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Modernizing Irrigated Agriculture in the Near East

Experience feedback on the achievements of the French Mission for Water and Agriculture (MREA) (1993-2007)

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IPTRID Secretariat
Food and Agriculture Organization of the United Nations
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Foreword

The French Development Agency's (AFD) geographical mandate in the Near East was extended at the beginning of 2000. Its interventions in the area are therefore relatively recent, whereas interventions around the Mediterranean began in the early 1990s, with a mandate over Maghreb. The water sector immediately appeared to be a relevant area of intervention, considering the hydrological situation in the region and the expertise AFD had acquired in other regions.

The French Mission for Water and Agriculture (in French "*Mission Régionale Eau et Agriculture* (MREA) has been identified by AFD as a source of valuable information, thanks to its accumulated experience and extensive knowledge of local actors in the sector.

The reform of the French cooperation entailed the transfer of projects belonging to the Ministry of Foreign and European Affairs (*Fonds de solidarité prioritaire or FSP)* to the AFD. Following the transfer, work quickly began on the project "Strategy for management and savings of Agricultural Water in the Near East" implemented by the MREA, and benefited from a privileged relationship with the Mission.

AFD's position as a donor rather than as a direct actor in the project has led us to seek institutional solutions to ensure a future for this structure. MREA was in fact strongly dependent on its relation with the French Diplomatic Service. This endeavour finally resulted in the creation of the Methods for Irrigation and Agriculture (MIRRA). This inheritor structure of the MREA was immediately mobilized as a partner in the management of a new project.

As the project was coming to a close, we also asked IPTRID to provide an external review of this process. The review was positive, and having noted the limitations incurred in the dissemination of results, it seemed appropriate to capitalize on this experience by seeking to enhance and disseminate it more widely. This is the core purpose of this report.

Once again we chose IPTRID to coordinate the capitalization effort. This will also enable us to disseminate the results throughout the IPTRID network. This experience will be presented at the World Water Forum #5 in Istanbul in 2009 to illustrate the importance of action research in the field of integrated water resources management. This production of intellectual knowledge is in line with the AFD strategy for intervention in this sector, and in this geographical area.

It was conducted in parallel with the preparation and funding of a new project based on the results obtained by the MREA on the optimization of irrigation in the Jordan Valley. The new project called IoJoV has been planned on a larger scale of intervention and will spread the proposals to the north of the Jordan Valley. This exemplifies the complementary nature of an intellectual production that has remained linked to the reality of the operational field, and of the practices of a donor looking for relevant projects.

As discussed in the document, the MREA's work addressed the complexity of integrated water resources management, although it focused partly on the agricultural use of water. Therefore, it was not limited by the scale constraint, but was able to consider problems on different levels: irrigation at plot level, but on the scale of the whole irrigation scheme, and more generally the issues of the entire Jordan Valley. The MREA's approach has a strong technical component, but does not neglect the social and institutional relations, or the economy, without which no progress is possible.

The focus on agricultural use of water also led the MREA to propose an approach to the production and marketing problems: the choice of these products must accommodate various technical and economic constraints, which must in turn take operators into account and condition their ability to optimize water use.

The donor must also integrate these different scales of intervention (that will influence sector policies and strategies of intervention and determine the impact of funding), as well as the relations between decision makers and the role of the other shareholders (which also depends on the effectiveness of investments).

Let us hope that AFD can find other opportunities to support programmes of action research, over long enough periods to achieve high-quality results and build other bankable development projects.

Let us also hope that thanks to this effort, other development partners will undertake similar initiatives and extend the investigations opened by the MREA in the Middle East region.

Let us finally hope that all those who contributed to the work of the MREA, engineers and technicians of the target countries, students and experts in project support, can enhance and enrich their experience and the regional dialogue around these issues of water management.

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Preface

An experience to serve the hydro revolution in the Near East

More than in any other part of the world, countries in the Near East suffer from water scarcity. While Africa is affected by problematic water access, the Eastern Mediterranean countries are confronted with an actual lack of availability. This situation is not new, as the ancient development of advanced hydraulic engineering in the region goes to show, bearing testimony of man's capacity to address the dictates of the environment. At the beginning of our era, the Nabateans distinguished themselves by inverting the apparently inevitable hydraulic fatality. The Arab civilisation, whose greatest hydraulic feats were achieved between the Ninth and the Twelfth centuries in an underprivileged climatic zone, also testifies to man's innovative capacities.

In the Twentieth century, however, the populations of the area were forcefully reminded of this natural constraint for both political and demographic reasons. The demographic transition multiplied the water demand to an unprecedented level, in a region that was also facing a major geopolitical transition, brought about by the creation of the modern States. Tracing the boundaries of these States thus lead to the internationalisation of the hydrographical basins, in a situation of unprecedented soaring of the demand in water supply. Under these conditions, it is not surprising that the countries implied should have assumed attitudes that gave scope to the etymological roots of the term river, namely *rivus*, which signifies rivality.

The Arab countries decided to develop the Jordan River basin without considering Israel, whose existence they did not accept. On the other hand, Israel wished to take advantage of the Six-Day War to modify the hydraulic equation in the region. Without being a Water War, as it could not be explained on the sole basis of water access, the June 1967 war allowed Israel to destroy the infrastructures put in place by the Jordanians, the Syrians and the Lebanese under their hydraulic development agreement. The Israeli State also used the war to bombard the construction works of the Ghor canal, whereby the Jordanians wished to bring water from the Yarmouk to the valley of Jordan, where numerous Palestinian refugees had settled after 1948. The West Bank aquifers were placed under Israeli management at the outbreak of the 1967 war. To this day, although 75 percent of the rainfall captured are in the areas of the West Bank, the Palestinians are only allowed to use 20 percent of the available volume, the rest being used by Israel and the colonies in West Bank .

Geography, demography and politics are therefore three important keys to the understanding of the hydraulic violence enacted in the area. Nevertheless, there is sufficient margin for manoeuvre to improve access to drinkable water without waiting for the achievement of a geopolitical solution to arise, and without interacting too heavily with the irrigation sector in the region that alone accounts for between 60 and 80 percent of the water consumption.

During the recent food crisis, the intensity of the question of food security was brought to the forefront highlighting the fact that irrigation is an intensifying factor that the countries in the region

cannot obviously do without. On the other hand, if certain elements of its implementation are respected, especially at plot level, irrigation is an important factor in the struggle against rural poverty. Given the tension surrounding the natural resource, it is important not to give up irrigation as a technical instrument, and to make the best possible use of it. Though the water supply policies have practically reached their limits in the region, margin for manoeuvring can be found in the improvement of water demand management. Irrigation could cover a larger role given its importance in volume.

Extension, substitution of ancient irrigation techniques, social organisation of the irrigators, pricing, wastewater reuse, are all elements of a non-exhaustive list of tools for this hydraulic revolution. For farmers to endorse these water saving strategies, it would be necessary to ensure that they themselves are integrated in a remunerative distribution chain. How, for example, should one issue irrigation water bills when farmers have difficulty in selling their produce on the market? It is obvious that water management refers first and foremost to agricultural development.

With this in mind, the Regional Water and Agriculture Mission (MREA) of the French Ministry of Foreign Affairs operated during 13 years on several territories that were, for different reasons, severely hit by water scarcity. In Lebanon, where despite relatively privileged climatic conditions, the valorisation of resources is far from being good, in Jordan where the natural hydraulic stress is one of the worst in the world, in the Palestinian Territories, where the shortage is due to «secondary[1]» reasons, given that though resources are relatively abundant – at least in West Bank - geopolitical constraints prevent them from being fully exploited.

Over these 13 years, successive teams have been working for MREA to promote a holistic approach to irrigation and optimize the use of water volume, under the constraint of limitations of various natures. Beyond its scientific and technical results, one of the project's major achievements would have been to associate the irrigating farmers, who are obviously highly involved, with the research activities.

The overview presented here by Alice Arrighi de Casanova, who was herself highly involved in this formidable hydraulic programme in the Near East, gives an account of the appropriate and extensive work carried out. For those interested in hydraulics, rural development and development at large, this book, fruit of a rich and determining experience, will be most welcome.

The delivery of this synthesis by no means implies that the experience is at an end. On the contrary, as the French cooperation is thinking of transferring this tool to national actors, universities and NGOs, whose work will be both interesting and essential.

Pierre Blanc
International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM)

[1] According to Leif Olhsson who opposes secondary shortage (linked to management problems) to primary shortage, linked to problems of availability.

List of acronyms

AFD	Agence Française de développement - French Development Agency
AFPS	Association France-Palestine Solidarité
CEMAGREF	Institut de recherche pour l'ingénierie de l'agriculture et de l'environnement (F)
EPA	Environment Protection Agency (USA)
EU	European Union
EXACT	Executive Action Team
FSP	Fonds de solidarité prioritaire. Priority solidarity fund
GRET	Groupe de Recherche et d'Echanges Technologiques (F)
GTZ	Deutsche Gesellschaft für Technische – German Cooperation Agency
IOJoV	Irrigation optimization in the Jordan valley
IPTRID	International Programme for Technology and Research in irrigation and drainage
IRWA	Improvement of Irrigation Water management in Jordan and Lebanon
ISIMM	Institutional and social innovations in irrigation Mediterranean management
IWMI	International Water Management Institute
FAO	Food and Agriculture Organization of the United Nations
JEPAFV	Jordan Exporters and Producers Association for Fruits and Vegetables
JEDCO	Jordan Enterprise Development Corporation
JUST	Jordan University of Science and Technology
JVA	Jordan Valley Authority
LRA	Litani River Authority
MAEE	Ministère des Affaires Etrangères et Européennes (France)
MIRRA	Methods for Irrigation and Agriculture
MoA	Ministry of Agriculture
MREA	Mission Régionale Eau et Agriculture
NCARE	National Center for Agricultural Research and extension (Jordan)
NGO	Non Governmental Organization
PA	Palestinian Authority
PARC	Palestinian Agricultural Relief Comittees
PHG	Palestinian Hydrology Group
PFU	Palestinian Farmers Union
PWA	Palestinian Water Authority
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
USAID	United States Agency for International Development
SCAC	Service de coopération et d'action culturelle (French Embassy)
SCP	Société du Canal de Provence
VI	Volontaire international (international volunteer)

Summary

The Near East is one of the most water scarce regions in the world. Water resources were mobilized only recently. There was a rapid irrigation development but also problematic sharing of the water resources leading to political tension and mobilizing the international community. This document describes the efforts carried out by the French cooperation from 1993 to 2007 through the Regional Mission for Water and Agriculture (MREA). The originality of the approach, based on action research, in contact with the field, is described here with concrete cases: support for the upgrading of the Jordan Valley Irrigation system, improving distribution at plot level, economic value of food production, wastewater reuse in Gaza and water balance at basin level. An assessment of the Mission completed by a Rapid Appraisal Procedure of FAO had confirmed that a margin of progress is possible in the management of irrigation and has suggested ways for local partners (NGOs and universities) to carry out these efforts of modernization.

Résumé

Le Proche-Orient est une des régions où le stress hydrique est un des plus élevé au monde. Son histoire récente est celle d'un développement rapide de l'agriculture irriguée mais aussi d'un partage problématique des ressources en eau entraînant des tensions politiques et mobilisant de fait la communauté internationale. Ce document relate l'expérience menée par la coopération française de 1993 à 2007 à travers la Mission Régionale Eau et Agriculture (MREA). L'originalité de la démarche, basée sur la recherche action, en contact avec le terrain, est décrite en s'appuyant sur des cas concrets: appui à la modernisation du réseau de l'autorité de la vallée du Jourdain, amélioration de la distribution à la parcelle, valorisation économique des productions, réutilisation des eaux usées, bilan des usages et ressources au niveau bassin versant. Une évaluation de la Mission complétée par une analyse de la FAO confirme qu'une marge de progrès est possible dans la gestion de l'irrigation et suggère des pistes pour que les partenaires locaux (ONG et universités) puissent poursuivre ces efforts de modernisation.

Section 1

Introduction

Over the last thirteen years, France has led an original initiative of cooperation in the Near East, in the field of agricultural water in Jordan, the Palestinian Territories and in Lebanon. Known as the French Mission for Water and Agriculture - in French: *Mission Régionale Eau et Agriculture* or MREA, this service was mainly based at the French Embassy in Amman for obvious reasons of stability and focused its corn activities on Jordan and, in particular, on the Jordan Valley.

MREA also had offices in Jerusalem and Beirut. Under the supervision of a regional agriculture expert, a team of local and French engineers carried out action research projects in close partnership with local partners.

The evaluation of the MREA, carried out in 2007, greeted the success of this initiative, especially appreciated because of its pioneeristic approach and the introduction of innovative techniques for action-research that were much appreciated by national actors. Thanks to a permanent presence in the field, at the side of the farmers and their local organizations, the work of the MREA was considered to be effective, efficient and to address issues in a relevant manner.

In a very difficult regional context, MREA worked consistently and in close collaboration with other donors. The precision of the Mission's findings have been appreciated, as well as its dedication to the farmers. MREA has introduced technical innovations and work methods, and has documented and attempted to understand the delicate problems of water in the area.

As this cooperation is coming to a close, we would like to present an experience feedback of the Mission, describing its technical and methodological achievements.

This document intends to share this experience of cooperation, as widely as possible, with development partners. Those donors who are well acquainted with the difficulties entailed by the endorsement of the programmes, will be able to appreciate the efficiency of action-research. One can achieve remarkable progress on a relatively modest budget by mobilizing researchers, beneficiaries, technicians and decision makers.

This document contains two sections: the first, after a brief presentation of the regional context, illustrates the positioning of MREA, its methodological approach and the lessons to be learned from this programme of cooperation. The second section, on the basis of selected examples, will attempt to present the main technical analysis and the innovations brought to the region by MREA.

1 An original cooperation to assist agriculture in a troubled region

1.1 A scarce water resource in a chaotic political context

1.1.1 Climate and water resources

The part of the Middle East that we will now focus on is first and foremost a land of contrasts: crossroad of many civilizations, it is also a crossroad of climatic zones, and a geological exception. The region is cut in two by the extremity of the East African Rift and presents differences of altitude that generate important variations between the temperature and the rainfall of neighbouring areas. The cool temperatures of the Jordanian hills make one forget the furnace scorching the "natural greenhouse" of the Jordan Valley, only a few miles further down. Similarly, the well-watered Lebanese mountains, with a good 1400 mm of rainfall per year[2], are in sharp contrast with the aridity of the East of Jordan[3].

Moreover, there is a very strong variability in annual rainfall. This has a considerable influence on the yield of rainfed agriculture but can also, at times of severe rainfall, entail severe damage along the banks of the permanent or temporary rivers with changing regimes (*wadis*).

It is in this region of contrasts that, around 6 000 B.C., one of the cradles of agriculture emerged. The climate, probably less arid than that of today, allowed for the domestication of plants and animals as well as the creation of the first cities such as Jericho in the Jordan Valley (Van Aken *et al*, 2007).

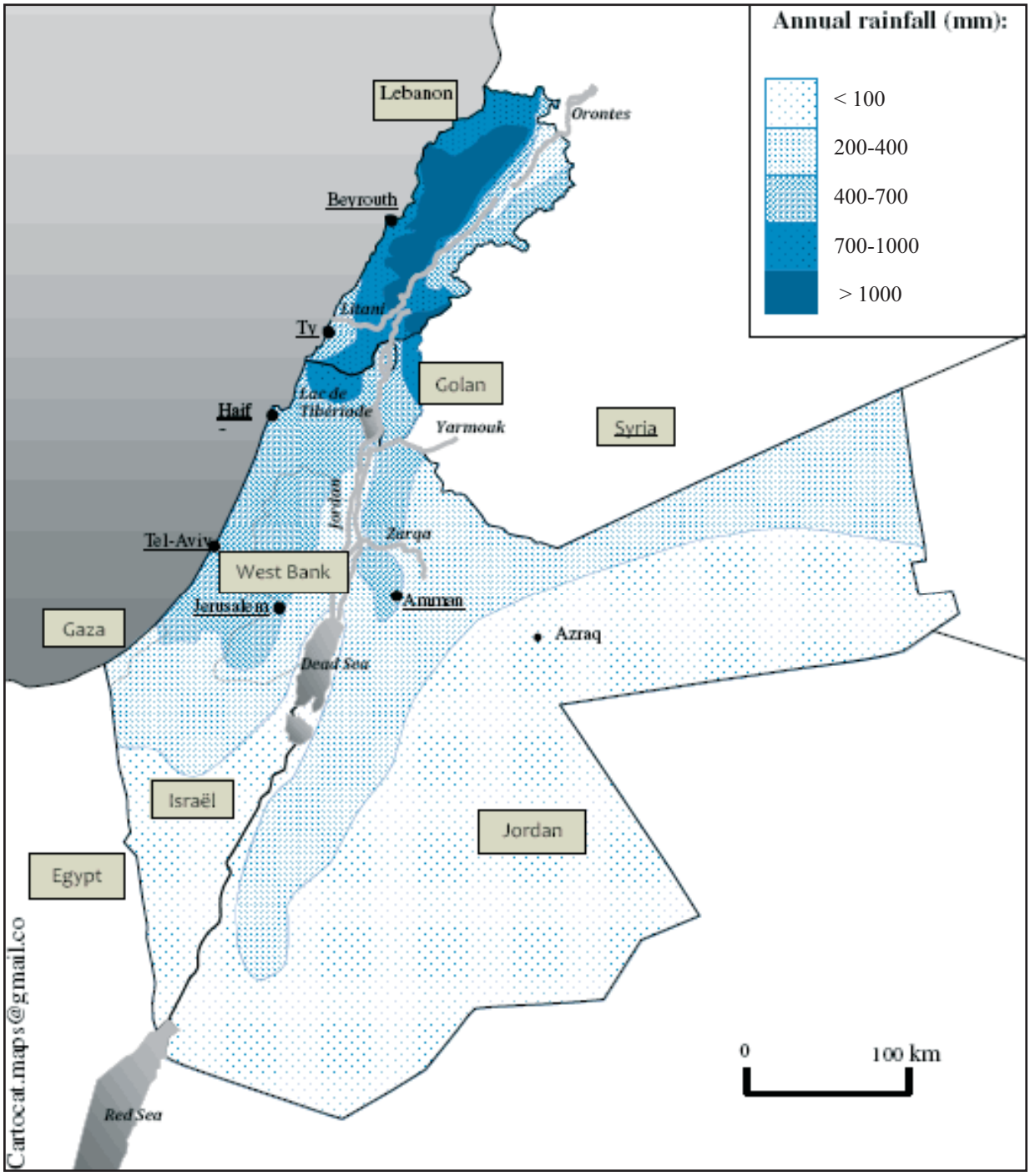
However, from those ancient times until the mid-Nineteenth century, the use of water both in agriculture and in cities remained fundamentally unchanged. No collective effort was made to modify the regime of rivers and for centuries irrigation consisted of small-scale earthen canals, stemming from the *wadis.* The bulk of farming activities were situated in areas where there was sufficient rainfall to grow the traditional Mediterranean species: wheat, olive trees and sometimes grapevine. Over the great majority of the territory, transhumant pastoralism was the main activity of a nomadic society that engaged in commerce. The agricultural surplus and the proceeds of commercial activities resulted in the development of flourishing cities.

In the course of history, the region went through stages of stagnation, of development and of decline, according to different influences and complex power games, but the way in which resources were used, and the quality of agricultural exploitation did not change.

In 1917, the Balfour Declaration and the support to the establishment of a Jewish state in the region opened the door to a radical modification of the exploitation of water resources and of the associated farming systems.

[2] Average annual precipitation in Lebanon is of 700 mm.
[3] 80% of the country is classified as having a desertic climate, with less than 100 mm of rain per year.

Figure 1
Map of precipitations (sources EXACT, 1998; UNCCD, 2002)



1.1.2 Independence and the creation of Israel

In May 1948, the creation of the Israeli State provoked the exodus of hundreds of thousands of Palestinians. This event deeply modified the equilibrium of the Near East, consequently the usage of the water resources in the region.

The kingdom of Jordan obtained its independence in 1946 and, during the immediate aftermath of the "Nakba[4]", found itself having to administrate the territory that is now West Bank , while also facing the arrival of 400 000 refugees in the transjordanian area of the kingdom. An additional 100 000 refugees moved into the south of Lebanon[5].

The public politics put in place by the different countries concerned varied in their orientation: Lebanon, where the confessional equilibrium was strongly upset, did not privilege agriculture, but services, that were mainly concentrated in cities like Beirut. On the contrary, Jordan and Israel launched vast programmes for public infrastructure and particularly encouraged the development of irrigated agriculture.

At that time, it was obvious to all the planners who were working on these projects that the problem of the refugees could be solved through economic development, and in particular through agricultural development which, in these desert areas, is necessarily linked to water management.

Water thus became essential in order to ensure the economic development and the control of the territory. The situation whereby neighbouring and at times rival communities shared water was altered: Water now became the key issue at stake in a battle between nations, and the core business of all development and planning policies.

The exploitation of water resources took a new turn after 1967; issues linked to water resource sovereignty became more and more pressing between the States, and a source of frequent tension.

Box 1
Development of the Jordan Valley

In 1951, the Jordanian Government decided to build the King Abdallah Canal, as well as a series of dams. The canal was to carry water from the Yarmouk (affluent of the Jordan River that marks the border between Syria and Jordan) to the east bank of the Valley of the Jordan, and the dams, constructed across various other effluents, were to contribute to the development of irrigated farming in the east of the valley. The West bank was to be developed according to a similar project at a later stage. The project was supported, and financed, by the international community, in particular by the United States of America and the UNRWA (United Nations Organisation for Palestinian Refugees). Most of the land belonging to Jordanian tribesmen was divided into 3.5 hectares lots, and irrigated by means of a network of secondary earth canals. The land value was gradually upgraded, and the full project eventually covered 30 000 hectares of irrigated soil (DoS online database, 2005). Citrus and vegetable cultures were determinant for the inhabitants of the Ghor, and the Palestinian refugees' economic growth. Planification for road, schools and housing is now centralized This has represented a great change in an area that had been used only for pasture in the past.

[4] The "Nakba" represents the event that most characterizes the expulsion of thousands of Palestinians in 1948 at the time of the creation of the Israeli state. In Arabic, the literal meaning of the word is "catastrophe".

[5] Source: interview Jalal Al-Husseini – June 2008

1.1.3 1970-1980: political instability, demographic growth and tension surrounding water resources

The more powerful states, benefiting from a more strategic location, endeavoured to gain maximum control of the resources nearer the borders. Tony Allan[6] has described this as a "hydroegemonical" position (Dupont, G. 2008). Though water control was not the key factor to armed conflict in the region, the general political context accounts for relatively aggressive policies as to water management and resource control.

In 1967, Israel took over Lake Tiberiade, occupied the Golan Heights and the Palestinian Territories, thus taking possession of most of the resources available in the area. Policies pursued over the previous decades were given larger scope: both Israel and Jordan continued to expand their infrastructure development and resource management policies.

Around this period the power of technological solution was challenged: would it be able to ensure sufficient development to sustain the fast growing population? In fact, in depth drilling techniques, paired with low-cost energy were revolutionizing the exploitation of deep groundwater. Public investment was mobilized to pump the groundwater and bring it to the cities. There also was a lot of private drilling for use in agriculture. The drip technique, a selection of new varieties and greenhouse culture revolutionized vegetable farming. This period is sometimes referred to as the "super green revolution" (Elmusa, 1994). The fruit and vegetable markets were selling big quantities, and the investments were rapidly recovered. Thus, approximately 3 000 private wells were drilled in the Jordanian desert, and provided for the irrigation of 40 000 hectares of vegetables and fruit trees (source: FAOSTAT, 1990).

If water was running low at basin level, inter-basin transfers allowed to "balance" the situation. Thus, the Israeli "National Water Carrier" transported water from Lake Tiberiade to the Neguev Desert. Similarly, the waters of the Yarmouk, deviated into the King Adballah Canal, were pumped up an elevation of almost 1 000 metres in order to bring drinkable water to the city of Amman, that was then rapidly expanding.

