance procedure
- Filtration characteristics and needs

*Fertilization*

A clear lack of methodology and technical skills were found in subjects related to fertilization. Training on sampling procedure, field EC and pH measurement and soil test interpretation were provided by IrWa Agricultural expert in collaboration with the GTZ reclaimed water project. PILazo methodology and NITRATEST tester were introduced in

the training program to provide extension agents with tools allowing rapid assessment of fertilization needs through soil and plant sap analyses. Finally, an Excel sheet was developed to assess farmers' fertigation practices and provide adapted procedure taking into consideration soil analysis.

*Training materials*

All the subjects presented during the training sessions were resumed in 10 technical sheets that were addressed to both extension agents and farmers.

Task definitions, activities and time schedules were discussed and approved by the extension agents before field work implementation on three main topics: irrigation, fertilization and demo plot organization. For each service two extension agents were allocated with specific objectives to reach.

*3.3. Technical assistance methodology*

Field work coordination was organized by the IrWa agricultural expert in collaboration with the NCARE national coordinator. The strategy adopted was firstly to understand farmer technical questions and to improve exchange between farmers and extension agents through regular farm visits, and secondly to sccomplish demo plots with appropriate irrigation and fertilization practices.

***Irrigation***

The pilot farms follow up activity, previously achieved by IrWa irrigation, were transferred to NCARE extension agents. The optimized irrigation systems installed in the 30 pilot farms are now monitored by NCARE extension agent under the supervision of the IrWa Agricultural expert. A field visit sheet is used to evaluate periodically the performance of the system and the application by the farmers of the recommendations provided by the IrWa team. The farmers have been ranked in three categories according to their management skills (low, medium, advanced), so that the follow up is calibrated in order to allow all the farmers to reach a proper operation and management system.

***Fertilization***

The fertilization practices are also monitored through the demo plots installed on farm and at the Deir Alla research station.

The main aim of the demo plots is to demonstrate the possibility of reduction of Nitrogen application, without reduction of yield. The monitoring of on-farms activities is the responsibility og extension agents, who are in charge of identifying the area, visiting the farm weekly, taking measurements of Nitrogen levels in the soil and plant sap, discussing with the farmer the evolution of the crop, identifying problems and proposing solutions.

***Demo sites***

Finally, the extension agents based in Deir allah were allocated to the organization and management of the demo plot on the evaluation of nitrogen fertilization for tomato grown under greenhouse using different organic manure sources, organized in Deir Allah

research center. The objective is to establish sound and economical fertigation planning that takes into account the endowment of the soil and organic matter using Nitrachek tool and PILazo method. The rational for the establishment of these demo plots has been provided by the study conducted about fertilization practices during the previous agricultural season, after a mission by the expert provided by APREL for the support to the definition of a strategy for the improvement of fertilization management.

*3.4. Training for farmers and field days*

A programme of training to be conducted through field days is planned to be realized by the extension agents, using the training materials developed by the project, part autonomously and part with the collaboration of MREA. The aim is to train 480 farmers of the area in the operation and management routine, and to demonstrate to them the results (in term of crop uniformity and decrease of clogging in the network) of the system studied and installed by Irwa team.

*3.5. Overall management*

The management of the field work was organised by the IrWa Agricultural Expert in collaboration with the IrWa project National coordinator. Weekly meetings to follow up on the work were organised in the Deir Allah Research centre. Additional field visits to the demo plots were done monthly to meet farmers and evaluate farmer satisfaction with methodology and results.

An evaluation of the performance of the services provided to the farmers has been conducted during 6 months of activities (from February to July 2007) on the basis of a multi criteria evaluation sheet, attributing to each extension agent a score which was then discussed with them. On the basis of the evaluation score, an economic incentive has been attributed to each of them.

## 5. CONCLUSIONS

The follow-up visits to the pilot farms showed that the farmers evaluated positively the impact of the intervention achieved in their farms, taking as the main indicator the higher uniformity of the crops in the field.

The IrWa Project established fruitful partnerships with other institutions working in the Jordan Valley in related fields of activities, through exchange of technical experience and support to farmers associations (e.g. the diffusion of sand filter prototypes and the support to Melon Producers and Exporters Association in partnership with MREA, or the support to Water Users Associations and the diffusion of the Guidelines for Reclaimed water irrigation in collaboration with GTZ, German Cooperation Institution).