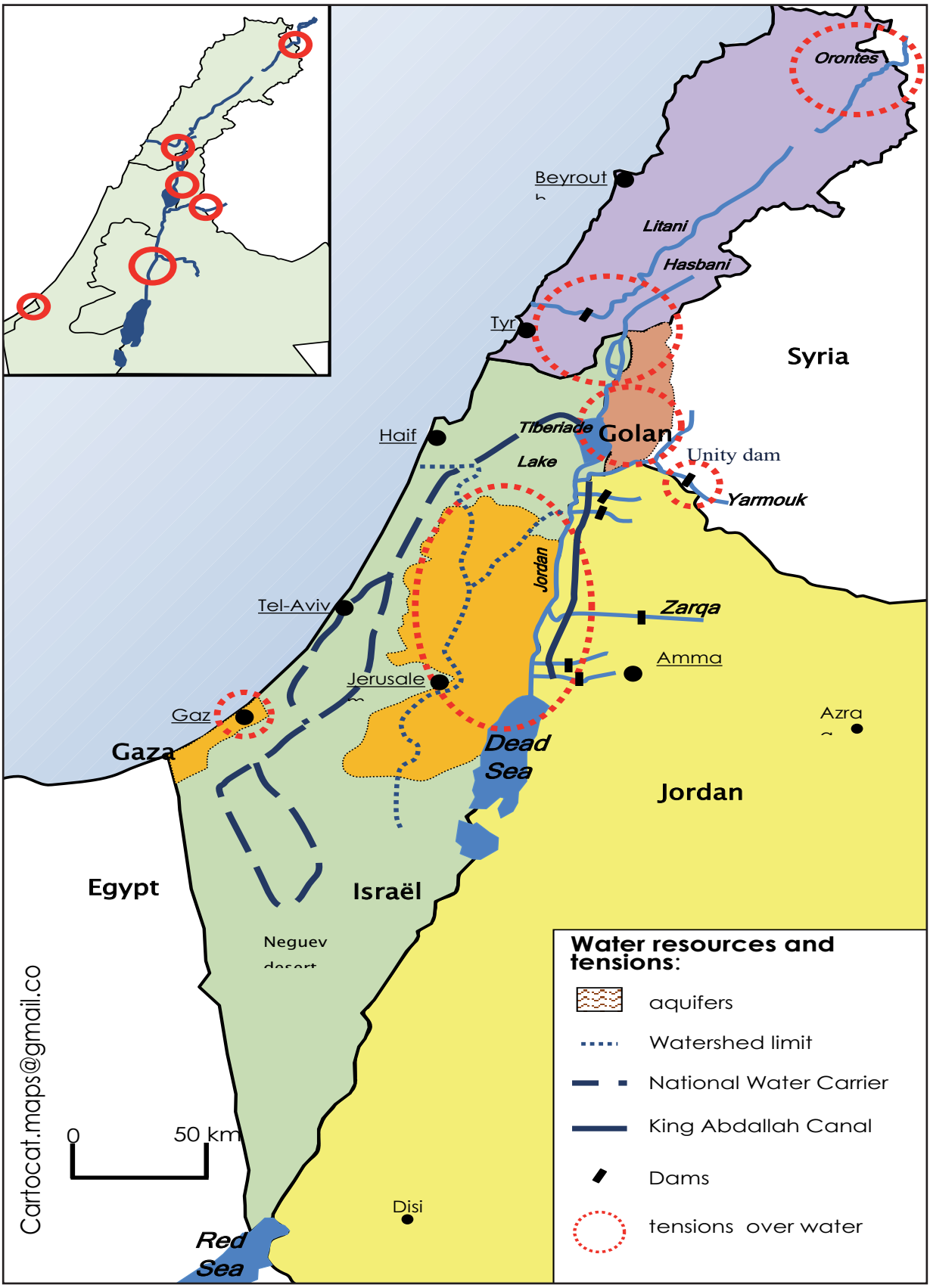
In addition to this, the Palestinian Territories were occupied and lost what little sovereignty they had over their water resources. While technology was allowing some to make the desert bloom, the Palestinians were witnessing the growth of Israeli colonies, and the dwindling and even regression of their own agricultural practices. The main aquifers in this sub-region are situated in the West Bank, but these reserves are strategically too important for Israel to permit them to be used without regulation. Consequently, well drilling is forbidden, the development of irrigation in the Jordan valley is reserved for colons, and no collective infrastructure – apart from traditional mud canals along the *wadis* – are allowed.

Lebanon, on the other side, plunged into a fratricide war that will last for over 17 years, and freeze all initiative and development throughout the country.

[6] Professor at *King's College*, London

Figure 2

Map of the main water resources and conflict zones linked to water sharing.



1.1.4 1990 –2000: Awareness of limits

At the beginning of the 1990s, during the immediate aftermath of the Gulf War, the political situation became less tense; the end of the Lebanese war, the peace treaty between Israel and the Kingdom of Jordan, the Oslo agreements recognizing a Palestinian Authority, were the basis of a possible regional agreement. Over this decade, numerous studies were carried out in order to establish the potential resources at the disposal of each state.

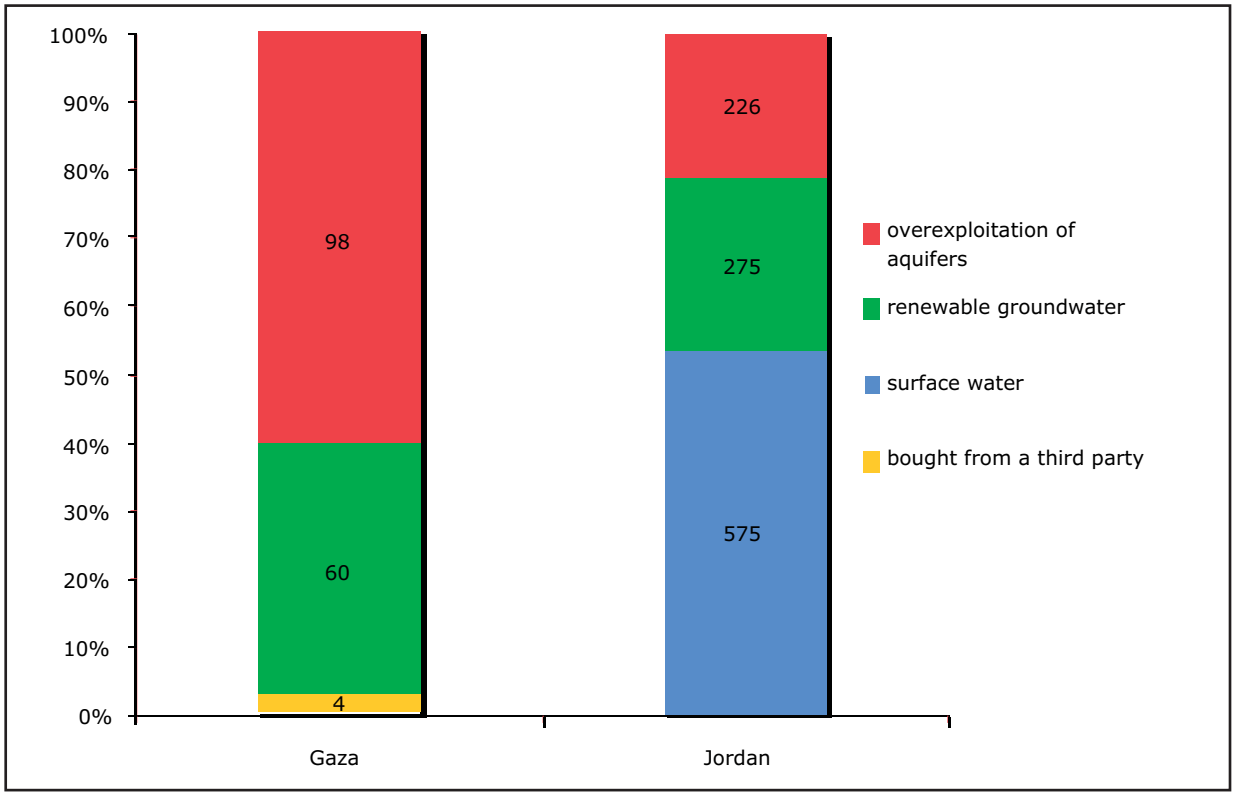
The first alarm signal was the general deterioration of the water quality. The population growth was such that the water treatment plants, if at all existent, rapidly became obsolete. The situation was particularly alarming in Gaza, where most households were not hooked up to the treatment plant. The countries were now facing an increasing problem of pollution, as well as the major challenge of guaranteeing sufficient drinking water supplies.

Over exploitation of the resources: Gaza and Jordan's structural deficit

Water demand inexorably increased with the intense demographic growth. The annual resource balance showed a structurally deficient situation in both of these territories: In order to compensate for this deficiency, the groundwater was exploited beyond its annual recharge threshold.

Figure 3

Water resources in Jordan and in Gaza (Millions of m³ used and fraction in the water balance)[7]



[7] Source: Palestinian Central Bureau of Statistics, 2006; THJK, 2004

The effect on agriculture began to make itself cruelly felt: every little river was exploited to bring drinking water to Amman and maintain agriculture. Drilling increased and water was transported over increasingly long distances. One example among many others: the level of the Dead Sea drops every year, in consequence of the deviation of its habitual recharge source. If nothing is done to prevent it, this treasure of mankind might completely disappear over the next few decades, as the Azraq Oasis that is drying up to the benefit of Amman *(Box 2)*.

Since 1990, there has been an attempt to cope with the situation: wastewater from Amman, once processed, flows into the Zarqa River, which then descends into the Jordan Valley. This "mixed" water is then used for irrigation. After 2000, more than 60 Mm^3 of partially processed water was recycled every year. The Water processing plant in Amman having been highly over burdened – until its recent renovation - processing was only partially efficient. This entailed severe pollution of the Zaraq River (Van Aken, 2007).

In Gaza, where only groundwater was available, the situation was even more severe: 3 500 wells, both for domestic use and irrigation, were pumping water year in year out. The groundwater recovery threshold was by far overstepped. Salinity was increasing at an alarming rate, threatening both farming activities, and drinking water resources in a small, over populated territory.

Box 2

Azraq - an ecological catastrophe (Source; Van Aken et al, 2007; Callaghan, 1998)

Until recently, the Azraq humid area Reserve, in the heart of the Syrian Desert, was an incredible Oasis, that few could compare with. Two artesian springs continually poured out their abundant water, creating a rich mosaic of shallow pools and marsh grounds, covering 800 hectares. In 1922, Colonel R. Meinertzhagen described it as "a real paradise […] with all the characteristics of an island". Several international expeditions later visited the oasis that rapidly became one of the most famous humid areas in the world, home to an incredibly diverse wildlife, and to remarkable water birds. In 1982, the Water Authorities of the city of Amman began to pump the Azraq groundwater by drilling about 15 wells, and bring the water to Amman for domestic use. The water drawn at these wells, to which one must add quite some pumping (authorized or not) for the irrigation of local farms, vastly exceeded the necessary annual recharge. In 1992, the Azraq springs dried up, and the humid area disappeared. Despite conservation efforts, and reuse plans, the Azraq oasis today is but a pale shadow of its past splendour.

Absence of sovereign rule: The institutional deficit

In the West Bank and in Lebanon, the situation appears less dramatic at first glance. The relative abundance of resources, and the scarce development of irrigated agriculture against its potential development, made it possible for both territories to issue a positive balance as to resource utilization. The conflict of utility between domestic water supplies and irrigation water supplies was by no means as intense as in Jordan or in Gaza.

However, the fact that in the West Bank, Israel was pumping 500 Mm^3 of water for its own use must not be overlooked. If one takes this additional drainage into account, the balance is barely respected. The

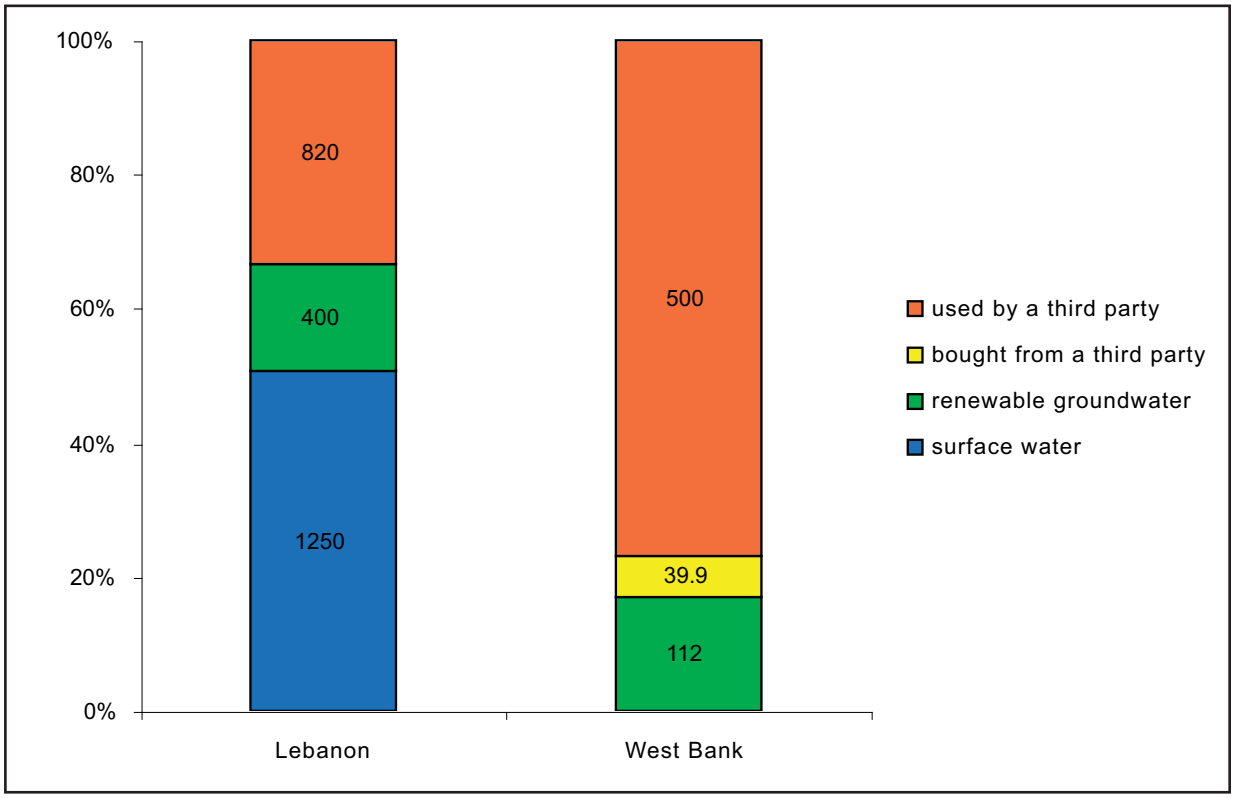
situation cannot be expected to remain sustainable for long. The weakness of Palestinian authorities, paired with the lack of sovereignty to enhance the resources put a considerable break on the infrastructure development. To this day, there are no dams in the West Bank.

In Lebanon, 670 Mm³ of water flows into the rivers of neighbouring countries. 150 Mm³ of underground water also flow across Lebanese borders every year. Out of 8 300 Mm³ that the country receives in annual rainfall, only 200 Mm³ are potentially exploitable. Total annual water consumption in Lebanon in the year 2000 was of 1650 Mm³. However, previsions for the future are alarming, as water consumption is expected to grow well beyond the potential exploitable by 2015 (Bou-Zeid and El-Fadel, 2002). Until 2002, there was only one dam on Lebanese territory (Qaraoun 220 Mm³ of the Litani River).

The water balance is found to be particularly alarming. While Jordan and Gaza were already in a critical and deep deficit situation, as water consumption widely exceeds the natural annual recharge threshold, the situation in the West Bank and Lebanon could rapidly become a critical one.

Figure 4

Distribution of water resources in West Bank and in Lebanon (Millions of m³ consumed and fraction in the water balance[8])



[8] Source: Palestinian Central Bureau of Statistics, 2006; Bou-Zeit and El-Fadel, 2002

1.2 A very thirsty agriculture: somewhere between waste and socio-economics

1.2.1 Farming systems disrupted by development policies

During the second half of the Twentieth century, agricultural development policies did not seriously consider water to be a limited resource. The main political challenges were food safety and land appropriation by means of agricultural improvement. Commercial strategies were strongly influenced by Ricardo's theory of comparative advantage: to produce and sell fruit and vegetable, and buy wheat and sugar. Water could always be found further, deeper, or in the neighbour's territory.

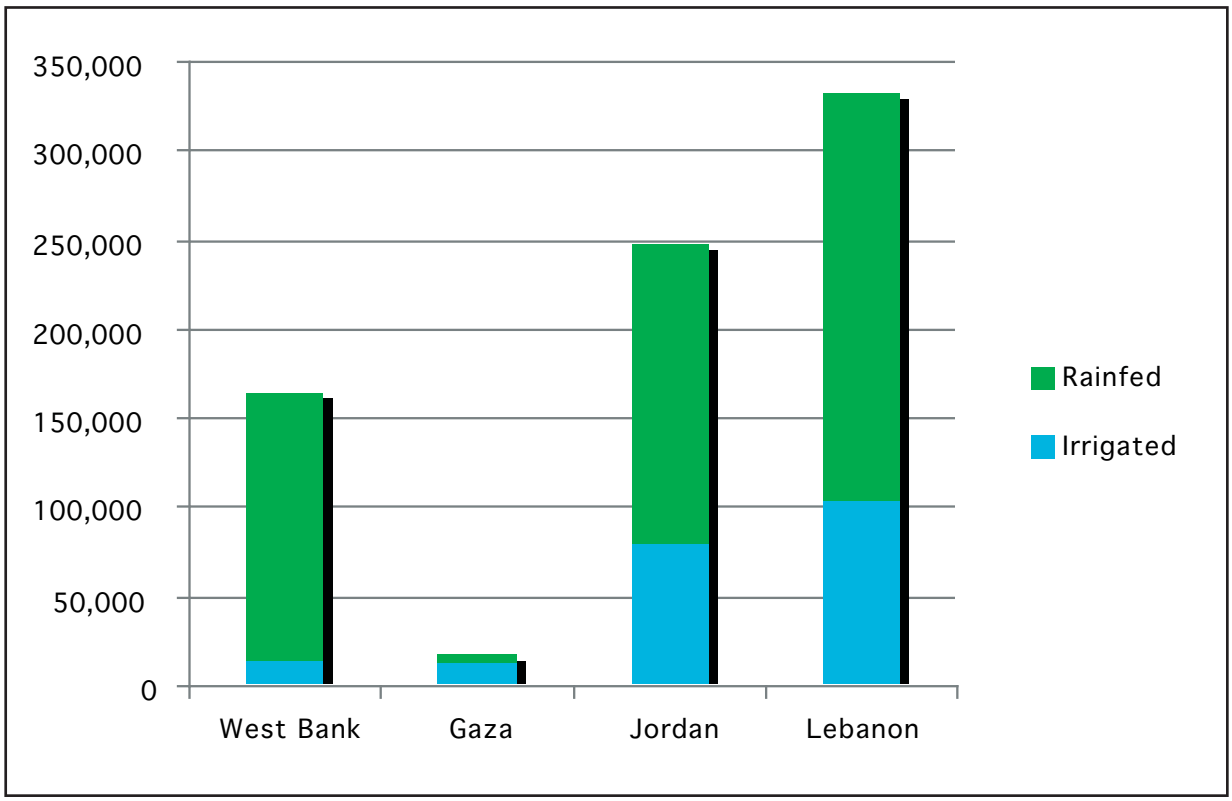
The region was divided into two coexistent farming systems: traditional rainfall farming, and highly advanced irrigated agriculture.

The survival of traditional agriculture: *fellah* and Bedouins

Traditional agrarian systems were maintained in the most rainy areas (Jordan mountains, West Bank, and Lebanon) or, on the contrary, in the desert heights still inhabited by a few transhumant Bedouin families.

Figure 5

Irrigated schemes and rainfed plots (in hectares)9



[9] Source: Palestinian Bureau of Statistics, 2007 – Agriculture Statistics 2005/2006; Blanc *et al*, 2003; Department of Statistics, 2005 data on Jordan.

In northern Jordan, populations strongly depend on income from agriculture, but receive very little support towards the modernization of their systems. In many cases, agriculture has become a part time activity. The particularly scattered land tenure structure of Lebanon and the West Bank strongly limits the potential for more modern agrarian techniques. Olive remains the main crop in these more traditional areas.

Expanding cities are gradually taking over fertile soil and good farming land. Over-grazing on slopes accelerates the deforestation process, leaving the soil bare. Rainwater runs down these bare slopes much too violently, causing mudslides and flooding, and particularly scattered land tenure structure.

Irrigated agriculture: between tradition and modern day

Irrigated agriculture was developed over vast public areas (in the Jordan valley), around private wells pumping from aquifers (Jordan heights, West Bank heights, Gaza wells, Lebanese costal plain[10]) or around traditional gravity canals (particularly inWest Bank).

When travelling in the region, visitors are often surprised by the coexistence of such different farming schemes, in areas that share obvious geographical and climatic resemblances. On the East Bank of the River Jordan over a few hundred metres, one passes from state of the art Israeli greenhouses growing vegetables for export, to traditional Palestinian citrus groves irrigated by earth canals.

Generally speaking, the region comprises three different categories of farmers using irrigation schemes[11].

Prestigious agriculture

In such a water scarce region, it is a paradoxical endeavour. Landowners whose revenues depend very little on agriculture keep up prestigious farming activities. The most striking examples are the vast irrigated olive plantations in the desert of the Jordan heights, and the citrus orchards extensively grown by absentee landowners in the north of the Jordan Valley. In both cases, these "agriculturists" use excellent water for crops that are barely productive economically. It is noteworthy that these landowners are often members of the more influential social categories, and are able to put a stop to any unfavourable legislation.

A class of Agro-businessmen

All agriculturalists using modern farming techniques in an intensive manner can be qualified as agro-businessmen. Some may be of rural origins, and have moved away from traditional agriculture, while others might have decided to invest capital in a rewarding activity. All, however, are exclusively interested in sales (and in export if possible); they use a paid labour force that is often of foreign origin: Syrian in Lebanon, Egyptian in Jordan. In the Palestinian Territories labour force remains local. The farms are run along the lines of capitalist enterprises.

The size and the productivity of these farms vary. Often, the farmer rents the land that he grows crops on, and is prepared to move from one plot to another as the productivity decreases (soil fertility and health, water scarcity, etc.).

[10] Since 1960, more than half of the supplies are derived from groundwater (52% according the latest measurements). Groundwater tapping in the area is in a state of complete anarchy. On the coast, uncontrolled tapping contributes to groundwater depletion, and facilitates the seeping of salt water (according to talks with P. Blanc, 2009).

[11] The categories presented here are a voluntary simplification. For major details, it is advisable to refer to the numerous agro-economic studies published by the RWAM.

These agro-entrepreneurs are to be found throughout the region, and particularly on the left bank of the Jordan Valley. In fact, in this area they are able to profit from the infrastructure put in place by the Jordanian state. Some of the bigger investors have created real little empires for themselves, completing their activities as producers by processing and marketing activities.

Family farming

Farmers managing their family plots do not use such advanced technology as their businessmen equivalents. The commercial difficulties that also affect the profits of agro-entrepreneurs are devastating for farming. The pieces of land are divided over generations with each new inheritance, and thus become insufficient to sustain big families. The farmers are also more vulnerable to water shortages because their plot irrigation systems are obsolete and they have no savings[12]. In Jordan, the current trend is for landowners to put their land up for rent or for sale. They are also increasingly dependent on financial support from the State. Landowners are very poorly represented at the institutional level, and, while suffering from the avidity of the entrepreneurs in the sector, they have very little say regarding resource management.

1.2.2 Agriculture in the Economy

Jordan

During the 1980s, Jordanian agriculture was highly profitable, and seemed to justify the development strategies chosen at that time. The following decade, however, brought a severe reversal of trend, and Jordan lost its prominence on regional fruit and vegetable platforms. The sales price of farm produce crumbled, while other economic sectors such as services and tourism found themselves in full growth.

In Jordan's economy, the part played by agriculture has considerably diminished. This sector, that employed 25 percent of the active population in the 1970s, was only employing 3.6 percent in 2005. Currently, the labour force is mainly foreign: two-thirds Egyptian, as well as Syrian or Pakistani emigrants (Van Aken *et al*, 2007). Agriculture's contribution to the GDP has dropped from 11 percent in 1980, to 3.8 percent in 2005 (Central bank of Jordan). However, the sector remains essential for the country: the export of fruit and vegetables still accounts for 14.6 percent of total exports and the whole of the agricultural sector represents nearly 29 percent of GDP (THKJ and Ministry off Planning, 1999; Van Aken *et al*, 2007).

Palestinian Territories

Agriculture remains the spinal column of the Palestinian economy, and contributes to nearly 30 percent of its GDP, accounts for 25 percent of the exports and employs approximately 20 percent of its active population. Moreover, it offers an outlet to a population that is seriously handicapped by the obstacles set against the circulation of workers. In recent years, many Palestinians have taken up agricultural activities again. The sector currently employs 80 percent of the labour force, more than in 1996, before the second Intifada (White, 2003).

[12] In Lebanon 63,5% of irrigation schemes are currently gravity based

In spite of its limited surface, irrigated agriculture ensures 50 percent of the agricultural production of the Palestinian Territories. The collective delivery systems of agricultural water have hardly been modernized, but many farmers have installed modern tertiary systems, such as drip irrigation plants, at plot level.

Lebanon (according to Blanc, 2009)

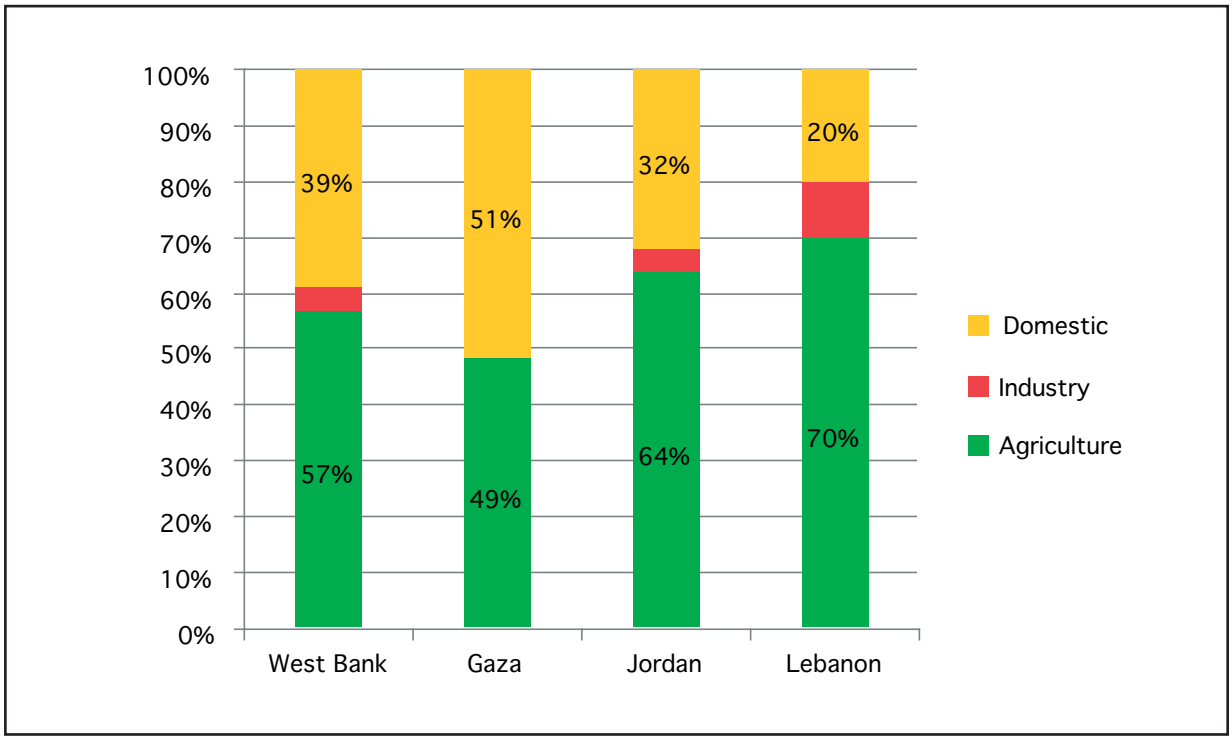
The Lebanese producers were famous on the Gulf markets between 1950 and 1960. The lack of public support, as well as the civil wars which have since devastated the country, have contributed to deteriorate the performance of this sector. Despite these difficulties, the agricultural sector still represents around 10 percent of the GDP. This share could decrease if reforms are not put into place.

Lebanese agricultural labour force is extremely strong in numbers, with approximately 195 000 family workers, to which one must add permanent and occasional labour, over a total Useful Agricultural Surface of 250 000 hectares. The territory is mainly divided between smallholders. In fact 75 percent of the workers have less then one hectare, and 95 percent of the production units have less than 4 hectares. Most of these farms, given their small size, have no investment capacity. This encroaches their production capacity, which is partially compensated by intensive use of the labour force (either paid or family based).

In Jordan and in Gaza, 96 000 irrigated hectares consuming between 65 and 50 percent of the water resources on these two territories are notoriously considered to be the cause of the water shortage. The governments finally acknowledge that it is time to change the development scheme. They are now facing a crucial question: Should irrigated agriculture be maintained or not.

Figure 6

Water usage by sector (expressed in % over total[13])



[13] Source: Palestinian Bureau of Statistics, THJK MWI and GTZ, 2004; MOA Liban, 2003

1.3 A dark future, which calls for mobilization

1.3.1 Pulling out of the rut: Directions

The situation of water crisis described above mobilizes national and international partners. The question is also viewed as an important stake in the peace process. Most actors share the analysis of the solutions.

1.3.1.1 To develop and diversify the offer

The mobilization of the national surface water resources will continue. In Jordan, some dams remain to be built across some minor *wadis*. Negotiations are still underway regarding the placement of infrastructure over more specifically contended rivers, shared by several States. The Syro-Jordanian dam called "Unity" finally built over the Yarmouk[14] after long years of hope and talks is the inspirational image of reference. Lebanon is planning the construction of a series of dams, but the finances are being delayed as the county is heavily indebted. Moreover, disagreements with Syria over water sharing have not been overcome yet.

The general tendency is to mobilize non-conventional water resources: re-use of treated waste water, desalination and remote transfer. Jordan has already made great progress in these fields and should continue in this direction (Jaber, 2001).

The offer being less and less forthcoming, the area could turn towards really "Pharaonic" projects in the near future, such as the "Channel of the two seas" which should connect the Red Sea and the Dead Sea and could generate, after desalinisation, approximately 850 Mm^3 per year for Jordan, Israel and the Palestinian Territories[15] (Harza JRV Group, 1998). In this race with the offer, regional cooperation is undeniably one of the keys of success.

1.3.1.2 Managing the demand

The new infrastructure projects should make it possible to reduce the shortage. However, these devices entail important investments and increasingly high running and maintenance costs. The water production and supply in certain zones are very likely to become extremely expensive in the short term. The governments are therefore unanimous in launching a race against resource waste by controlling user consumption and by optimizing the water supply systems. All the studies show that substantial savings can be achieved: the drinking water network of Amman is in a state of general decay and wastes nearly 25 percent of its total volume because of leaks[16] (Darmane, 2006). The efficiency of the irrigation systems hardly exceeds 50 percent in spite of modernization initiatives (Van Aken *et al*, 2007). The efforts to be carried out are technical but especially organisational. It seems necessary to involve both consumers

[14] This dam has a capacity of 110 Mm^3 and was to allow the collection of the surplus waters of Yarmouk upstream (for example in times of overflow). Unfortunately, because of the dryness and of uncontrolled tapping, it is only partially filling up (12 Mm^3 out of 110 Mm^3 capacity in 2007).

[15] Two-thirds of the water would be brought to Amman, the other third would be divided between Israel and the Palestinian Territories.

[16] Numerous rehabilitation projects began in 2003 thanks to German, American and Japanese financing and should reduce leaks by one-third. On top of physical leaks in the system, administrative waste has been estimated at 25 percent due to broken counters and consumer incivility.

and managers in order to limit over-consumption. These strategies, sustained by the Government, are unfortunately frequently opposed by corporate interest and general inertia.

1.3.1.3 Increasing the water productivity in agriculture

If one connects the share of agriculture in the economy and its weight in the water balance, most economists would probably simply advise to put a stop to the activities. Agriculture in the area is not a profitable activity and economists would advise to concentrate on other branches of industry which would maximize the economic return on each cubic metre of water. However, the social reality must be taken into account. Many sociologists thus underline the low adaptability of the rural populations to this situation of shortage, in particular in Jordan and in the Palestinian Territories (Van Aken, 2004).

A consensus has thus emerged among the policies: if irrigated agriculture is maintained, or even developed, it is necessary to improve its economic profitability. For example by producing plants with higher added-value, by improving the marketing operations, the transformation, and by limiting the post harvests losses, etc.

1.3.2 Mobilization of the international community

The international community is mobilized to support the governments in tackling the issue of shortage management, according to national priorities and to the nature of the problems of each of the countries treated here (Tarawneh, 2007). The considerable efforts backed by certain donors, generally through subsidies, should also be underlined.

Drinking water and used water processing being the absolute priorities for the governments, the donors give priority to the financing of water treatment, plants and support the modernization programmes of the urban water supply networks. Nowadays they are careful as to the financing of large irrigated plots. In the past, the installation of the valley of the Jordan - Jordanian bank – received huge support from the international community. One of the aims of this effort was to sedentarize the migrant Palestinian refugees. From now on, the main issue is the management of the request in the strongly overdrawn water zones like Jordan[17]. Donors remain prudent in the Palestinian Territories and in Lebanon. There is much hesitation between the will to develop and modernize agriculture, and the fear of promoting irrigated agriculture as it would be very difficult to dismantle it in the event of severe water shortage.

The projects in support of irrigated agriculture are therefore often “very institutional” projects, except in the Palestinian Territories where projects are implemented to face immediate humanitarian concerns. There, efforts are made to limit the effects of the crisis on a population that has been weakened by war (distribution of breeding kits and truck farming, income-generating activities for the women communities, etc).

International projects support the local governments in trying to obtain an evolution of the legislation, but the structure of the projects (frequently of short duration) often prevents teams from working in concrete application of these directives. Set aside the problem of the duration of the projects, one should

[17] Lebanon expects to face severe shortage by 2015, and wishes to mobilise some resources. However, being strongly indebted, Lebanon has limited investment capacity.

also consider whether the political officials have assimilated the projects' concepts, and whether the administrations take into account the projects' recommendations.

Unfortunately, all issues concerning water in the Near East are tainted by its notoriety. Each and every organization is interested in taking up the challenge, and wishes to participate in finding the solution. The issue is captivating, and it is also true that there is much at stake. The resulting situation is a "sweet-sour" mix, where good will fires isolated projects that are carried out without proper consultation with national authorities. On the other hand, the main "strategy" of local civil servants seems to entail being part of as many international projects as possible, without organizing possible collaboration, or addressing possible contradictions and inevitable waste of time and means.

1.3.3 Numerous attempts in regional cooperation

Conflicts over water have not all been defused. The question of the division of the waters of the Litani, Oronte, Yarmouk, Upper Jordan, the aquifers of the West Bank Mountains and Gaza Mountains are and will long remain extremely topical questions to which there are no easy answers.

However, mentalities started to change on the day when the States realized there was an actual shortage and became aware of the fact that there was quite simply not enough water. The question of the "shortage" has become so critical that it could even be an engine for regional cooperation. Since the shortage exists, the States are to some extent obliged to tackle the question of water in a rational way. Providing sufficient quantities of good quality water to all in a fair and equitable manner, is an essential condition to carry out negotiations and to consider regional solutions.

It follows that, for example, the project of the "channel of the two seas", already evoked above, continues to advance year in year out, in spite of a difficult political context. Beyond its symbolic value, it could – in the near future - free Israel, the Palestinian Territories and especially Jordan of their problem of extreme water shortage.

To pass from a state of "hydro-conflict" to a phase of "hydro-cooperation" (Diena, 1997), it is first of all necessary to recreate an atmosphere of trust between the various actors. The task is obviously not easy given the context, but it remains the main objective of regional initiatives which try to bring technicians, and even farmers, to work together without tackling any of the ideological or political issues. It is with similar ambitions that groups such as the EXACT[18] group or certain NGOs, like Friends of the Earth (www.foeme.org) are working in the area.

1.3.4 Persistent difficulties in the implementation of the projects

Institutional insufficiencies

During the 1990s the Lebanese war came to an end, and the Palestinian Authorities were established. However, difficulties were by no means over. The governments in place had to face the lack of experience

[18] EXACT (Executive action team is a management committee, created in 1995 to coordinate a data base collection project on water within the general framework of the peace process between Israel, Jordan and the Palestinian Territories. It comprises representatives from the water management agencies from these three territories, while financial and technical aid were mainly from the United States, Europe, France and the Netherlands.

of the local administrations. The public authority had to reinvest in fields where the civil society and the private investors had played a back-up role for years. Sovereignty on the territory is far from being acquired since Israel and Syria are still extremely present. In Jordan, the State is still divided between *clientelism* towards certain categories of the population (big tribal families in particular) and the equal rights of the community at large. The links with the civil society, except in the traditional tribal society, are extremely weak. The farmers' trade unions, for example, are badly organized and are not able to constitute a reference for local development. The structural adjustment recommended by the International Monetary Fund limits the usual form of "patronizing" intervention, and the means at the disposal of the institutions are very strongly diminished.

Complex issues

The issues at stake have become increasingly complex and multidisciplinary approaches are often necessary. The decision makers lack references to set up policies. Often, the projects are repetitions of old failures, and the capitalization efforts are very limited in a context of continuous emergency.

A context of undermining war

Peace remains extremely fragile and the recrudescence of the conflicts since 2000 is slowing down the crucial reform process. In Lebanon and in the Palestinian Territories, the infrastructure projects are frequently slowed down by this political context. In addition, preventive or declared war skirmishes are responsible for continuous destruction. The Palestinians are increasingly isolated, both politically and economically, especially since human transit in and out of the Territories is extremely constrained. The seizure of power by Hamas in Gaza, Hezbollah's intrigues in Lebanon, and the surge of Iraqi refugees in Jordan are many factors which contribute to the chronic instability of the area (see chronological table in appendix).

1.4 The French cooperation's position in this context[19]

Since the 1990s, during the immediate surge that followed the peace process, France decided to take part in the collective effort, and to invest its previous experience and knowledge in the question of agricultural water use in the Near East.

The analysis of the situation at that time reveals that:

- The governments do not have adequate management tools to face this new context of shortage: technical references could enable them to set up more coherent agricultural development policies.
- The support projects often deal with the decision makers from the national institutions but there are few projects that directly train the operators that will operate in the field at the side of the recipients.
- The peace process entails a "small steps policy" whereby technicians must meet, focus on common interests and common work projects before passing on to the higher stage of political decisions.
- It is necessary to keep track of the actions carried out, so as to avoid implementing the same projects continuously.
- Given the regional instability, it is desirable to use the diplomatic network to allow the circulation of the people and to benefit from a certain measure of neutrality.

[19] Source: Orientation Notes: 1997, FSP project notes, regional agriculture expert reports.

In this context, the French Ministry for Foreign Affairs established an Agricultural Mission in Amman in 1993, which became the Regional Mission for Water and Agriculture (MREA) in 1994. Its role was to disseminate a series of technical innovations for a better control of agricultural water, in collaboration with the local technicians. It was located within the Service of cooperation and Cultural activity (SCAC) of the French Embassy in Jordan, and originally intervened on a rather large group of countries: Jordan, Lebanon, Oman, Syria and the Palestinians Territories.

The Mission concentrated its work on the rational piloting of plot irrigation. The first encouraging results enabled the mission to become a "technical reference" in the area. It organised regional conferences[20] during which national technicians were brought together.

From 1998 onwards, given the Mission's initial success, the Ministry of Foreign Affairs increased the means and the mandate of this original cooperation tool. In 2000, a budget[21] was approved towards the implementation of a regional programme. This programme was to be carried out by an organ of the French cooperation: the Solidarity funds priority (FSP). This new regional programme began in 2001 as the "Strategy of Water Management and Savings in the Near East". In order to work more in-depth, the Mission reduced its field of geographical intervention, and concentrated its actions on Jordan, the Palestinian Territories and Lebanon.

The programme set out to produce some elements of technical and socio-economic theory that the participating governments were lacking, regarding water management, the protection of the environmental and agricultural and rural development. While working on pilot scale the MREA hoped that information would reach the decision makers who could then convert these references into strategic decisions.

Box 3

Example of required and diffused references (according to Prévost, 2001)

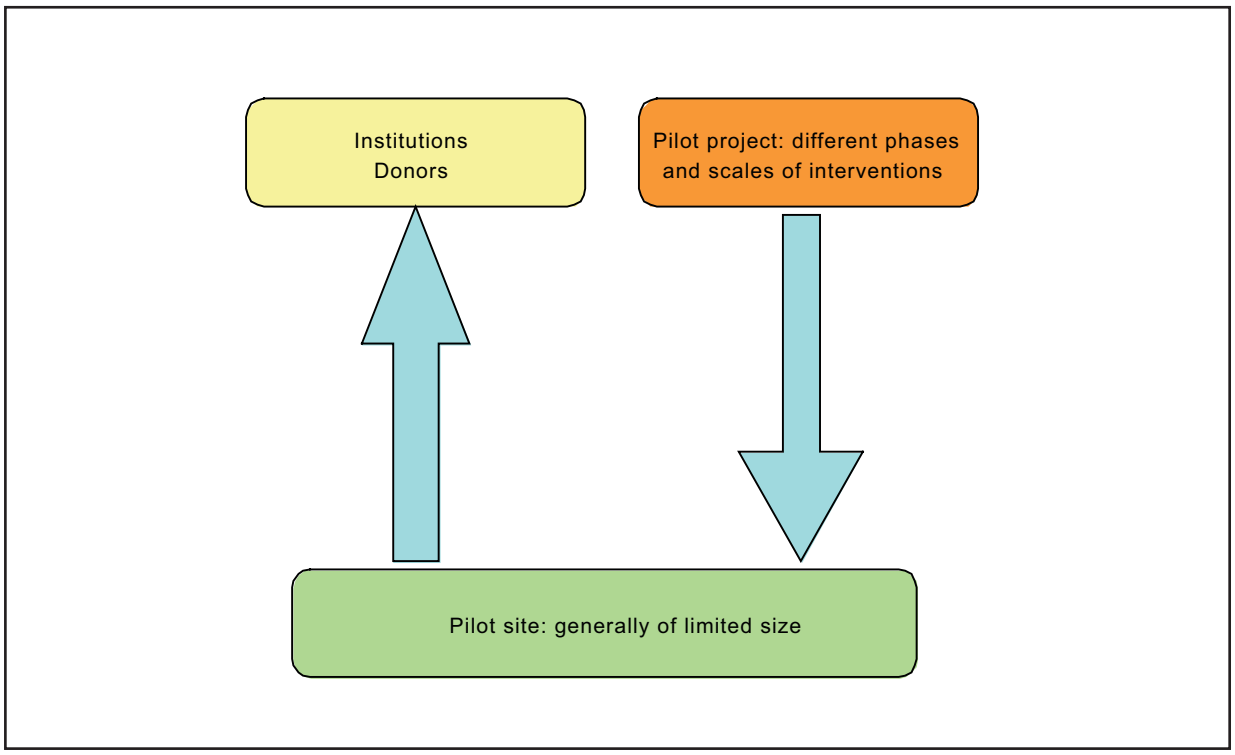
- Data concerning the technical routes and the materials allowing a sparing and rational water management at plot level
- Technico-economic results allowing to appreciate the efficiency of these technical endeavours and of the materials used at farm level
- Information concerning the farm environment and the factors favourable to its development (productions chains, markets, etc)
- Hydrological data in order to connect the impact of the use of water in agriculture (in particular a more efficient use) to the total availability of this resource

[20] For example in 1997, two conferences were organized, one based on irrigation research in the Mediterranean basin, in collaboration with the research center on water and environmental matters of the University of Jordan, and the other on reuse and processing of wastewater, organized in partnership with the Jordan Water Authorities (JWA).

[21] An original amount from approximately 1 million Euros was envisaged for the first 3 years.

Figure 7

Theoretical diagram of information flow between the pilot projects and the decision makers



This original instrument of the French cooperation was very different from the traditional types of intervention. The Mission was granted vast autonomy and certain flexibility as to its modes of intervention so as to be able to face the periods of crisis that regularly shook the area. From 1998 to 2007, the MREA enlarged the scope of its activities and gradually formalized its own methodology which will be presented below.

2 The MREA Method: action research and networking

The methodology developed by the MREA is comparable to action research. Indeed, the various projects initiated by the Mission consist in working on a pilot scale "to transform reality" via the installation of projects but especially "to produce knowledge on these transformations" (Hugon and Seibel, 1988). The pilot projects are thus characterized by their cyclic aspect. The teams redefine the methodological tools permanently to adapt to the requirements of the situations. They are conceived according to short cycles of "Design - Implementation - Evaluation - Design". The results of each action implemented are evaluated and are used as a basis for a new action. (Panzani *et al*, December 2007).

The starting point of each project is a technical problem, often identified at farm level. During the pilot project, the object of research was analyzed and possibly tested on several scales (according to Prévost, 2005):

- the farmer's plot (irrigation practices, watering tools, choice of cultures);
- the farm (systems of agricultural production, technical and economic results);
- the environmental conditions (operation of the irrigation networks, farmers organization, product marketing and organization of the marketing chain); and
- finally, the geographical and institutional scale of the water resource management (administration, private sector and professional actors, water billing, laws and regulations).

Figure 8

Simplified model of the action research process (Mac Isaac, 1995)

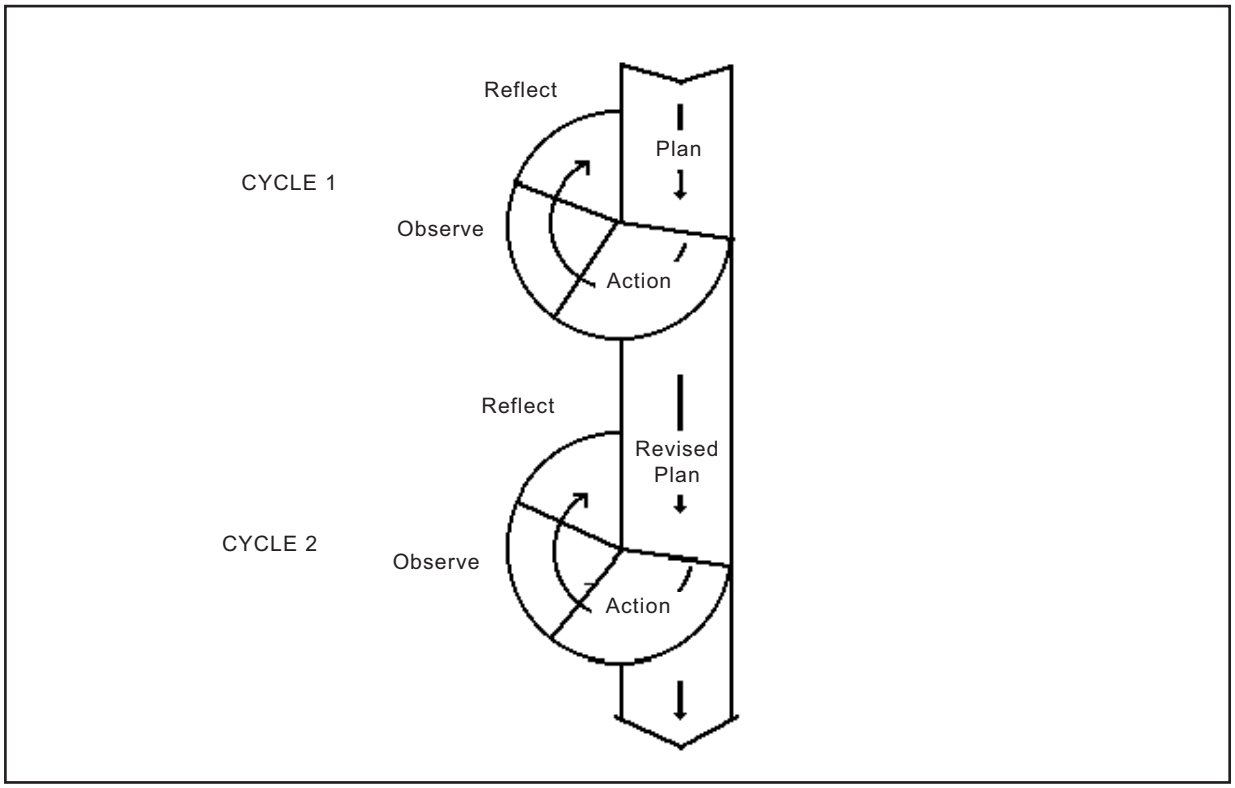
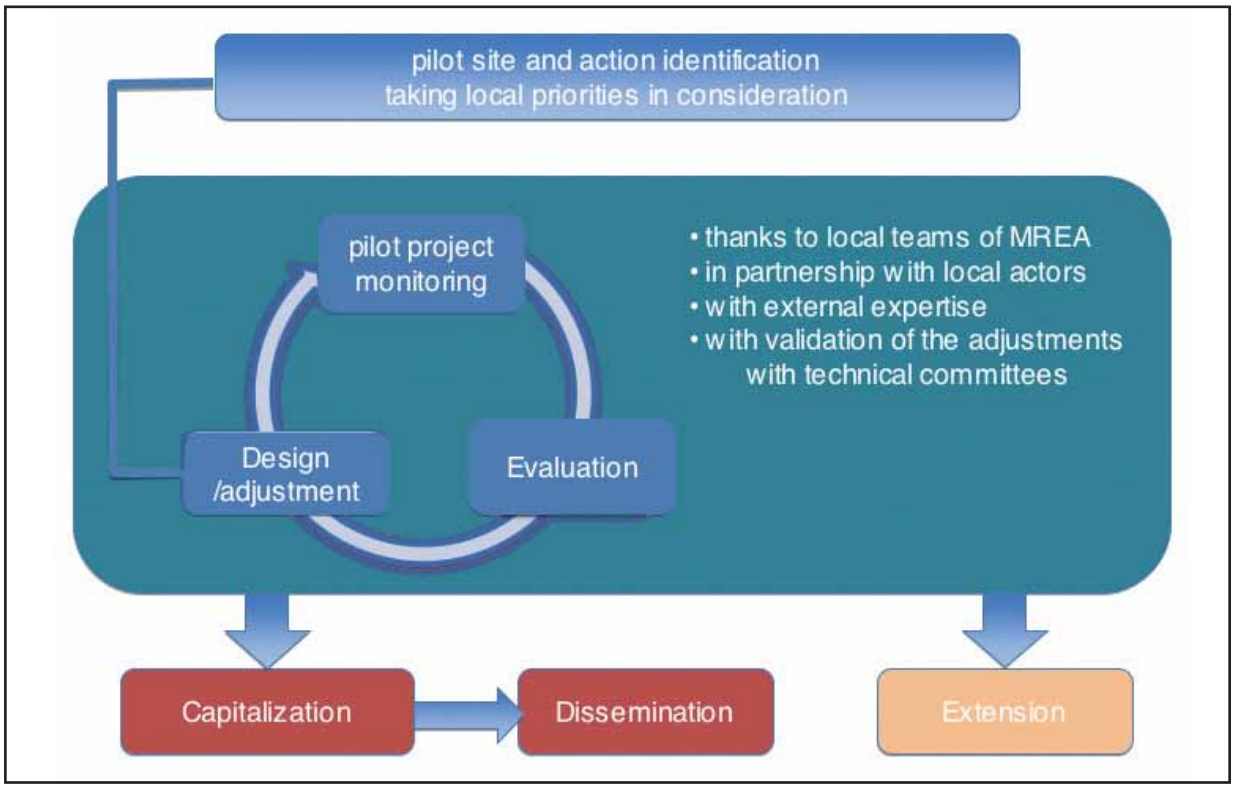


Figure 9
Pilot project cycle



The pilot projects were used as a basis for multidisciplinary research, ranging from "pure" technique to economy or sociology. The lessons learned were formalized to be used as reference and to influence the local authorities in their decision making if possible. The aim was not to promote standardized recipes or good practices, but to produce references (technical or methodological) anchored to practice and to given contexts, which would make it possible to reflect and build relevant and adequate action strategies (Lassalle, 2007).

The diagram Figure 9 summarizes the cycle of projects implemented for each topic or on each pilot site.

Beyond the theoretical aspects presented here, one will see in the following sections of this document how the action research activities were implemented.

2.1 A network of reference sites reflecting regional diversity

The first section contains an inventory of the main problems identified for agricultural development in the area, and of the general directions pursued by the donors. Given the means at the disposal of the MREA, it was decided to concentrate on themes of particular regional importance.

2.1.1 Mode of selection of the themes and of the pilot sites

The intervention themes concern a participatory approach that systematically associated the recipients (farmers), the development actors (ministries, NGO, etc.) and the MREA.

(I) Priority of the national actors and complementarities with the other actions of the donors
In order to reflect the priorities of the national authorities, the administrations (ministries of Agriculture, Water Authorities, research centres) were the recipients of the project steering committee. Coordination efforts were carried out with the other donors. The Mission endeavoured to limit the development of twin projects while working on complementary themes or by adopting a different approach. For example, unlike Jordan that has been working on the problems of wastewater for a long time, (in particular thanks to the assistance of the German cooperation), the Gaza Strip lacked field experience on this theme. The steering committee thus decided to establish a pilot site for re-use of wastewater in Gaza which would profit from the experience gained in Jordan thanks to the regional anchoring of the Mission.

(II) Feasibility and local receptivity to innovation
The Mission's positioning defined in the course of time, and it was able to keep track of the various initiatives launched over time. Previous cooperation experiences made it possible to appreciate the various local partners' receptivity to innovation, likewise their degree of motivation. In addition, it quickly emerged that given the regional instability, certain pilot actions in extremely vulnerable zones were doomed to failure. It was not very realistic, for example, to want to import material via Israel or to install a reference site in an area like Gaza. Similarly, to work on the development of exports chains for fresh fruit and vegetables from the West Bank remains a challenge when in fact Israeli *checkpoints* prohibit road transport. On the other hand, in Jordan, that remains the only relatively stable territory of the area, it was possible to carry out several experiments. These were used then as regional examples for the neighbouring areas. Moreover, it is the only State in the area which allows real freedom of movement to experts.

(III) Complementary themes per region
The sites on which the Mission intervened were to become the seat of observations, experiments and demonstrations. It was thus possible to acquire, validate, and compare technical, technical-economic, and organisational references in situations that were representative of the diversity of regional agriculture. The sites were selected in situations that were pedo-climatically, agronomically and socio-economically different. It was out of the question to reproduce identical experiments in the three countries. The regional exchanges regarding the established references had to contain sufficient elements for national debate.

2.1.2 Main themes selected for Action research

Improvement of the practices at plot level
This theme includes the optimization of the irrigation practices (localized irrigation, filtering and maintenance, irrigation piloting, etc.) and the control of crops (optimization of the fertilization, farming techniques under greenhouses, introduction of new cultures, improvement of the technical choices, etc.). The various innovations were tested on a network of pilot farms scattered across the area (*cf* Section 2, Chapter 1).

Wastewater reuse
Two pilot sites were set up in the Gaza Strip by re-using water from the two processing stations available in this territory. The first site experimented with fodder cultures, while the second analyzed the effects of the use of processed wastewater in citrus fruit plantations that had been irrigated by well water in the past (*cf* Section 2, Chapter 2).

Irrigation scheme management

This theme led to questions of management sciences but especially to the organizational aspects (participation of the water users, training of the managers, etc.). It was primarily addressed in three pilot networks in the Jordan Valley in Jordan within the framework of the project called IOJoV (Irrigation optimization in the Jordan valley) in close collaboration with the public authority in charge of the management of this area (JVA). It was also approached by the study of the operation of the various modes of management and division of water in progress in the valleys of Al-Bathan-Al Farah in the West Bank (traditional community channels, private drilling wells used by few owners, etc.) (cf Section 2, Chapter 3).

Development of the marketing chains

For a better valorization of the production, the Mission is interested in the operation of the marketing chains of agricultural produce. It primarily develops its activities in Jordan on the support of exports of high-added value fruit and vegetables. On this set of themes, it has overflows besides the strict framework of irrigated agriculture to be interested in the principal rain production in the area: olive oil, while following the pilot actions initiated in the West Bank by the Consulate-general of France and the AFPS (cf.section 2-chapter 4).

On a larger scale at basin level

More general questions linked to conflict between users and orientations of development are addressed using studies on three basins as reference: The lower Jordan (East bank), the Al Bathan – Al Farah Valley in West Bank , and the Oronte basin in Lebanon (cf. section 2 – chapter 5).

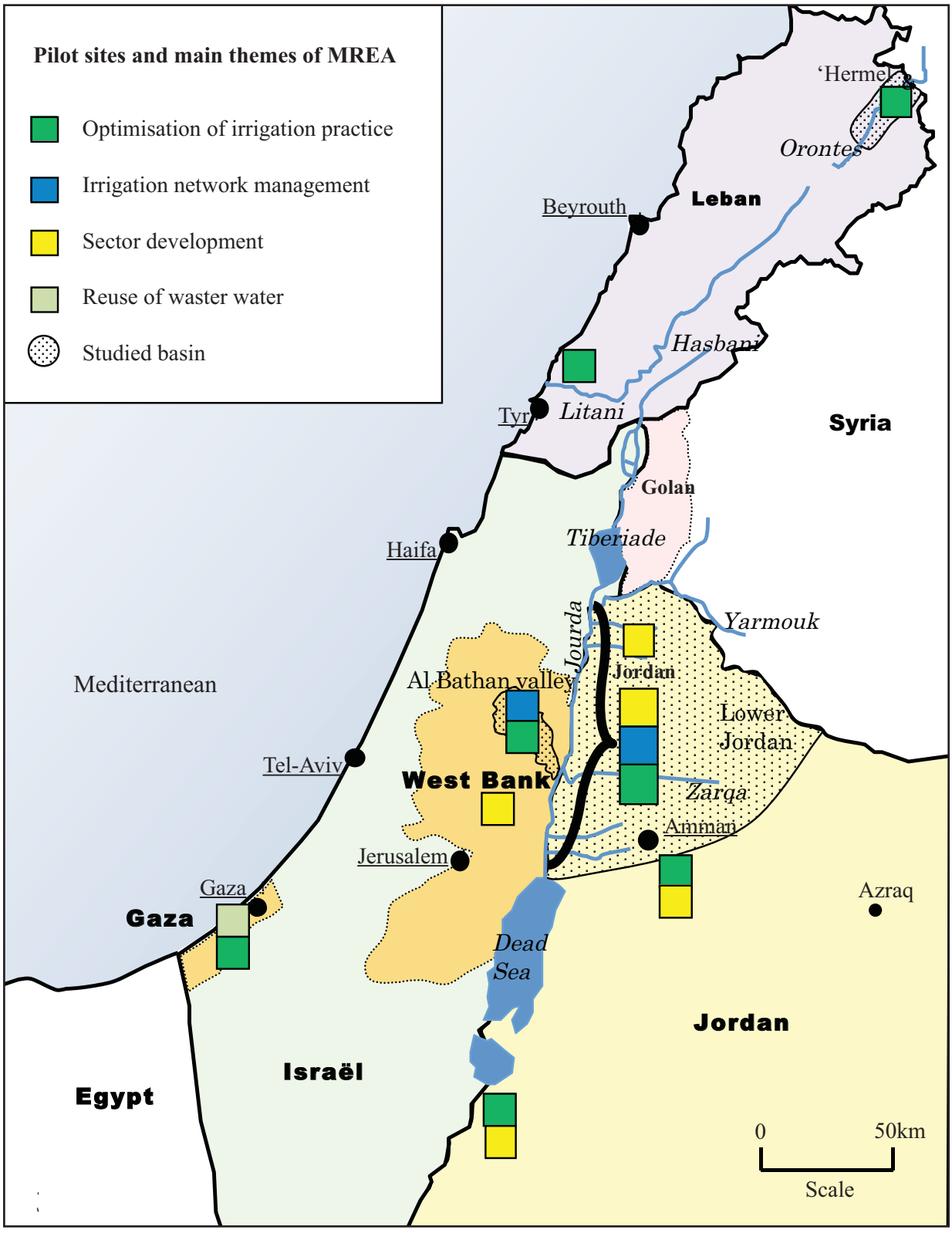
Table 1

Distribution of themes and corresponding pilot sites

Thème	Jordan	Lebanon	West Bank	Gaza
Improvement at plot level				
Irrigation optimization	pilot farms	pilot farms	pilot farms	pilot farms
Introduction of new crops	fruits and vegetables	capers - Hermel		
Wastewater reuse				citrus fodder
Irrigation networks management	Jordan Valley		Al Bathan Valley	
Sector development	fruits and vegetables olive oil		olive oil	
River basin studies and conflict of use	Low Jordan River	Oronte river (near Hermel)	Al Bathan valley	

Figure 10

Map of the various pilot sites



2.2 A cooperation based on presence

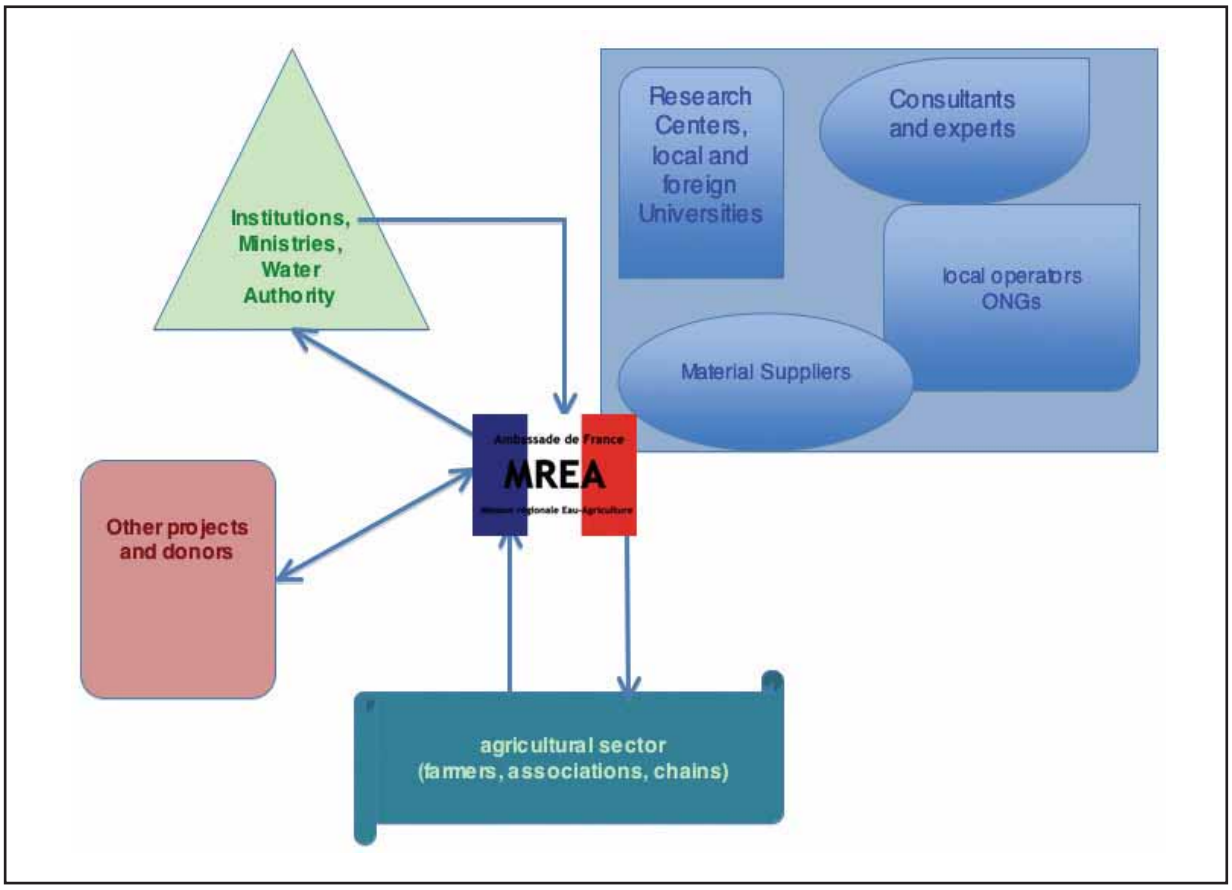
2.2.1 Leading the network: MREA and its partners

The uninterrupted presence, over thirteen years, of four successive regional technical assistants, and above all that of an "institution" located within the French Embassy in Jordan, made it possible to develop a relevant network of national and international partners. Over time, the Mission became a privileged exchange platform used by the different development actors. The following figure is a simplified presentation of the relations that came to be within this network.

Progressively, by its sole presence, the MREA became an efficient and essential link between the different actors. Given the nature of its activities, the Mission also became an appreciated operator in project implementation.

Here follows an excerpt from a verbal communication by Jean-Philippe Venot, author of a PhD thesis with IWMI[22] who largely contributed to the study: "Historical trajectory of a river basin in the Near East: The lower Jordan river basin, (in Jordan)".

Figure 11
The MREA network



[22] International Water Management Institute: www.iwmi.cgiar.org

"The presence of the MREA greatly simplified the organization of this study: first of all on a logistic level, as the IWMI researchers were put up in the MREA offices, but also because this set-up facilitated contacts with institutions, administrations, development agencies (GTZ/JVA/MWI, etc.) with which the IWMI would probably not have established such close relations if it had been on its own. The IWMI also benefitted from the understanding of the region acquired by the MREA".

2.2.2 Field Teams working in close collaboration with the local actors

"At the MREA, one must get up very early and drink a lot of tea". Thomas, a Third Grader from the Lycée Français of Amman who came to spend a few days and learn more about agronomy.

During the final evaluation of the MREA, the characteristic that came to the foreground, and was often referred to by the interviewed partners, was its presence in the field. "They are based at the Embassy, but remain very simple, and wear field clothes," explains a manager from the Palestinian Farmers Union (PFU). On every pilot site, technicians and engineers from the Mission worked directly with the actors on the field: with the farmers, first and foremost (farm visits, technical assistance, surveys); with the irrigation plant managers and the extensionnists; and with the representatives of producers associations or irrigated farming associations. Formal and informal discussions provided the basis on which to elaborate proposals for innovation, and ideas for new projects.

The links with the field and the element of trust that was developed between engineers, farmers and managers are very important aspects in the rural Arab world. Hospitality and solidarity networks are essential to daily water management and more in general to produce marketing (Van Aken *et al*, 2007). Interaction takes place in the *diwan,* which is the traditional space where guests are received. Whether it is in the comfortable leather armchairs in the offices of the local administrations, or in a simple plastic shelter on a humble farm, each actor provides a *diwan* on the workplace. In order to understand the relations and the power games between the actors, it is essential to be received in this space.

On the other hand, by working regularly with the beneficiaries, and by acting as intermediary with the administration, the engineers contributed to re-establishing relations that had often become distant, if not conflicting. In Jordan, for example, where farmers' associations and farmers' trade unions are not very representative of the base, the least influential farmers find it very difficult to make their voice heard by the public authorities. By meeting and interviewing as many smallholders as possible, and making sure that the weakest were not under-represented, the MREA tried to encourage them to express their points of view and describe their necessities.

Photo 1

MREA engineers during a field survey in a farmer's diwan.

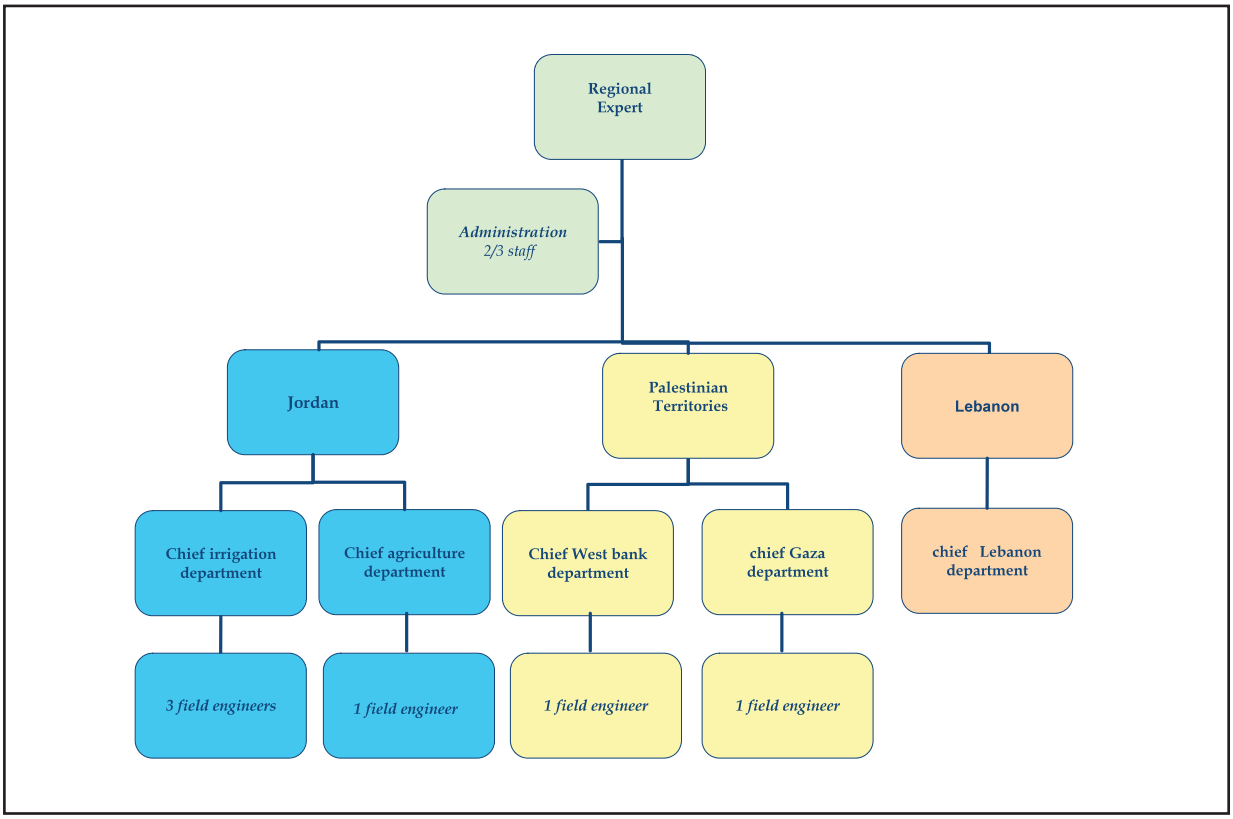
Box 4
The farmers as first source of innovation

A new filter was tested on a farm in Wadi Rayan, in the Jordan Valley. While the measurements were being taken, the farmer and the MREA engineer discussed many issues: the low prices fetched on the market, the water shortage, the high costs of labour, the limited management skills deployed on the distribution network, etc.

Having more or less covered the long list of problems affecting the system, the farmer went on to propose the solutions he would enforce if he were the "minister of water". He coined the term " water bank", that in his conception was to replace the quota system. This conversation triggered MREA to carry out a study aiming to look into the strategies developed by farmers in order to bypass the rigid quota system, and to prepare proposals that should make it more flexible.

Other than the French technical assistants, the Mission also employed over fifteen international volunteers - called *Volontaires Internationaux* (VI) in French - for a maximum two-year contract. In their capacity as Project leaders, the VI ensured the formation of local engineers and supervised the interns employed to monitor the pilot projects. Between 2000 and 2007 no less than 24 Jordanian engineers and 5 Palestinians worked for MREA.

Figure12
The MREA Organigram in 2004[23]



[23] Local employees are in Italics

2.3 A step by step process, backed up by French expertise

Action-research is a dynamic process whereby project enforcement and study are in continuous interaction. Each phase of a project must be analyzed and evaluated in order to define new actions on a different scale or another theme. The process requires an entire pool of experts and researchers from various fields of expertise, who intervene in the course of time and according to the progress the project is making.

2.3.1 Regular interventions by specialists

In order to introduce new techniques or to define a methodological framework, the Mission regularly sought expert advice over short time spans (one or two weeks). The reports written by these experts make up most of the project literature. Each intervention became the object of detailed feedback from the partners concerned. In the second section of this document, one will see how the work of these specialists brought an essential contribution to the overall development of the pilot projects[24].

The flexibility of the financing mechanism made it possible to involve irrigation plant managers, certifying specialists in irrigation tools and materials (often belonging to CEMAGREF), marketing of fresh products and sales managers, as well as technicians specialized in crop follow-up.

2.3.2 Pilot project leadership by the Société du Canal de Provence

The *Société du Canal de Provence* (SCP) was selected by legal tender to support the piloting of the regional programme. From the beginning of the regional project in 2000, the SCP Rural Development Officer formulated the general project guidelines. As the project evolved, he regularly returned to the region, followed up on the progress made and proposed reorientation guidelines when necessary.

Box 5

Case study - specialized technician called in for the cultivation of Charentais melon

Within the framework of the project aiming to develop the exports of high value fruit and vegetables, carried out in Jordan, the mission chose to introduce the *Charentais melon* (see Section 2, Chapters 1 and 3). It became apparent that the *Charentais Melon* is a very "technical" crop, being extremely sensitive to all types of excess: water, heat, nitrates all strongly and rapidly affecting the quality and the quantity of the crop. The introduction of such a sensitive plant in an environment as extreme as the Jordan valley calls for expert advice. Mere theoretical knowledge and gardening skills are not enough to ensure success. After an unfruitful season, the MREA called in a specialized French technician. Over the course of three visits of five days each he was able to pinpoint the main difficulties of *Charentais melon* production in autumn, and to suggest a series of technical adjustments to the engineers and farmers involved in the project. A technical guidebook containing the results of the different attempts was edited some time later.

In this specific case, the usefulness of the expert's intervention appeared to be undeniable; it avoided long months of research and ineffective attempts that would probably lead to the discouragement of many of the farmers involved.

[24] In certain cases, the experts invited were able to establish contacts with the beneficiaries and were later re-invited within the framework of other projects.

Box 6
The SCP and the JVA: over fifteen years of fruitful partnership

Over time, the Société du Canal de Provence has acquired solid experience in the Jordan Valley. During the early 1990s, and under KFW funding, the SCP installed the dynamic regulation system over the King Abdallah Canal, and designed various software management systems for the irrigated plots (WMIS system, designed for water demand management).

During the IPTRID evaluation in 2007, it appeared that the SCP was highly appreciated by the JVA managers. The Jordanian managers said that "there was a good understanding between the two organizations". In fact, both were created with the aim of developing the territory, and are both facing similar challenges: satisfying a big variety of users ranging from irrigated agriculture, communities, industry and tourism. The JVA provides for 30 000 hectares of irrigated land, as well as for big cities like Amman. The SCP covers 83 000 hectares of irrigated land, and 120 municipalities, including Aix-en-Provence. Their respective representatives (400 at SCP and 850 at the JVA) worked together on numerous occasions, during technical visits in Jordan and in France.

2.3.3 In-depth studies

"MREA's strong point is developing its own tools, that are well adapted to the local context (Doctor Emad Shudifat -conversation during the IPTRID-2007 evaluation)."

Pilot activities should not be appraised from a purely technical viewpoint. Field approach can have very limiting effects, by reducing the scope of action to a restricted area. It is therefore essential to gain perspective by stepping out of the framework of the actual activities.

These studies were carried out thanks to the intervention of several interns from French schools of engineering, and from local universities (3 to 6 months study visits). Researchers in human science, economy and geography also contributed to these studies. These students were assisted and supervised by the permanent members of the Mission, and by the experts that were regularly involved in the Mission's work. Collaboration with international study centers – such as the IWMI – was essential to guarantee the scientific rigour of these studies.

These studies make it possible to go further in the development of each project site, to connect one problem to another, to make comparisons between various regional situations, and to elaborate a better understanding of the situation.

The next step, following this method, was to bring the results to as many different actors as possible, across the whole range of different categories. The following paragraphs specify the tools used to achieve this result.

Box 7
Type of studies carried out by the MREA

Diagnostic Analysis of the Agrarian Systems[25]*:* Aiming to establish the local dynamics underlying the evolution of agriculture in the area, these studies concentrated on the farming history of a "small region". The farms are categorized under precise type models, and technical and economic data are gathered. The MREA supervised 8 studies of this type, across three countries (the UMR "Dévelopment agricole et agriculture comparée" by Agro Paris Tech.).

Study of the distribution networks: In order to acquire better knowledge of the distribution networks and their development potential, in depth studies based on surveys and statistical data were carried out.

Basin level study: These studies focus on the various uses of water at basin level, or on the conflicts linked to water use. Carried out at various levels of detail and depth, these studies retrace the chronology of the existence of a basin, and to replace man and his development in this history. Within this framework, specialized and controversial research topics were explored: for example several studies dealt with the impact of price of water on water savings. (Venot and Hassan, 2007).

Study of the conditions for the up scaling of pilot projects: On the basis of a technical appraisal of the projects and their impact, the Mission looked into the possibility of expanding the pilot activities. These studies consist in the elaboration of simple recommendations and practical suggestions geared to specific interventions.

2.4 Training as a core activity

"During my training at the MREA, I finally understood the scope of the four years of studies I had just completed!" Lina, final year as engineering student at JUST."

If one were to pinpoint only one aspect of these past thirteen years of cooperation, it would have to be the importance placed on training activities.

Within its own framework, the Mission trained young engineers who, thanks to their involvement in the Mission's projects, learned project management skills, and acquired field expertise that was acknowledged by professionals[26].

The training of the beneficiaries took various forms in the course of time, and according to the project type. Technical training was either continuous or imparted in the course of brief training sessions. Table 2 illustrates the training of over 1 000 individuals between 2005 and 2007. Training took the form of short practical sessions, based of the project resources used to illustrate theoretical concepts. At the same time, more specialized or thematic training was available thanks to study visits organized in France or abroad (thematic visits, technical training and study grants for long term training).

[25] According to the UMR methodology "Development Agricola et agriculture comparée" by Agro Paris Tech.
[26] Numerous young engineers trained by the MREA were later hired on other projects, or by local administrations.

Figure 13
Example of brochures and technical guidebooks

Finally, the Mission carried out awareness and information operations targeting a larger public, over issues of rational management of water resources in agriculture. Thanks to the publication of brochures and technical guidebooks (Figure 13) or by organizing information campaigns in Gaza (see Box 8) the Mission was able to reach a large audience. These operations were carried out in partnership with information agencies (Ministries of Agriculture, Farmers Trade Unions, Water Users Associations, teams from other projects, NGOs, etc.).

It is difficult to measure the impact of the different types of information described above. It is, however, clear that they will have a durable impact on the technicians from the region.

Box 8
Organization of an awareness and information campaign in Gaza on the reuse of treated wastewater

In Gaza, an information campaign was launched to illustrate treated wastewater reuse to the public at large. To this aim, various information tools were prepared: technical presentations, pamphlets, and above all a film. The film was shot locally, and illustrates the current situation of wastewater reuse and potential danger situations that could arise. It then goes on to show the achievements in wastewater reuse obtained on projects led by the Mission. Following the viewing of the film, debates were held during the course of which the organizers answered questions from the audience. Different sessions were held, geared to different types of audiences: The children, the women, the farmers, or the technicians. This type of information campaign can be very influential, by reassuring the public, familiarizing it with the issues at stake, and thus paving the way for projects on a larger scale (cf. Section 2, Chapter 2).

Table 2
Short-term training between 2005 and 2007

	Jordan	Palestinian Territories	Lebanon	Iraq
Trainers	3	7		
Civil servants	48	86	5	30
Private sector technicians	4		5	
Students	15			
Farmers	400	435		
Total	**470**	**528**	**10**	**30**

2.5 A resource centre allowing for the dissemination of innovations

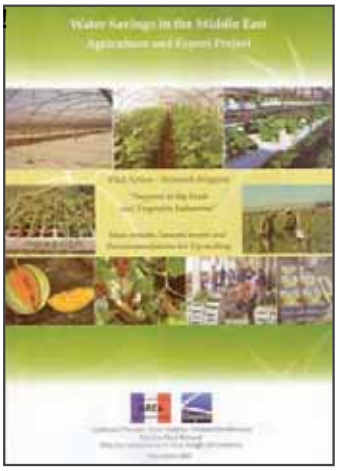
The references acquired during the projects' implementation phase must be validated and spread as widely as possible. Communication at the regional level, and several publications, are all to serve this purpose. This process leads to an evolution of the local mentalities and opens the way to change and innovation.

2.5.1 Diversity of the publications, each geared towards a different audience

The Mission teams dedicated quite some time to the editing and publication of various documents, which were to be consulted by a large public. A trilingual magazine called "Water and Irrigation" was regularly issued to inform the local technicians of the main technical results obtained. Reports describing the activities, and summarizing the recommendations were used to approach donors and governments. Thanks to its collaboration with research institutes, highly respected authorities validated the Mission's results. This enabled the Mission to reach an international public (see Box 8).

Figure 14
Examples of publications

Water and irrigation News



Pilot project final report

Scientific Publication

Box 9

Collaboration between MREA and IWMI (International Water Management Institute) for the study of the lower Jordan basin (Jordanian bank)

Between 2002 and 2007 the Mission collaborated with IWMI to carry out a study of the lower Jordan basin (Jordanian bank). This study was included in a larger, global study covering ten basins scattered around the world.

The basin on the lower Jordan River exemplifies a situation of extreme tension. The water resources in this arid climate zone are the objects of strong usage conflicts. The study begins by describing the transformations undergone by the basin in the past, replacing and quantifying the history of the development of water resources in the human context (see Section 2, Chapter 5). The social, economic, and political context of the current management of the basin are described in detail. Finally, scenarios and projections are elaborated to highlight possibilities for future evolution.

In the field of international research, the improvements brought to the lower Jordan basin received *"widespread diffusion and very positive feedback"*. The total number of publications on this topic includes: 2 research reports; 3 articles in international journals; 2 chapters in books; as well as the general summary document (interview, Venot 2008)[27].

The impact of the projects in the pilot areas was thoroughly documented, and the main results are presented in Section 2 of this document. The list of the publications is to be found in the bibliography. Most of the documents[28] previously found online on the Mission's Internet webpage (www.mrea_jo.org) will be available on the web site http://www.wca-infonet.org/iptrid/infonet/index.jsp shortly.

2.5.2 Inputting in the regional network

Inputting in the regional network was one of the core commitments of the MREA: each pilot site was to enrich the experience of the entire group of actors. However, regional tensions made it difficult to carry out this component of the Mission's work. Despite the hopes raised by the peace process in 1994, the region has been involved in new spirals of violence over the past few years. The diplomatic positioning of the MREA helped to avoid disagreeable inconveniences (for example with the circulation of foreign experts or the shipment of work material). It did not, however, provide an overall shield, nor was it sufficient to overcome all the obstacles[29]. The Mission was forced to reduce its initial ambitions, but succeeded in maintaining its regional activities, such as the organization of field visits, conferences and seminars, or supporting its partners' participation in international conferences. The Palestinians regularly availed themselves of these opportunities to communicate with the outside world. The partners from Gaza made the most of these trips to sensitize the international community to the extremely tense situation in which they find themselves.

[27] To consult the publications: http://www.iwmi.cgiar.org/Assessment/Reasearch_Projects/River_Basin_Development_and_Management/Projects-Locations/jordan_rift_valley.htm

[28] As well as the project documents

[29] It is noteworthy to recall that the two pilot sites in Gaza were destroyed by the Israeli army. Also, it was impossible for Palestinian colleagues from Ramallah to reach the pilot sites in West Bank. Human transit from and into Gaza was increasingly dangerous. One of the Palestinian engineers returning from a training session in Jordan was detained at the border between Egypt and Gaza for over three weeks.

Participation in the "peace process"

The following box highlights the possibility that a technical Mission such as the MREA can trigger initiatives at a higher political level.

In the third part of this document, we will see how the Mission, despite its limited means, was able to exert a certain influence in the field of agricultural development in the area.

Box 10

The EXACT group and the role played by the MREA

IN 1992, several international work groups were set up to support the peace process and in particular the Oslo agreements. In 1995 the *Executive Action Team*, or EXACT was set up with the support of the United States, the European Union and France, later joined by the Netherlands, Norway and Australia. The committee's objective was to contribute to the creation of a regional hydro-climatic database collection system. This database was intended to improve the level of the technical cooperation between the governmental institutions in charge of the water supplies. Moreover, it was to be used to foresee and manage crisis situations in the Jordan Basin.

The EXACT group convened twice a year and concentrated its efforts on the creation of a database. Though the meetings were held regularly, project implementation was very slow, and there was not much action in the field. In 1999, the Fonds Français pour l'Environnement Mondial (FFEM) launched a practical programme, and automatic hydrologic stations were put into place. According to Jean-Marie Barrat, ANTEA Project Chief working with the EXACT group, the input of MREA contributed significantly to the advancement of EXACT's work. Before larger projects were launched, the Mission played an active part during the biannual reunions, and contributed pertinent elements to the work groups on the issue of water for agriculture. The questions pertaining to the modernization of irrigation plants were of particular interest to the technicians. As technical discussions evolved, technicians from different countries developed closer relationships. The EXACT procedure has now become standard in terms of hydrological data sharing in conflict zones[30].

[30] http:/international.usgs.gov/projects/pawc-exact.htm

3 Lessons learned and future perspectives

3.1 Appraisal and extension of pilot projects

The references acquired by the Mission often served to convince local institutions and even donors that it could be interesting to upraise and extend the recommendations resulting from the general framework of the pilot projects. The table below summarizes the different projects organized by the Mission according to the various themes that it had identified. Currently, there are several projects on hold, awaiting financing. This list only presents project proposals with donors having shown interest in or that are officially in the implementation phase.

As shown in the table, and for each of the selected topics, a multiplier effect has been observed. It is noteworthy that many different institutions wish to take over the projects, and that financing is offered from such a variety of different sources.

It is undeniable that MREA pilot activities had a concrete leverage effect. However, it is important to look at its limitations. The institutional positioning of the MREA implicitly placed it within the "Donor" category. In fact the MREA was a member of the French Cooperation and could only receive financing from France. However, in the overall donors list, MREA only represented a tiny part of the international aid offered to the local governments either in the form of loans or grants. In the fields of water and agriculture, the Spanish Cooperation in Palestine, and the German, American, European and Japanese Cooperations in Jordan, offer a much stronger financial contribution to the beneficiary countries. Initial ambitions and intuitions were rapidly put in check by the reality principle. Ministries have their own agendas, and in order for recommendations to be taken into account by the decision makers, it is essential to have the necessary funding. Of course, seminars, conferences and participation in donors' round tables[31] can make it possible to circulate certain ideas. More often than not, however, when attempting to influence the local decision makers, the lack of financing can only be compensated by full time lobbying by an independent national organism.

[31] In Jordan, technical committees regularly meet, grouping different projects on similar topics under the supervision of the *Donor Lender Subgroup on Water.* This group is comprised of the main donors in this field. Concerted debates enable the group to define common strategies.

Table 3

Appraisal and extension of pilot project recommendations according to main themes

Theme	Pilot Project	Possible extension	Local Partner interested	Description	Funding	Situation
Irrigation networks management	IOJoV	North of the Jordan Valley	JVA	7 irrigation schemes – 3 400 ha better management of 4,5 Mm^3/year	AFD	Ongoing
		Wadi Araba region	JVA	Optimization of the management of South Ghors' schemes		
		Jericho schemes	PFU	Network 400 ha - 500 farmers	MAE	Ongoing
		Bekaa Valley South Lebanon	LRA	Experience sharing between LRA and JVA on network exploitation		
Optimization of irrigation at plot level	pilot farms	North of Jordan Valley	JVA	Optimization of irrigation at plot level 1 100 units	AFD	Ongoing
		Wadi Araba	JVA	Optimization of the management of plots in South Ghors		
		Jericho Command areas	PFU	85 beneficiaries – 70 ha	MAE	Done
		Hebron region and Bethlehem	PFU	190 beneficiaries – 37 ha	Arab funds	Project prepared
		Jordan Valley	IRWA	Equipment of 30 farms	UE	Done
Reuse of wastewater	Gaza pilot sites	Gaza Strip	PWA MoA	10 farms connected to the Gaza wastewater treatment plant Plot level equipment	Spanish Cooperation	Done
		Gaza Strip	PWA PHG	100 ha connected to the Gaza wastewater treatment plant		
Sector development	export of high value added fruits and vegetables	Reinforcement of cooperatives	JEDCO	Registration of 15 cooperatives		
		Support of marketing	JEPA	Creation of market information system		
	Olive oil production Palestinian cooperatives	West Bank	PFU	Support to 21 cooperatives - production of 450 tonnes of quality olive oil	Swiss UE-AFD	Ongoing
		Jordan- Ajloun mountains	MoA JEDCO	Support to cooperatives for quality olive oil Registration and promotion of a geographic indication	AFD	Project prepared
River Basin management	Hermel site	Hermel Region	VERSeau	ISIMM case study on social water management	UE	done
	Al Bathan pilot site	Al Bathan Valley	PWA MoA	Water resources planning		
		Al Bathan Valley	An-Najah University	Experiment on social water management		

The following Box 11 illustrates the role of MREA in European projects.

Box 11
European projects MREA and MEDA

In late 1999, the MEDA Water initiative was launched (on a 40 Million Euro fund). It gave birth to ten projects, three of which dealt with irrigation in the Near East. The MREA, in its capacity of Service of the French Embassy, was not in a position to make contributions as a direct partner. The Ministry of Foreign Affairs, however, indicated that the MREA mission should act as a catalyst. This was done according to three modalities:

1) By allowing French actors to take part in the projects: Thus the VERSeau group, previously active in Lebanon at the side of the MREA on the pilot site at HERMEL was able to participate in the ISIMM project (Social and Institutional Innovations in Irrigation Management in the Mediterranean).
2) By the intermediary of managers trained by the MREA: for example, two Jordanian and a French engineer took part in the IRWA project *(Improvement of Water Management in Lebanon and Jordan – www.irwaproject.com)* .
3) By sharing its tools and methods: Lebanese and Jordanian engineers from the IRWA project, and Palestinian engineers from the MEDWA project *(Stakeholder Participatory Sustainable Water Management at Farm Level)* benefited from training at the MREA; this collaboration takes the form of common publications.

3.2 Cooperation with a large number of other organisations

3.2.1 Strengthening the capacities of the organisations

By working in close collaboration with the local organizations, the Mission was able to strengthen their project management capacities and to offer suggestions as to strategy formulation.

Support to the institutions
Cooperation with certain institutions has been going on for many years. At the JVA, for example, an entire generation of engineers “grew up” with MREA. Some young engineers who benefited from training opportunities in France with SCP, are now occupying high responsibility posts. They remain very open to the tools and methods that they learned at that time. These individuals, who have elaborated the message in their own manner, will play an important role in defining future farming policies.

Support to operators
The regional operators who contribute to the project implementation are even more reactive in acquiring references and using them at best. Let us cite the example of the Palestinian Hydrology Group (PHG), ex-pilot project operator for Palestine. When financing was interrupted, the NGO expressed the desire to retain the Palestinian engineer who had been involved in the experiments in wastewater reuse in Gaza. The organization thus interiorized the project’s conclusions and became a reference point on that subject. One can easily imagine PHG playing a key role in future projects on wastewater reuse.

Another illustration of this impact is given by the case of the Palestinian Farmers Union (PFU). Following its positive experiment in the modernization of olive oil production, the PFU decided to reproduce this model and to open an irrigation department. This department is largely inspired by the references on irrigation divulgated by the MREA. The PFU opened its first project at Jericho and recruited two former MREA[32] engineers to this end. The PFU directors chose the following strategic orientations for its departments:

- Support to farmers for the optimization of plot level irrigation schemes, on the basis of the technical package and training methods previously developed.
- Social water management: support to irrigating farmers and managers, full usage and maintenance of irrigation plans.
- Wastewater reuse.

Fruitful partnerships with the private sector

Working with the private sector ensures the long-term diffusion of innovations that are technically and economically interesting for the farmers. Farming material suppliers selling filtering materials provide a good example of the efficiency of this type of partnership.

Having analyzed the types of filters available locally, and having observed the ways in which they were used by the farmers in the Jordan valley, the Mission perfected a vertical sand filter with the help of the Société du Canal de Provence experts. This filter was designed to respond to the local needs, and came with an instruction sheet for the local farmers. The utility of this filter was demonstrated on pilot farms, and the sand filter supplier for the Jordan Valley now recommends this model to his clients.

The examples above provide a satisfactory illustration of the dynamism of the MREA network, and the reality of certain local partnerships. However, as the time comes to convert pilot project recommendations into development actions, the question of the distribution of new projects arises. The situation of the Palestinian Territories and that of Jordan greatly differ.

3.2.2 Capacity of the local networks to spread recommendations on a large scale

In the Palestinian Territories, given the absence of a government up until very recent times, civil society played a surrogate role and organized itself in order to carry out development projects successfully. In 1983, the Palestinian Agricultural Relief Committee (PARC) was created to make up for the absence of a Palestinian technical institute. This agricultural development organization aimed to help farmers to enhance their resources. It has grown a lot, and now counts 130 employees and 6 500 volunteers (see PARC web site). Along similar lines, other powerful NGOs, as well as Farmers Trade Unions have emerged, and have become local development reference points, capable of reaching a very large base. Thanks to these organizations, it is relatively easy to collaborate with an NGO that is able to reach a large number of beneficiaries despite the obstacles due to the occupation in the Palestinian Territories.

Since its creation, the Palestinian Authority has been trying to centralize the activities that had been managed by associations hitherto (Abu-Saada, 2006). Though certain overall agreements have

[32] 100 000 Euro fund from the French Consulate in Jerusalem, and several project proposals underway with Arabic funding.

been reached, the relations between a weak Palestinian Authority and a powerful plethora of NGOs is often tense.

Palestinian Ministries are in fact struggling to strengthen their authority in the territory, and suffer the effects of competition from the NGOs. The donors are torn between the desire to strengthen the PA[33], and their desire to ensure that aid should be distributed in a transparent and efficient manner.

To exemplify this case, it is interesting to compare the evolution of two pilot projects financed by the French Cooperation. One project was carried out in partnership with a local trade union (the PFU), and the other with the Ministry for Agriculture and the Water Authority.

In 2002, the French General Consulate financed a pilot project on the improvement of the quality of Palestinian olive oil. Three cooperatives that worked with the Palestinian Farmers Union (PFU) were given support. The farmers and the mill owners received tools, material and training. The trade union rapidly accepted the technical results obtained, and took over the project. Two engineers were hired (one French and the other Palestinian), and financing was sought in order to enlarge the scope of the initiative. This proved to be a successful move, as there are currently 550 farmers, grouped into 21 cooperatives, and producing 450 tonnes of high quality olive oil. This was made possible thanks to financing from the Swiss Cooperation, the European Union, lately joined by AFD (Cazalis, 2007).

The second pilot project addressed the improvement of irrigation techniques and was carried out in the Al Bathan valley in partnership with the Ministry of Agriculture. The technical-economical results obtained were just as pertinent, and an action plan was proposed to develop this initiative (Onimus, 2006). Given the paralysis at the time, the Government found itself in the impossibility to circulate, underpaid employees and lack of financial means, hence the pilot project never translated into action on a larger scale.

The will power of civil society makes up for institutional deficiencies. Better coordination between these two realities is hoped for by all concerned. Until then, the NGOs provide an essential basis from which to bring forth innovation in the field.

In the Kingdom of Jordan, the situation is the complete reverse. The strong and patronizing central government did nothing to encourage the development of the civil society, which remains non-existent to this day. During the liberalization process that appeared in the country after 1990, organizations operating in support of agriculture were substantially weakened. Non-governmental organizations were not there to take up that space. Only individual private enterprise was encouraged by the State. The resulting situation is a caricature. A tiny group of farmers receives most of the aid offered by international projects, in a kind of funnel effect, whereby all the subsidies are distributed to a few people. This is also due to the absence of local reference points. When it was ready to propose large-scale activities, the MREA was confronted with these insufficiencies and the absence of local reference points. Some of the existing project proposals will probably never be implemented since no relevant interlocutor exist for the moment.

[33] Periods of political turmoil during which the PA is overwhelmed are excluded. The international community, for example, decided to suspend its relations with the Palestinian Government after the victory of the Hamas movement in the 2006 legislative elections.

Currently, the managers agree that it is necessary to develop the farmer's trade unions, the extension agencies, and to provide assistance to improve sales and distribution. Unfortunately, none of the local development organizations is able to provide such assistance.

There are top-level consultancy firms, but they tend to focus on issues linked to infrastructure, or to specialize in institutional piloting, and have little experience in agriculture support structures. Moreover, in order to enhance the capacities of the local institutions it would be necessary to obtain long-term expert support. This is only possible via international projects that often lack overall coherence and coordination. Finally, the few existing NGOs or foundations that are in charge of development programmes are very reluctant to work in partnership with governmental institutions. In fact, they are well aware of the administrative setbacks involved, and are afraid to be slowed down in their progress and thus lose credibility with the beneficiaries. In the future, it would be decisive for the evolution of new projects to have an independent organization as local reference point. This organization should also be able to provide support to the local structures.

3.3 The necessary evolution towards national institutions

Given the recent developments, and the long-term existence of the MREA, it seems crucial to reconsider the MREA's positioning. In order to play its role as a catalyst at best, an action research organism needs to be anchored to a "regional or a national" structure, that can guarantee its neutrality and reinforce its final influence.

Moreover, as pointed out in the previous paragraph, in order for the outputs resulting from action research to reach the greatest possible number of beneficiaries, they must be taken up by development organizations. Those structures currently lack in Jordan. In its capacity of emanation of the French Embassy, the MREA was not in a position to fulfil this role. It is also noteworthy that in 2005-2006 a major reform of the French Cooperation took place, leading to a complete reorganization of the technical cooperation, and leaving the MREA without regular funding.

An exploratory study was undertaken in May 2007 by the GRET (Lassalle, 2007) in order to establish whether it would be interesting to create a structure to take up the MREA inheritance. After a rapid evaluation of the existing resource centres, talks with the key actors and a series of visits to the donors, the GRET expert opened discussions on the collective future of the MREA.

During a seminar held in Amman in May 2007, attended by most of the MREA's "historic" partners (about fifty representatives from Palestinian and Jordanian organizations), the participants proposed five main strategic orientations for the inheriting structures. The proposals entailed: 1) concentration of issues related to water in agriculture, and agriculture; 2) continuing action research activities; 3) guaranteeing the production of references and know-how; and 4) inputting information in the regional network. These institutions should also promote the implementation of large-scale projects by mobilizing funds from several donors.

The participants insisted on the necessity of taking on a double mission in the future: on the one hand an action research mission (in continuation of past activities), and on the other, an important role to play in development. Several institutional settings were suggested and evaluated. The assembly finally chose to create two distinct inheriting structures.

The following two sub-chapters describe the two structures that inherited the MREA know-how. They contain the details that justified their creation, and retrace the first steps of these new structures.

3.3.1 Continuing action research activities in Universities

Choosing the institution that will host the action research activities

Action research projects require certain institutional, financial and organizational conditions, that are not readily available in all research institutes. To produce concrete and relevant innovations, the chosen institute must satisfy the following conditions:

- Professionals specializing in a variety of subjects must be easy to mobilize.
- Access to research funds must be relatively easy.
- Above all, the institute must have the authority and the mandate to engage in the specific research (Lassalle, 2007).

With these criteria in mind, the governmental research institutes and the NGOs were rapidly discarded. In fact, the only two institutions with an adequate *pool* of professors, were Universities. These professionals work on various disciplines, and are accustomed to publishing their results. Moreover, the Universities enjoy a certain degree of independence from the state, and are platforms where excellence is put to the service of society. Finally, they can easily create contacts with other international universities. This was not the case for the other institutions that were taken into consideration.

Obstacles identified that will condition some of the strategic choices

In the region, the Universities are well considered in the academic circles, but suffer from a bad public image: they are accused of being "disconnected" from the field. The training they offer is considered to be too theoretical. The professional formation imparted to the students is not thought to be well adjusted to the job market[34]. When questioned, students tend to confirm this diagnosis.[35]

Hosting the action research centres could be a good opportunity for the university to correct this negative image. By taking part in the activities, the students would be able to "leave the classrooms", and gain practical experience related to their future jobs. They could also gain awareness of the complexity of agriculture. It is plausible that the courses of study could be modified to integrate new subjects, or at least take on a more practical approach.

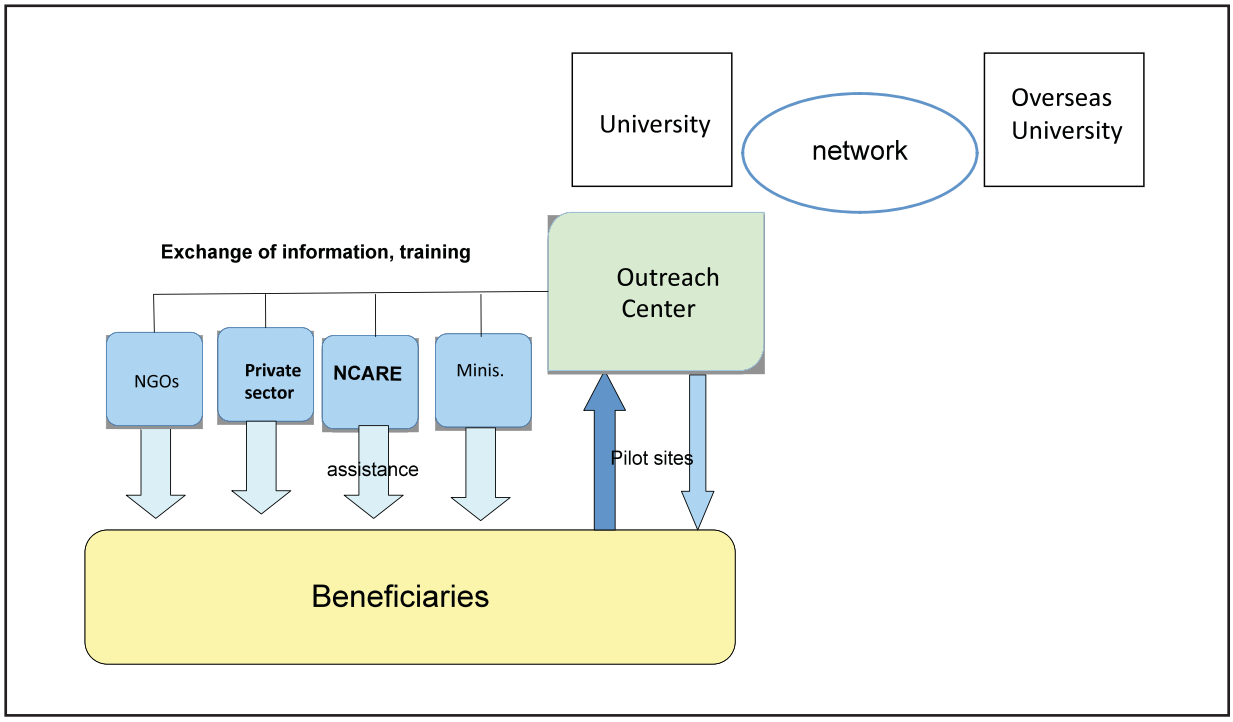
The centres could become a space were the academic world comes into contact with the outside world (*outreach*). To this end, it is important to ensure that the research carried out is aligned to issues of current concern in the field of agriculture. Research orientations must therefore be decided in agreement with non-academic representatives. An example would be a steering committee comprising state-run institutions as well as NGOs. This committee would also represent a valid discussion centre where pilot project recommendations could be elaborated. These recommendations would then be projected at a higher political level. Figure 15 illustrates the recommended functions of the action research centres.

[34] Remark made during the seminar MREA on the move – Amman, May 2007

[35] Questionnaire filled out by young laureates from Jordanian Universities (MREA, 2007, unpublished survey).

Figure 15

Recommended exchanges for action research centres



Last, but not least, it is a well-known fact that the regional universities – despite their autonomy – lack flexibility and are weighed down by hefty administrations. In order to ensure the success of the future action research centres, it will be necessary to avoid administrative paralysis, and to combine flexibility and reactivity[36]. These two qualities will be essential to ensure that external competences are rapidly sought for when they are not found to be available within the university.

For the time being, two universities in the region have declared themselves available for the creation of action research centres: the Al Balq'a, an Applied University in Jordan[37], and the An-Najjal University of Naplouse in West Bank. They are currently seeking financing in order to develop action research activities in centres attached to the universities. The MREA's historic partners strongly expressed their desire that this type of research should be continued in the region. From now on, it is up to them to ensure that these universities receive the support they need to implement this initiative. Similar projects have been carried out in other countries, such as Haiti, the West Indies, Brazil, Ethiopia, Tanzania, etc.)[38]. They have proven to be successful. The MREA project was strongly supported by the local administrations at its outset. It would be a shame not to allow the project to grow beyond the conceptual phase, when it is ready to become fully operational.

[36] It is recommended that the centres should be placed under the direct authority of the President of the University, and to commence the activities with a very tight and operational team. Also, funds should be raised outside of the University by responding to research offers.

[37] Located in the Salt region, halfway between Amman and the Jordan Valley, this University also has decentralized offices.

[38] In partnership with GRET.

3.3.2 The creation of an NGO for development in Jordan: MIRRA

As noted above, numerous donors and institutions deplore the absence of organizations specializing in farming development in Jordan. Such organizations would be much needed to support development projects. In the Palestinian Territories, on the contrary, project implementation is possible thanks to the presence of powerful NGOs. These organizations, provided with the necessary support, can implement projects in the field[39]. During the seminar organized to discuss the MREA's future, participants insisted on the necessity of creating an organization of this type.

Creation and organization of MIRRA

A group of former MREA engineers decided to register a non lucrative company with limited responsibilities[40], and called it MIRRA (Methods for Irrigation and Agriculture). The MIRRA specializes in supporting agriculture development programmes.

The French Embassy helped them to collect the necessary funds to register the company, which was registered in 2007.

The shareholders directly nominated five directors to ensure the governance of the MIRRA, in conformity with the recommendations of the GRET expert.

The Directors' Bureau is comprised of the following members:

- **One member from a University:** an academic is designated to be head of the Directors Bureau: he must guarantee the rigour and correctness of the methods applied, and conveys scientific credibility to the NGO. He also ensures the link with the academic world.
- **Two representatives of the beneficiaries:** to ensure that the NGO's Governance takes into account the actual needs of the farmers, who are the main beneficiaries of the projects. Representatives from the main farmers' Trade Unions from Jordan[41] and from the Palestinian Territories were offered membership in the Directors Bureau. The Palestinian Director also opens the possibility of regional interventions for MIRRA.
- **One representative of shareholder:** As stakeholders have financial responsibilities within the structure, their representative ensures that their interests are protected, and takes care that the original intentions underlying the creation of the society are respected.
- **One representative of the personnel:** to guarantee the good governance of the group and to protect the interests of the employees. Given the unstable job market, it is important to ensure employee wellbeing to avoid excessive turnover.
- **An Operational team** consisting of a core of four people in charge of fund raising and project implementation. MIRRA is able to recruit, train and manage teams on the project sites.

[39] In the future, this kind of support could be provided by one of the research-action centres (For example, the centre hosted by the University of Naplouse), or by means of partnerships with other NGOs, or Consultancy Agencies such as MIRRA.

[40] This status is generally adopted by Jordanian NGOs.

[41] To this day, the Jordanian representative has not been selected. This chair is held by stakeholders. The rapid resolution of this situation is hoped for.

Strategy and positioning

Though MIRRA has not produced strategy documents to this day, its thematic orientations are well-known. MIRRA advocates agricultural development based on the principle of sustainable resource management. It also believes in the empowerment of farmers' associations according to the following axioms:

- Support to technical innovation in the field of agricultural development within the framework of sustainable resource management (water, soil, etc.).
- Support to Farmers' Associations, including marketing aspects, and common management of shared water resources.
- Support to structures offering aid to agriculture (network managers, information agencies, etc.).

Risk

It is too soon to judge the success of this new company. Currently, the NGO is working on activities that were initialized in the past by MREA. The real challenge ahead is for MIRRA to develop new activities.[42]

A feasibility study showed that, quantitatively, MIRRA had good chances for success (economic balance and clientele). It is on the qualitative level that there are greater risks. After over one year of existence, three series of questions demand urgent answers:

- Will the personnel succeed in enhancing its level of competence and manage to diversify?
- Currently, the stakeholders that are engaged on the project are technicians: will they be able to change their approach from a fundamentally technical one to assume a more political stance? It might be tempting to develop a private clientele that would know how to appreciate expert farming advice. This would be detrimental to the Farmers Organizations.
- The creation of this NGO is a collective project that needs to be interiorized by the local administrators. Personal conflicts and interests need to be set aside.

In fact, the transition from the MREA to the MIRRA was carried out under great pressure (end of credit announced at the last moment). The French component took a very active role in granting independence to the inheriting structure. The rapidity of the transition obviously entails a certain element of risk.

MIRRA comes into being at a time when national NGOs are rapidly gaining ground and power in the field of cooperation. Whereas in certain countries the civil society traditionally plays an important role, this experience is a real challenge in the case of Jordan. At this time, it would be beneficial for MIRRA to form partnerships with other NGOs in order to ensure its future longevity.

[42] For further information on the MIRRA and the projects underway: http://www.mirra-jo.org

Conclusion

MREA was originally conceived as an instrument through which the French diplomatic services could participate in technical discussions surrounding the peace process. Over the following thirteen years, it gradually evolved, and became a well established technical mission, operating according to a convincing methodology.

MREA's permanent link to the field, coupled with its capacity to carry out in-depth studies, allowed it to acquire considerable knowledge of the region, over a relatively limited period of time. The quantity and richness of MREA reports, published in collaboration with scientific partners brings forth testimony of this knowledge.

A vast system of technical guidelines was elaborated on the basis of the dynamic action research process enforced during the Mission's work-life. Section 2 of this document only offers partial coverage of these guidelines, but aims to inform the public of the actions carried out, and of the possibility of using the resulting technical material.

In a region where water resource issues are complicated by demographic and economic growth, political instability and by the consequences of the climate change, all mechanisms operating in the favour of innovation and disseminating new modes of thought or action are welcome.

The "MREA story" clearly illustrates how human and financial means can achieve significant advancement. By promoting the creation of action research centres within the framework of local universities, the Mission hopes to be setting the first stone to more permanent action. There is still a long way to go, and it is now up to the MREA's former partners to ensure the future of the newly-born *think-tanks*.

Finally, the MREA experience highlights the fact that it is pointless to elaborate technical packages and pertinent strategies, if there is not any organization capable of disseminating the recommendations on a large scale. Of all evidence, the main urgency is to support all development organizations (governmental or non-governmental) that take this mission upon themselves. The "network of partners" gathered over the course of the MREA experience, affords a vast choice of operators, associations, administrations, or consulting agencies that can compare notes and act in support of one another. The richness and complexity of the MREA experience is certainly due to the valuable information shared in the network by many organizations with different backgrounds. This type of concerted approach, which has proved itself so effective, should inspire other actors working in development in the Near East, or find an application in different contexts. In fact, adoption by as many actors as possible will determine the method's success over time.

Section 2 Examples of MREA actions

1 Innovation at plot level for a sustainable management of the farm

It is generally admitted that in the Near East water savings can be achieved at plot level. It has been documented that in most farms, irrigation efficiency barely reaches 50 percent. Furthermore, producers can choose high added-value productions.

MREA, in collaboration with local partners, has introduced a number of plot-level innovations, testing if the local farmers were open to said innovations. The Mission started assessing their efficiency, according to two criteria considered as priorities: water-saving and income maximization. Lastly, several systems enabling the diffusion of the most relevant innovations were put to the test. This chapter summarizes the main results obtained and the methodology developed.

1.1 Introducing and Testing Plot Innovation

1.1.1 Typology and Location of Pilot Farms

The impact of the introduction of a technology varies considerably according to the nature of the farms concerned. Farmers react differently to innovation according to the constraints of their farms and the previously developed strategies.

The farm types underlying the choice of the pilot farms were determined following diagnostic analyses of the agrarian systems (Calderon and Lacroix, 2000; Ducros and Vallin, 2001; Millet and Moreau, 2002; Naussac, 2003; Mondon, 2006; Belna and Bouby, 2007).

To make sure the pilot farms are as representative as possible of the different types of farms in the region, several characteristics were used:

- **Type of crops**: the most representative crops are bananas and vegetables grown in open fields or in greenhouses.
- **Water Access Means:** farms either depend on a collective perimeter (pressurized or not), on private borehole (sometimes shared among several farms), or on much more expensive water supply systems (delivery by lorries or desalination). The quantity of water, the flexibility of its distribution ("water turn", quotas, or upon request), but also quality and costs, are the decisive elements determining the choice of irrigation systems. The issue of the reuse of wastewater has been studied more in-depth in Gaza and will be the object of a separate chapter.
- **Type of plot irrigation system:** gravity irrigation, pressure irrigation, with or without private reservoirs.
- **Farmers' socio-economic level:** this often goes hand in hand with their commercial strategies (see Section 1).

Table 4 offers a summary of the different farm types used as references for pilot plot actions.

Table 4
Pilot Farm Typology

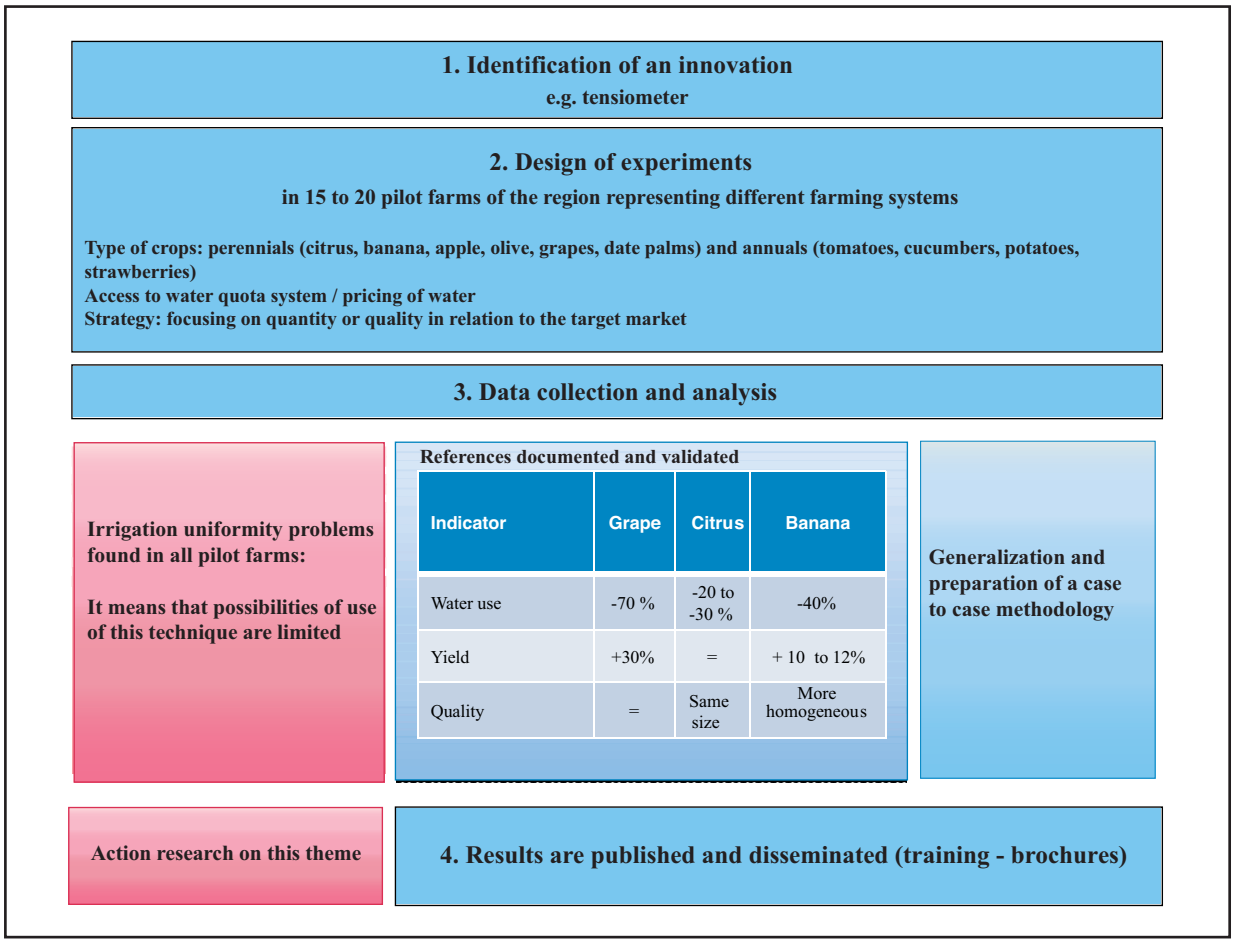
	Collective System with Quotas	Traditional Collective System	Individual borehole System	«Expensive » System
Citrus Plantation and other Fruit Trees	North of the Jordan Valley 	Al Bathan Valley 	Jordan Highlands Al Bathan Highlands 	Export Crops in the Jordan Valley
Vegetables Grown in Open Fields	Middle Jordan Valley 	Al Bathan Valley 	Jordan Highlands Al Bathan Highland 	
Vegetables under greenhouse	Middle Jordan Valley 		Jordan Highlands 	Tammoun (West Bank) 
Bananas	Jourdain Valley 		South Lebanon 	

1.1.2 Introduction to tensiometric Irrigation Piloting: illustration of the action-research method

The work achieved by MREA on the introduction of tensiometry clearly illustrates the action-research approach used and described in Section I. The diagram summarizes the action courses, the main results and the lessons learned from this project.

Figure 16

Stages followed in the Action-research



The essence of this approach is not innovation as such, but the way in which it is adopted locally. Monitoring pilot farms has made it possible for the project engineers to become better acquainted with the farmers' constraints and to launch new, often more suitable, or priority modernization ideas. Each topic leads on to another, making this a lively research process. The use of tensiometry raises the issue of irrigation uniformity, which leads to the concept of new systems, and then to the issue of maintaining said systems, or controlling fertilization and drainage, and lastly how to valorize such crops.

Since all the topics are more or less interlinked, the Mission, by means of its successive researches and thanks to its network of pilot farms, has progressively been able to develop a technical package for plot modernization, adapted to the different situations encountered in the region, which can be introduced to the farmers by technicians. Without entering the details of the technical package, the following paragraph offers a general outline of the innovations and their effects. We have divided the topics into two broad categories:

- Topics related to irrigation and fertilization management at plot level.
- Topics related to crop choices that enable an increase of water productivity.

1.2 Main research topics at plot level and results

1.2.1 Conception of Irrigation Networks[43]

In the 1970s, pressurized irrigation gradually replaced gravity irrigation via earth canals. Certain areas, or certain farmer categories, did not have access to these new techniques for economic reasons, due to lack of information, or for fear of the potential effects on crops (namely old citrus plantations).

Table 5 summarizes the results achieved thanks to the introduction of irrigation techniques in farms using surface irrigation.

The second category of farmers concerned by the programme is made up of those who have undertaken to modernize their systems, though they still lack the technical know-how, or the capacity of certain practices. Notwithstanding modernization efforts, global irrigation efficiency remains weak, thus entailing poor economic performances.

In the course of its experiments, the Mission has validated a methodology for the conception and/or optimization of irrigation networks at plot level, with the purpose of making it widely accessible. With the help of a hydraulics expert, a software to assess/conceive plot irrigation networks was developed. This easily accessible software (usable with Microsoft Excel), after a short training course, enables technicians to optimize irrigation networks from a hydraulic and installation costs perspective. It can be adapted to most situations encountered in the region.

Furthermore, as it appears in the results presented in the tables above. One same technical innovation can have very different impacts according to the farm type. The engineers trained by the Mission learn how to take into account said factors prior to offering advice to the farmers.

1.2.2 Best Practices in Operation and Maintenance

Bad operating, or poor maintenance of existing systems, strongly affects performances. For instance, instead of renewing the lines of the drip systems every 5 to 10 years, the farmers should do so after three or four years. The drip systems are easily clogged, which greatly affects irrigation uniformity, while performance drops as from the third year after the systems are installed (-30 to -50 percent of production).

The Mission has developed a certain number of tools to improve the functioning conditions of irrigation systems, and their long-term performance. We will synthetically deal with some of the issues below. Details can be found in different technical publications.

[43] Below are the results concerning the farms that have access to pressurized water , either by means of personal reservoirs, or collective, correctly functioning systems (for instance within the framework of the IOJoV project in several pilot command areas of the Jordan Valley, (see Section 2 of Chapter 3).

Table 5

Impact of the Introduction of Pressurized Irrigation on Farms Irrigated by Gravity

CITRUS FARMS IRRIGATED BY GRAVITY - Lack of financial means - Lack of technical know-how - Water distributed by a collective gravity canal or low-pressure system; no means for storage or pressurization at plot level	→	Weak global efficiency: about 50% Minimum uniformity of irrigation Heterogeneous production	
Tested innovation	**Model**	**technical indicators**	**Economical Indicators**
Moving from a Gravity to a Pressurized Irrigation System	**Restricted Quota System:** example in the North of the Jordan Valley	Efficiency has increased from 50 to 85% Water Deficit Reduction: 85% Production:50% Increase (+6 t/ha)	Yearly net added value: + 90%
«Open tube» 			
Micro-Sprinkler 	**Traditional gravitation system** [(1)]**:** Al Bathan model	Efficiency has increased from 50 to 85% Water Consumption: -35% Production: increase up to 20 %	Investment for Storage and Pumping: $8000 Production costs: -17 %
Drip System 			

Table 6

Impact of Optimizing Pressurized Irrigation Systems

FARMS USING PRESSURIZED IRRIGATION SYSTEMS - Poor distribution conditions from the secondary network - Lack of technical know-how		→	Global efficiency remains weak: 50 to 75% Emitters operating well below their nominal pressure (0.2 bars instead of 1) High level of emitters clogging	
Tested Innovation		**Model**	**Technical Indicators**	**Economic Indicators**
Design Optimisation: - Reduction in post size - Pipe diameter increase to reduce load losses - Change of emitter: reduction of the nominal outflow - Wet surface increase - Choice of pumps with adequate features (outflow, pressure)	citrus	Jordan Valley	Efficiency from 65 to 85% Production: 18% increase	Net added value : +47%
	Open-field vegetables	Jordan and Al Bathan Valley	Efficiency from 70 to 90% 10% production increase	Yearly net added value: +45% Installation costs: 200 EUR/dunum
	Greenhouse vegetables	**Cheap water:** Jordan Valley	Uniformity: 95% 16% Production Increase	Yearly net added value: +15%
		Expensive water: Village of Tammoun	Water consumption: - 18% Uniformity: 95%	Production costs : -10% Yearly net added-value: + 20%
	Bananas	Lebanon	Water consumption: -40% Production Increase: 12%	

Figure 17
Improvement of Filtration Practices in the Jordan Valley

Introduction of the screen filter

Former sand filter

Modernized sand filter

1.2.2.1 Filtration Improvement

Good filtration at the head is essential to ensure the correct functioning of pressure systems. However, it appears that the systems available in the region often lack efficiency or are very badly used. Many farmers have actually discarded their old filters. Several experiences, and working in close collaboration with filter suppliers, have enabled MREA to reverse the trend. By finding a technical solution to each type of filtration, and by making farmers, technicians and suppliers aware as to the technical and economic interest of such models, filtration is progressively improving: the most blatant example is the introduction of disk filters in the Jordan Valley, which are slowly replacing the old models[44].

1.2.2.2 Improving Fertigation

Technical-economic studies have underscored that fertilization in the region is performed empirically. In the Jordan Valley, farmers use about twice the amount of fertilizer necessary for their crops, which is about 25 percent of production costs (Belna and Milloz, 2007). It is therefore essential to start by improving fertigation techniques. The Mission has therefore compared several infection systems and recommended the «fertigation tank» as the most suitable system for most farmers.

Then, MREA introduced a user-friendly method for producers to assess fertilizer requirements: **the PILazo® method** enables direct, weekly estimations, at plot level, of the nitrogen levels in the ground prior to plantation, and in the sap, during the production. References are currently available for aubergines, carrots, cauliflowers, strawberries, melons and potatoes. By comparing measurement results with these references, producers can instantly adjust their fertilisation programmes. The method tested on a production of greenhouse *aubergines* (MREA, 2007) has made it possible to drastically reduce the quantities of nitrogen under constant production conditions. For some crops sensitive to nitrogen excess, such as *Charentais melons*, 75% fertilizer reduction was achieved while strongly improving the quality of the product (Dubreucq, 2005).

Figure 18
Fertigation tank

[44] Source: ADRITEC disk filter producer.

Figure 19
the PILazo® method

1.2.2.3 Increasing water productivity: introduction of new crops

Productivity by cubic metre of water is quite poor for irrigated agriculture in the region, with the exception of a few high added-value crops essentially destined for the export market (see data for Jordan under Figure 20).

The Mission has therefore launched an action-research programme on the development of high added-value sectors (see Chapter 4 of the present section for an overall presentation of the project). The Mission focused on Jordan for this experience, namely on the Jordan Valley that *a priori* has a strong potential for export of out-of-season fruits and vegetables. A first study performed by Cabinet Gressard made it possible to pinpoint a certain number of crops that could potentially occupy a niche market in Europe.

The study has revealed three scenarios. In each case, the Mission has launched experiences with producers and at research stations, in partnership with NCARTT, in order to determine the following:

- technical itineraries ensuring timely production and the necessary quality criteria; and
- adaptation of the farms in order to achieve the production objective: investment, labour and access to technical support.

Figure 20
Revenue per cubic meter of irrigation water for several crops in Jordan (MoPIC, 2000)

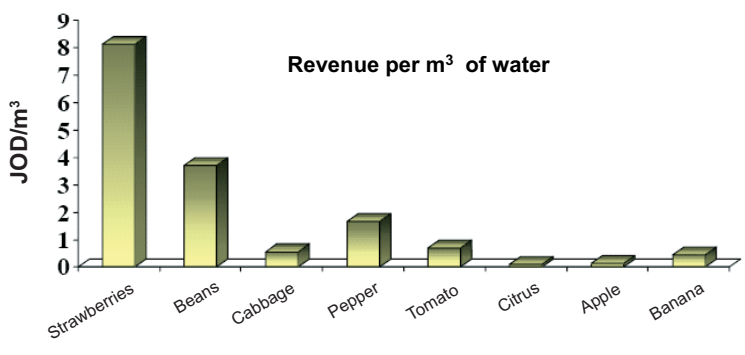
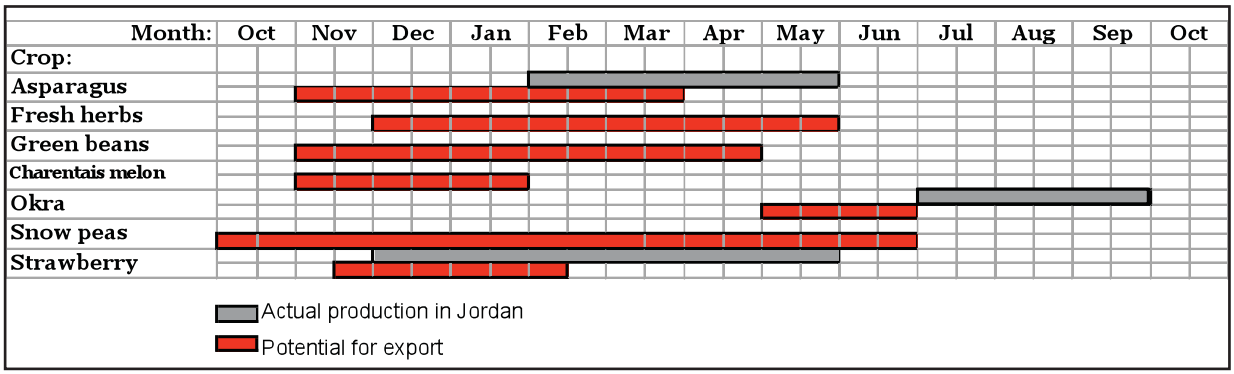


Figure 21

Chronogram of Jordanian export opportunities towards European markets (guillaud,2003; Cabinet Gressard, 2002; Bos, 2005)



Strawberry Type: strawberry crops are already well implanted locally, though an earlier production would offer access to highly remunerative markets.Strawberries have been produced in Jordan for about fifteen years. The production peak begins in November and ends in February. On the European market, in November, no country exports strawberries. Prices are very high. Three experiments have been attempted to foster earlier strawberry production:

- Importation of "frigo plants".
- Ventilation improvement in greenhouses.
- Soil-less systems to anticipate the planting period.

Bean type: a crop produced by the large agri-businessmen (though not by average-size farmers) with export potential: e.g. green beans, snow peas and gombos. Several plot tests were performed to determine the most favourable varieties. Labour management is an acute problem in medium-sized farms, because harvesting for most products of this nature is very demanding (in terms of work and attention) and small producers do not necessarily have the means to address said requirements. It is necessary, though risky, to specialize the entire farm.

***Charentais melon* type:** a product with strong potential, though still unknown to farmers, such as the *Charentais melon*, requires in-depth studies on production potential. Experiments were led in several Jordanian agro-climatic areas, in about twenty pilot plots, with the support of specialized technicians from France. The possibility of producing quality *Charentais melon* in Jordan has been confirmed.

This first "plot-level" stage raised the issue of launching the products and diffusing the new practices entailed (see details in Chapter 4 of this section). Experience has also shown that most farmers are willing to change their practices, provided market conditions allow them to do so: to grow Charentais melons, which is much more demanding than tomatoes, the farmers involved in the project accepted to perform the necessary changes (by rehabilitating their irrigation and

Photo 2
Experience of production of open field Charentais melons in Jordan valley (photo MREA)

fertilization systems) in view of the potentially important economic impact. During the 2006 season, the revenue per cubic metre of water for the *Charentais melon* amounted to 3 JOD in average. This figure is very similar to the results for green beans and by far superior to the traditional crops in the area (tomatoes, cucumbers, citrus, bananas, etc.).

The introduction of new techniques by MREA has generally been successful at the pilot plot level. The diffusion of results by means of publications and training is quite satisfactory, though diffusion on a larger scale is still an issue. Several channels have been tested to try and reach the highest number of beneficiaries. It is of course important to underscore the numerous training courses for technicians and farmers who have become acquainted with these new techniques thanks to the articles published in specialized magazines, brochures, etc. More in-depth reflection was performed to propose the perpetuation of this kind of innovation validation, and several diffusion channels are proposed.

1.3 Proposals for the Reorganisation of Extension Services

The shortcoming of extension services is well known and acknowledged by all. The public services in charge of this Mission find it difficult to fulfil a role requiring flexibility and adaptability, as well as strong operational means. Administrations are unable to receive funds for their counselling services with farmers, and the latter are in any case not ready to pay for technicians who are poorly acquainted with the latest innovations.

Nevertheless, farmers indirectly pay a lot for agricultural counselling which is largely performed by private trade companies selling seeds, fertilizers or equipment. Thus, very frequently, fertilizer amounts largely exceed plant requirements; this is a real economic burden for farmers who are unaware of their losses.

Several projects focus on such issues, and the objective of this document is not to judge or supply a precise action plan to reorganise the services, but to supply a few guidelines deriving from years of experience on the field and cooperation with the different local players. Recommendations are made bearing in mind that there is no perfect and unique extension technique, that the public sector can in no case shoulder all the costs, and that it synergies among the players can be found.

According to the degree of specialisation of the innovation concerned, the time necessary for its introduction and its importance in relation to governmental priorities, different solutions can make agricultural extension more effective.

1.3.1 Innovation Flow Fostered by Action-Research

Plot-level pilot activities have largely proven that tools and methods well adapted to the local context are easily accepted by communities, and have potentially significant economic and environmental impacts. Action-research is therefore a good way of fostering innovation.

Action-research centres hosted in the universities of the region could adopt this methodology (see section 1).

1.3.2 Information and Awareness-Raising Campaigns

Public agricultural extension bodies should certainly limit themselves to general information campaigns, like they do for instance for health or environment issues.

The tools developed (pamphlets, radio messages, technical specifications, etc.) can supply farmers with information on the people and the bodies that are able to offer them tailor-made support on these issues; they should become reference places able to offer **general agricultural advice.**

1.3.3 Public Modernisation Campaigns, With or Without Subventions

Given the interesting results achieved at plot level in the Jordan Valley irrigation networks, FDA has decided to fund a large modernisation campaign for existing irrigation systems (component of the IOJoV 2 project). During the project feasibility study, it appeared that no Jordanian public body was in the position of taking on the task (3-year intervention with 1300 beneficiaries, and a material subvention amounting to around 1 million Euro). The lack of recruitment flexibility, together with procedural hindrances, no doubt compromised the successful outcome of the project.

1.3.4 Technicians Hired by Private Persons for Specialised Expert Opinion

The experiment made with the introduction and follow-up of Charentais melons has underscored that only highly specialised expert opinion can foster the evolution of cultivation practices of farmers of good general level. However, the States are not in the position of funding such a position; it is furthermore indispensable that such extremely qualified services be free. Market gardening advisory engineers are often generalists who cannot cover all the issues raised in a farm that grows several different varieties.

For more specialised expert opinion, for instance concerning the methods to monitor irrigation by means of tensiometers, or agronomic advice on the how to monitor high added-value crops, it is necessary to resort to specialised technicians, sometimes from abroad.

For the time being, only *agri-businessmen* who manage large farms already focused on the export sector have access to this kind of advice. The project has therefore tested the possibility for a group of farmers to get together and form, for instance, an association, resorting together to local and international experts. The results of this experiment are supplied under chapter 4.

Box 12

Opening of an Extension Body Within the Palestinian Ministry of Agriculture

In Al Bathan, in the West-Bank, the programme resorted to an engineer from the Ministry of Agriculture to supply personal assistance to farmers on issues concerning the conception of irrigation systems. If a farmer wishes to install a new system, he can go to this person to obtain material advice, or even ask for a project to be drafted.

For this kind of action, it appears to be more reasonable to resort to bodies such as NGOs that are able to recruit and train adequate personnel according to project requirements.

1.3.5 Material Certification

The work achieved on filtration, in partnership with local equipment suppliers, has underscored the interest of developing a certification system by independent bodies. Public authorities can here again play an essential role, for instance by creating a label for the services supplied by private bodies: i.e. agricultural experts, of course, but also equipment suppliers that can in no case be circumvented and play an essential part in the diffusion of new techniques (Molle, 2006).

These few recommendations do not have the purpose of revolutionising agricultural extension services. The multitude of issues examined by the Mission has shown that different approaches are possible, according to the different topics, and that it would be in the interest of the Ministry of Agriculture to concentrate its efforts on coordinating said services.

Conclusion

The several innovations tested by MREA have proven that it is possible to optimize the limited resources available at plot level. This demonstration is meaningful only providing extension and support systems for farmers are implemented effectively to sustain them in their desire to change.

Furthermore, it has often appeared that the conditions necessary for modernising the systems are lacking: thus, a defective irrigation network discourages any modernisation desire of even the most courageous farmers; low-performing marketing channels defeat individual efforts to launch new crops. Even more seriously, due to the lack of regulations and controls, in such a context of shortages, farmers develop individualistic strategies that progressively destabilise the entire system. For instance, in the Jordanian High Plateaux, any water saving innovation will be used to extend cultivated land, thus in the long-term increasing pressure on water resources.

2 Pilot project on reuse of wastewater for agriculture in the Gaza Strip

Introduction

Water resources in the Gaza Strip are particularly scarce. In this area, municipal and agricultural waters are pumped from the aquifer. The yearly extraction rate exceeds the natural replenishment rate by over 40 percent. Excessive pumping causes saline intrusions into the aquifer whose quality deteriorates year after year. Furthermore, the population is increasing at a record 3.7% rate per year, thus worsening pressure on water resources.

The Palestinian Authority (PA) is addressing a real challenge of supplying drinking water, while preserving the existing irrigated agriculture. The reutilization of treated wastewater would represent an additional water resource, while limiting pollution by avoiding direct disposal in nature. The PA medium-term strategy is to use treated wastewater for agricultural use; however, no concrete project was launched until 2001, which is why MREA supported a four-year action-research project, in collaboration with the Palestinian Ministry of Agriculture, the Water Authority, and the Palestinian Hydrological Group (PHG). The purpose of the said project was to define the technical and social conditions for re-using safe wastewater at plot level, underscoring the economic and environmental benefits of such a practice, to train and sensitize population on the issue and finally to propose recommendations for future large-scale projects.

2.1 Two Reuse Pilot Sites

2.1.1 Areas Bearing Different Characteristics

In the Gaza Strip, two wastewater treatment plants were built in the 1970s, one in the North near Beit Lahia and the other in the centre, collecting water from Gaza City, near the area of Sheikh Ajleen.

Fodder and citrus, two crops traditionally present in the Gaza Strip, can be irrigated unrestrictedly with treated wastewater, in compliance with WHO criteria (WHO, 1989). It was thus decided that the project should focus on these two crops.

Beit Lahia is a sandy area with limited agriculture. A Bedouin community breeds cattle along the shores of the artificial lake created with the treated wastewater rejected from the treatment plant. Following a visit organized by the project to farmers cultivating fodder thanks to wastewater in the area of Madaba[45], in Jordan. The members of the Bedouin community have accepted to take part in the experiment, namely, to produce fodder using the treated wastewater from the lake.

[45] About 50 km south-west from the Jordanian capital.

Figure 22

Localization and Main Features of the Wastewater Treatment Plants in the Gaza Strip

1.Beit Lahia Waste Water Treatment Plant

receives the water from Jabalia, Beit Lahia and beit Hanoun municipalities (around 190 000 inhabitants).

Designed to operate the treatment of 5 000 m3/day, it is proceeding nowadays almost three times this design flow. Therefore, the water is only partially treated and the effluents that can not be infitrated are spread on the surrounding lands, generating a 30 ha lake (3 million m3). Apart from sanitary risks for the population, the sand dikes can break.

2. Gaza city WWTP

upgraded in 1998 to treat up to 33 000 m3 a day of wastewater from Gaza city. When it was upgraded, a conveyance pipe was built to be the backbone of a future reuse irrigation scheme.
The plant now receives more than 50 000 m3/d, and after treatment, treated wastewater is rejected to the sea through a conveyance pipe. Its operation is often affected by power shortages

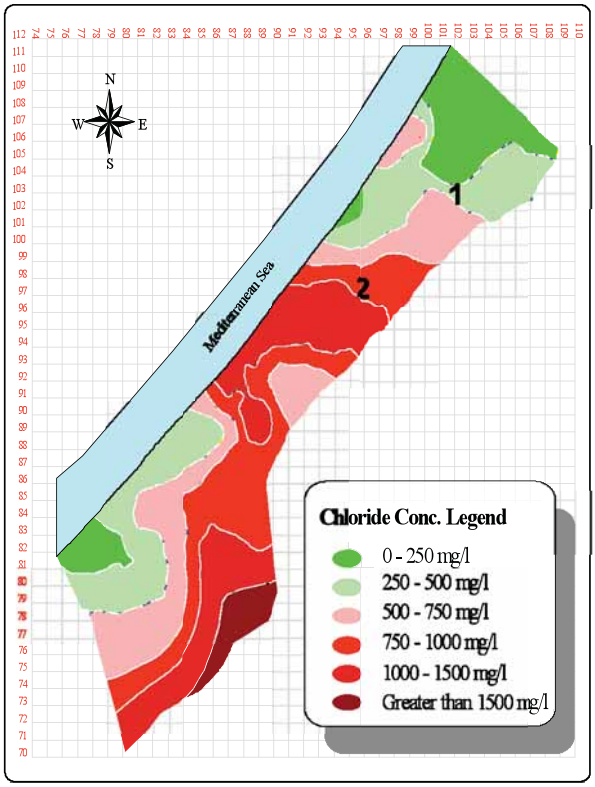


Table 7

Experimentation Conditions on the Two Pilot Sites

	Beit Lahia	Sheikh Ejleen
Treated Wastewater Origin	Pumped directly from the Beit Lahia pond 	Transported from the wastewater treatment plant of Gaza City by means of a 500 m long pipe, then stored along the plots in a cement reservoir to be pumped. 
Crop	Fodder for the local livestock	Citrus fruit for the local market
Surface	17 dunums (then 25 dunums during stage 2) 3 control dunums	12 dunums 3 control dunums
Management	Salaried workers supervised by the City Council	Farmers (generally using a private well for irrigation purposes)

Table 8

Analysis of the physical quality of the treated wastewater (Source: MREA, 2003)

	Lake Beit Lahia	Stockage Sheikh Ejleen	Standard Palestinian
Suspended solids (mg/l)	64	38	40/50
DBO5 (mg/l)[46]	57	34	45/60
DCO (mg/l)[47]	119	76	150/200

To the South of the Gaza City plant, an area dedicated to citrus cultivated by local farmers is irrigated by the fresh groundwater pumped from private boreholes. Over-exploitation of the groundwater causes its salinization. Citrus suffers from excessive salinity and, in the medium-term, this water will no longer be fit for domestic use. One farmer has accepted to cooperate in order to study the benefits of replacing groundwater with treated wastewater.

2.1.2 Installation of an adequate irrigation system

Since the beginning of the project, the technical committee and the farmers chose to take as many precautions as possible to limit any contamination risk with the water (both for workers and the public). Thus, an irrigation drip system was chosen for both the citrus fruit and the fodder.

Needless to say, in view of the very mediocre physical quality of available water (see Table 8), to prevent the drippers from immediately being obstructed, filtration is essential, though technically difficult. On both sites a filtration station, made up of a sand filter upstream and of a disk filter, has been installed [48].

Figure 23

Filtration and irrigation systems installed on the two pilot sites (MREA, 2003)



[46] BDO5, or Biological Oxygen Demand over 5 days, represents the amount of oxygen necessary for micro-organisms to oxidize (i.e. degrade) all the organic matter of a water sample maintained at 20°C, in the dark for 5 days.

[47] Chemical Oxygen Demand (COD) is the amount of oxygen (mg/l) consumed chemically by wastewater. It represents the quantity of oxygen necessary to entirely oxidize all the water components likely to require oxygen, including those that could be assimilated by the micro-organisms (including the latter).

[48] The installation allows for backwashing the different filters. For further details on filtration, see Chapter 1 of Section 2, and the brochures published by the Mission.

2.1.3 An Important Monitoring Programme

To be able to analyse the impact of the pilot project, the technical committee, with the assistance of an expert from SCP, defined an exhaustive monitoring programme to evaluate whether the utilization of wastewater enabled the production of fodder and citrus fruit in conditions that are:

- Technically feasible: by recommending the most adequate (safe and user-friendly, efficient in terms of crop production and water saving), but also entailing limited interventions (dripper clogging rate, pump and filter operation, etc.).
- Safe for farmers, consumers and the environment: thanks to laboratory analyses of water features and their impacts on the soil, and of the health characteristics of the productions and their derivates (vegetable and animal).
- Economically cost-effective by following yield and production costs, compared to a situation of reference in which treated wastewater is not used.
- Socially acceptable: by assessing how the public welcomes the idea of reusing treated wastewater as opposed to groundwater.

Analyses in local and regional laboratories, monitoring production and economic data, surveys in the surroundings, and the daily monitoring of pilot sites, were organized thanks to the Palestinian Project Coordinator and a junior French Technical Assistant. Irrigation began in 2003[49], three production seasons were examined by the project. The paragraph below offers a short overview of the main results of the two experiments.

2.2 Project Results and Diffusion

2.2.1 Main Results of the follow-up programme

One year after the project was launched, considering that the water quality (from the health point of view) of the Beit Lahia basin was correct and stable, the project was able to test other irrigation systems that were less demanding in terms of maintenance: the system locally known as «open-tube» is readily recommended under similar conditions.

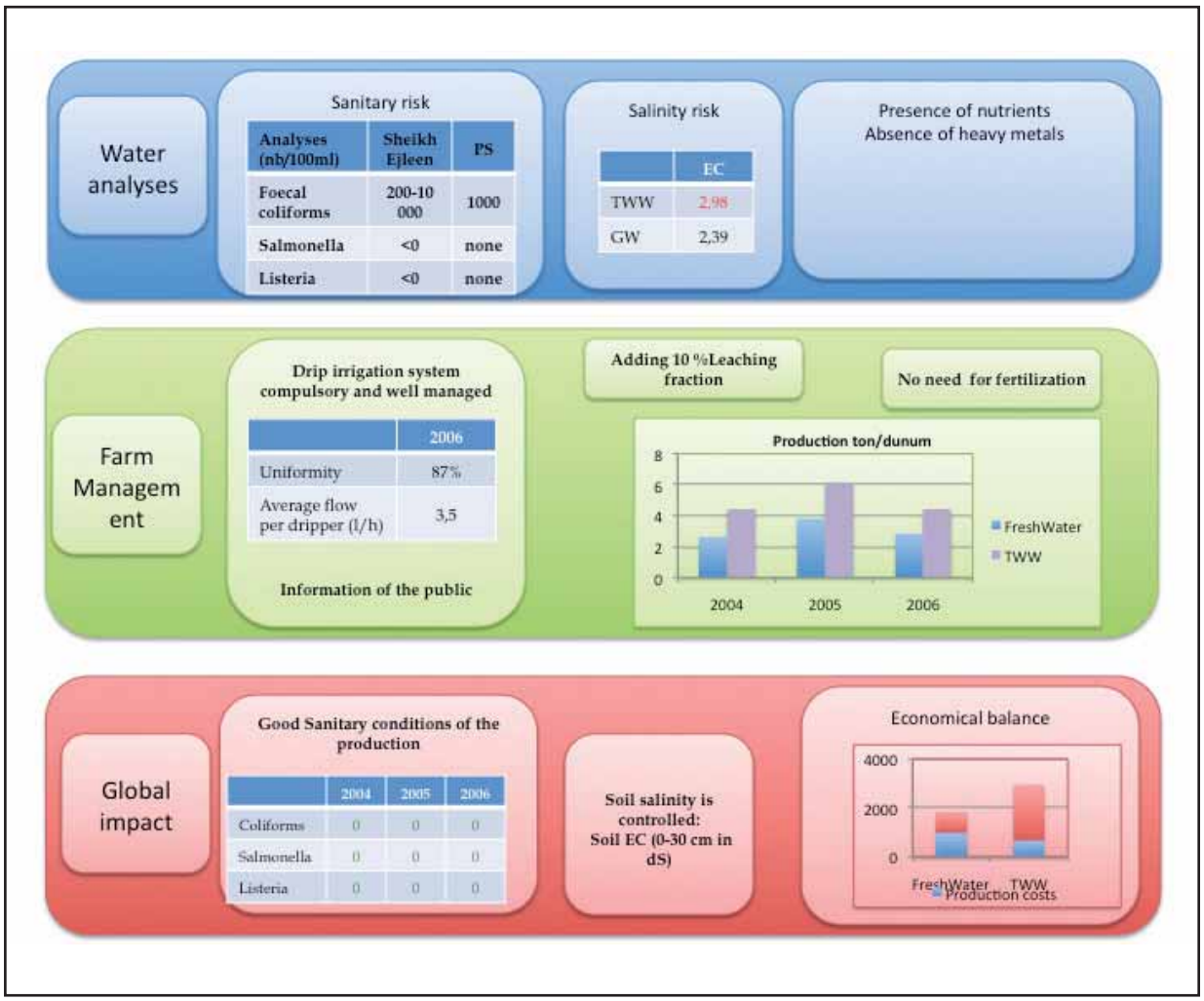
However, in the citrus sector, where the quality of water from a health point of view is doubtful and variable, and the area is more open to the public, it is necessary to continue with the drip irrigation system, as a basic health precaution. The project was instrumental in developing guidelines of best practices concerning the functioning and maintenance of such a system. Also, an information system for the public and the neighbourhood is necessary to limit risks.

Furthermore, the monitoring system has underscored that the productions were healthy and did not entail any danger for consumers.

[49] Owing to the highly unstable situation in the Gaza Strip, some data are lacking: the security conditions did not always enable the data to be collected; furthermore, the pilot sites were destroyed twice by incursions of the Israeli army into the Gaza Strip. Nevertheless, enough data have been collected to outline the main conclusions.

Figure 24

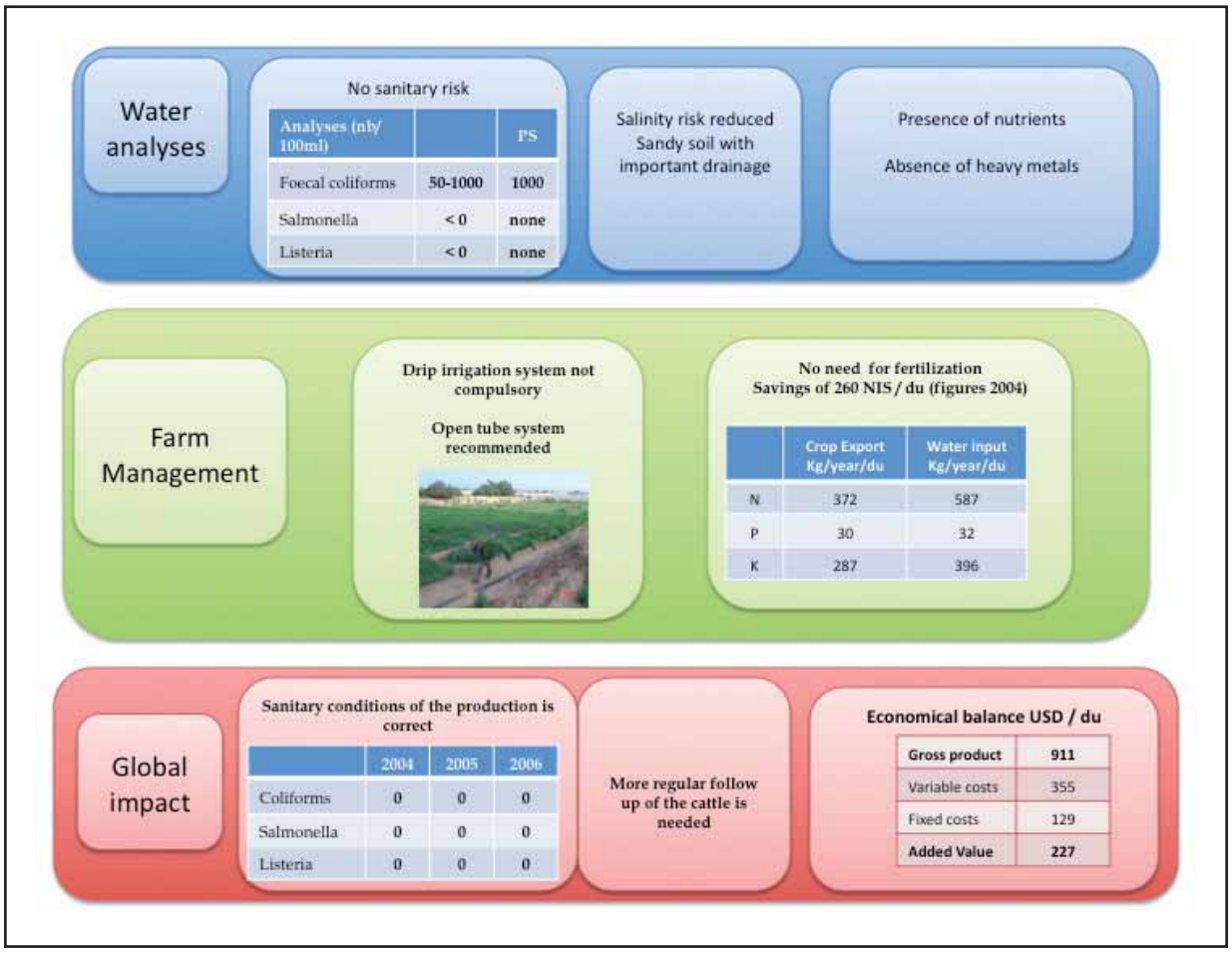
Main results for the citrus fruit pilot site in Sheikh Ajleen



It has appeared clearly that using wastewater to replace very poor quality groundwater is certainly economically advantageous, in the context of the Gaza Strip. In fact, on citrus farms, the yield increased by an average of 62 percent over three years. Furthermore, the fertilizing elements contained in the treated wastewater covered production needs, entailing that no additional fertilizers were necessary; savings on pumping costs, added to all the afore-mentioned benefits, enabled a spectacular 170 percent increase in added-value.

Nevertheless, even though the monitoring programme appears to have underscored that sustainable production is possible, it is advisable to be cautious and to continue monitoring the various indicators. An increase in the content of certain elements in the soil has been noticed (salinity and potassium). Though additional drainage and leaching by winter rainwater should be able to balance any excesses, however, contamination of the shallow aquifer is possible, which is why regular monitoring is necessary.

Figure 25
Main results of the fodder production pilot site in Beit Lahia



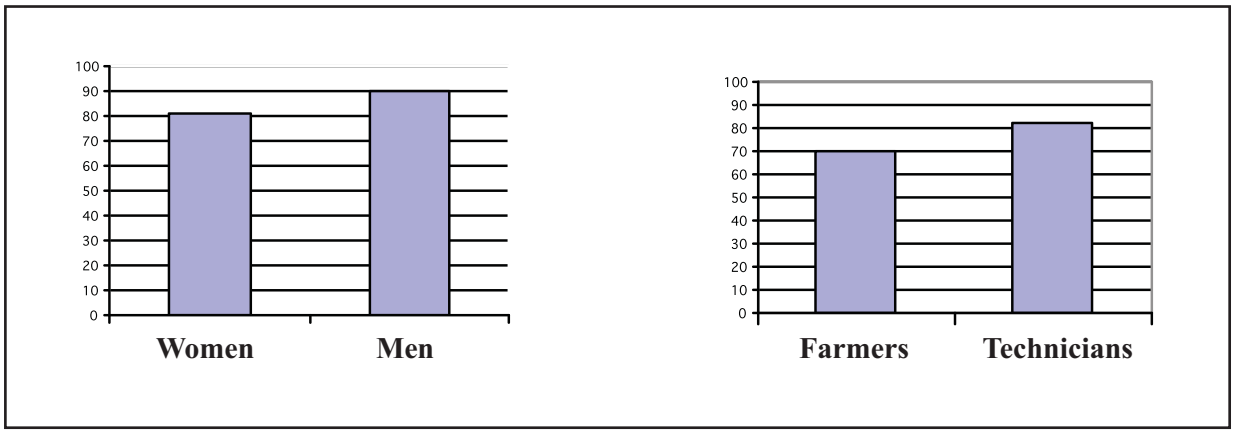
2.2.2 A Training programme and Awareness raising campaign

Following the very encouraging results obtained thanks to the monitoring programme, the technical committee decided to organize an extensive training and awareness raising campaign for farm technicians and the general public. The purpose of the campaign was to raise local community awareness as to the challenges and features of wastewater reuse. Different modules were prepared, which included a 35-minute film made in Gaza presenting the reuse of wastewater, in a manner accessible to the general public.

The results of this campaign are very encouraging, underscoring that the large majority of the community would now be in favour of developing the reuse of treated wastewater for local irrigation. The pilot project was also presented at several international workshops and conferences.

Figure 26

Acceptability of wastewater reuse in agriculture by the general public and professionals in Gaza (results of the questionnaires at the end of the awareness raising campaign – MREA, 2006)



2.3 Prospects

Treated wastewater reuse for agricultural purposes has become one of the main political issues of the Palestinian Water Authority for the Gaza Strip. Several studies financed by the international community are preparing the foundations for the organization of this sector: in the future, three wastewater treatment plants are to be built along the Eastern border of the territory. The wastewater from each of these plants should be reused in agriculture, either directly or indirectly after infiltration and pumping (OTUI, 1998; Dorsch Consult, 2006; Boliden Contech, 1999).

Gaza is therefore getting ready for two major changes:
- the first is to reuse wastewater on a large scale and therefore to set-up the monitoring and control systems necessary to ensure safe reuse; and
- the second is the passage from private and individual irrigation systems (thanks to private wells) to public pressure networks shared by several dozen or hundreds of farmers.

The planned projects should also entail transition stages, though considering the urgency of the situation and the time needed for their establishment, the Palestinian institutions wish to work quite soon at a pilot level so as to understand the real issues and prepare to address new challenges.

This is the spirit in which the Mission proposed a pre-feasibility study for the creation of a limited sized irrigation network, reusing the wastewater from the Gaza City treatment plant (Lambert, 2007). A pipe has already been installed for this purpose during the rehabilitation of the plant in 1998, although it has never been used to this end.

The new proposed pilot project would cover an area of about 100 hectares planted with citrus and olive trees, situated on both sides of the pipe. After the necessary adaptation work at the head of the network (pumps, filtration), the water would be distributed under pressure to a collective network (about thirty hydrants). The works necessary at plot level would refer to the “technical package” developed during the previous pilot stage.

The project proposes to concretely study the issue of management delegation between the main system operator and the users (whether members of irrigator associations or not). The issue of the choice of the regulatory and control authority will also be raised in the course of this project.

Thanks to this concrete example, the Palestinian institutions have been able to define organizational schemes allowing for a more serene approach to the great projects planned.

Conclusion

Even in Gaza, where the chaotic situation does not favour field activity, an action-research programme was able to prove its usefulness. The pilot project supported by MREA was the first concrete attempt in the reuse of treated wastewater in the Gaza Strip.

This approach is especially well adapted to this area where a mere theory – the case of many published studies – is no longer sufficient. The relative flexibility of said approach makes it possible to adapt to local conditions. The project has supplied local stakeholders with concrete references that have comforted them in their political choices.

3 Distribution improvement of irrigation networks: the IOJoV Project in the Jordan Valley

In the 1980s, the Jordanian Government launched an extensive programme aimed at modernizing irrigation networks in the Jordan Valley, with the purpose of enabling substantial savings. However, the modernization of the distribution networks actually failed to fundamentally modify farmer practices at plot level. In order to help the Jordan Valley Authority (JVA) understand the reasons for this poor performance, and to offer support in finding solutions, between 1998 and 2006, MREA launched an action-research pilot project known as IOJoV (*Irrigation Optimization in the Jordan Valley).*

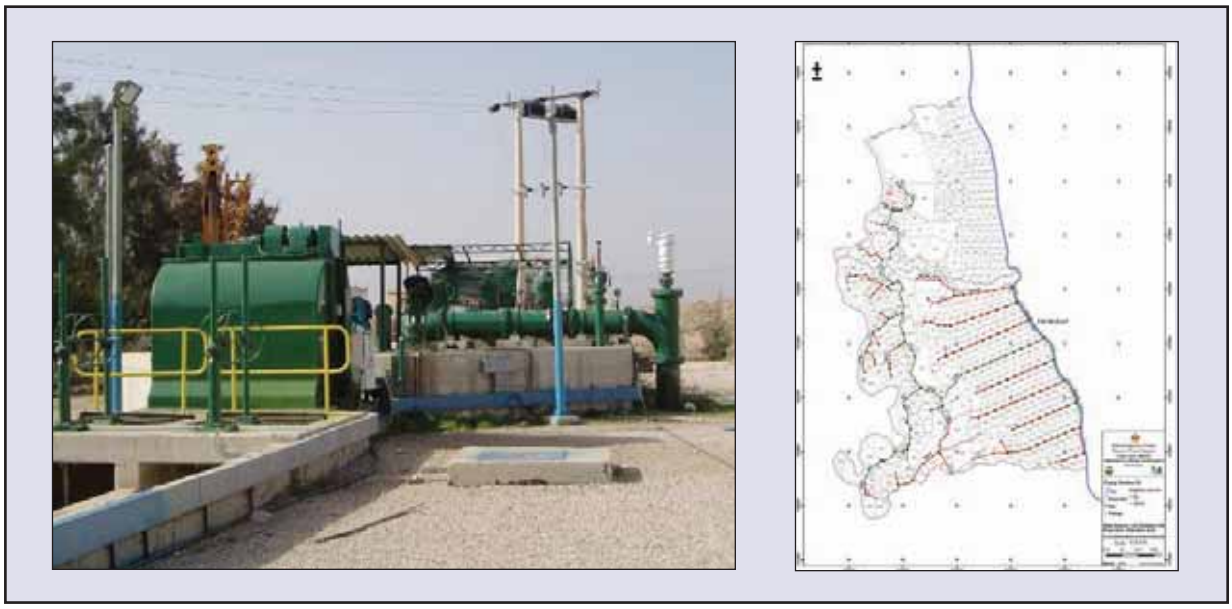
3.1 The vicious circle of pressurized networks in the Jordan Valley

Under the responsibility of the JVA, gravity canals were converted into pressurized networks thanks to a set of buried canals and pumping stations (Figure 27).

The last perimeter was converted in 1996: each farm was connected to an irrigation hydrant that was meant to distribute water under pressure, with a low outflow. This considerable investment should have led to substantial water saving, in two ways: i) in the secondary distribution level by limiting leakage; ii) by preventing evaporation from open canals. Different studies have shown that the objective has largely been attained, since transport efficiency in the JVA networks has reached 75 to 80 percent (Hagan, 1998).

Figure 27

Pumping station (Wadi Rayyan-photo MREA) and scheme of the hydraulic network in Kreymeh (Source: GTZ-JVA) – Northern and Central Jordan Valley



Pressurizing (with outflow reduction) should also have led to an increase in the overall efficiency of the system, thus allowing for the modernization of plot distribution systems. Instead, the farmers received no support (neither financial nor technical) for modernization, to adapt their equipment and practices to the new conditions. They even opposed the flow reduction (to 4 or 6 l/s) and requested the installation of flow limiters at 9 or 12 l/s, thus upsetting the hydraulic characteristics of the network even before it became operational.

Insufficient service pressure

Instead of the promised 3.3 pressure bars, the service pressure at the hydrant of each farm only reaches 1 bar (see Figure 30), thus not allowing for the connection of modern irrigation systems to the plots that require at least 3 bars to function correctly. Therefore, vegetable producers go on using their storage reservoirs to pressurize the water themselves, and those citrus farmers who invested in pressure systems during the conversion to the secondary network use pipes without emitters to fill the basins at the foot of trees (system locally known as open tube).

Opportunist behaviour that is detrimental to the overall function

The highly variable service pressure at the different network points has engendered strong distribution imbalances, as it appears in Figure 31. Many farmers tend to open their hydrants illegally outside their irrigation hours. To prevent any form of control, the water counters usually found in each hydrant are often damaged[50].

Farmers are obliged to establish individualist strategies to face the poor functioning of the collective system, thus drawing the entire network into a vicious circle. Instead of a modern pressurized system, the Jordan Valley networks function with the same efficiency as the old gravity system that was to solve the leakage problems! The overall efficiency of the system is actually evaluated to be only 50-60 percent, just slightly above an effective gravity system. This very poor result is problematic for facilities that are among the most expensive in the world (per hectare). This analysis has been confirmed by the recent RAP analysis performed by FAO (see box in Section 1).

3.2 The IOJoV Project: Improving irrigation "from the source to the plant"

The purpose of this project is to find the conditions for a more rational management of JVA pressurized networks and, simultaneously, to enable farmers to benefit from improved service conditions by optimizing their plot practices.

3.2.1 Three representative pilot areas

The actions were launched between 2000 and 2006, focusing on three pilot areas representative of the different agronomic and social situations in the northern part of the Jordan Valley. These sites, irrigated by the fresh water conveyed by the King Abdullah canal, are command areas covered by pumping stations referred to as *Turn-out* (TO)[51].

[50] When a counter has not been damaged by a farmer, it is soon clogged by suspension material; the shortcomings of maintenance services do not improve the situation. At TO41, barely half the counters were operational prior to the launching of the project, at TO55, practically none were in function.

[51] Each TO is characterized by its position with reference to the beginning of the canal; therefore, TO2 refers to the pumping stations situated 2 km away from the beginning of the facility.

Figure 28

Presentation of the Three Pilot Areas

	TO2 Adassyeh	TO41 – Wadi Rayan	TO55-Kreymeh
Citrus and other fruit trees	95%	30%	5%
Bananas	5%	0%	0%
Open-field vegetables	0%	60%	10%
Greenhouse vegetables	0%	10%	85%
Gravity irrigation %	51 %	0%	0 %
Private reservoirs at plot	Almost none	60%	Almost all farms
Social relations in the community	A Jordanian tribe, mostly farm owners 	Two Palestinian tribes working on their own plots and renting others 	Agro investors renting land 

3.2.2 Approach

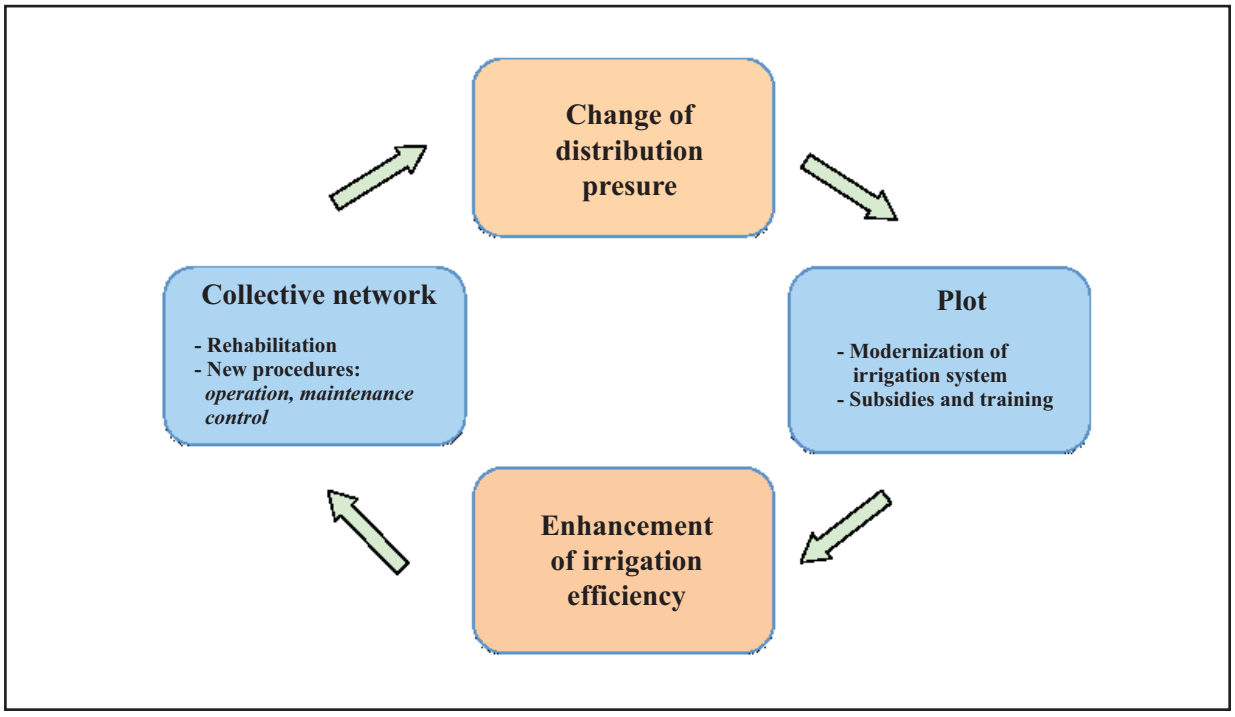
The project entails that it is possible to break the vicious circle deriving from the poor functioning of the system, to replace it by a virtuous circle, where improved service conditions will favour plot-level modernization. Aware of the benefits, the farmers would be more willing to preserve the system by adopting less individualistic behaviour. In each pilot area, the project simultaneously had a two-level approach: at the level of the collective distribution network and at plot-level.

At the collective distribution network level

The project has allowed for some technical rehabilitation, and for the set-up of new management procedures. Thus, individual watermeters were as a priority repaired or replaced, and then protected from the risk of clogging thanks to the implementation of new filtration practices at the network level. Changes on the irrigation hydrants will also make it possible to protect the new equipment against any form of vandalism, while making them visible thanks to a grid placed on the hydrant lids. The outflow at each hydrant has been reduced so as to conform to what was foreseen originally when the networks were conceived (from 9 or 12 to 6 l/s). Each hydrant should therefore receive a weaker outflow over a longer period of time. New operational, maintenance and, needless to say, monitoring procedures have been defined, for example:

- Transferring the farmers' responsibility for opening and closing individual gates, so as to enable a more flexible and hydraulically correct irrigation turn.

Figure 29
Pilot Project Principle



- Conception of adequate water turns (also called rotation schedule) thanks to an hydraulic software[52] EPAnet coupled with an Excel file developed by MREA (Shudifat, 2003) ;
- Regular reading of the watermeter by the ditch-rider to monitor the illegal use of water:
- In the event of the illegal use of water, a squad of ditch-riders controls the offenders and the general section gate downstream from the pumping station is no longer used to control the outflow.

At plot level

The project has supported farmers to incite them to invest in more efficient plot-level irrigation techniques. This modernization was made possible thanks to the general service pressure increase and outflow decrease. All the farmers in the pilot areas were offered technical assistance and subsidies, as they were proposed plot-level innovations (see Chapter 1 of this section)[53].

3.2.3 Main results

Thanks to field monitoring and training of managers and farmers, this pilot project has enabled the rehabilitation of the concerned command areas, as well as their functioning under better hydraulic conditions.

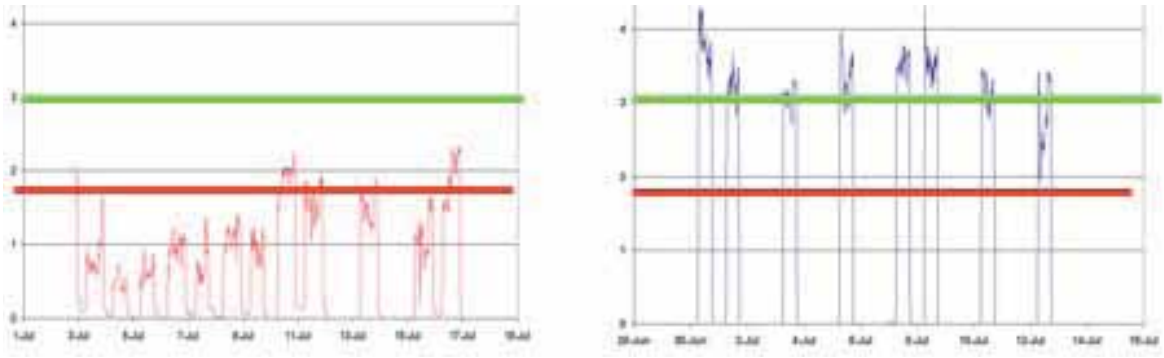
The most convincing result is the service pressure which, as shown by Figure 30, remained high and stable throughout the irrigation season. The three-bar threshold corresponds to the necessary level for the

[52] EPANET is an hydraulic behaviour simulation software developed by the US Environmental Protection Agency (EPA), freely available on the Net: http://www.epa.gov/nrmrl/wswrd/dw/epanet.html

[53] The subvention was based upon a socio-economic farmer typology in each pilot area.

Figure 30

Pressure measurements before and during the pilot project (Pilot Project TO2-2002)

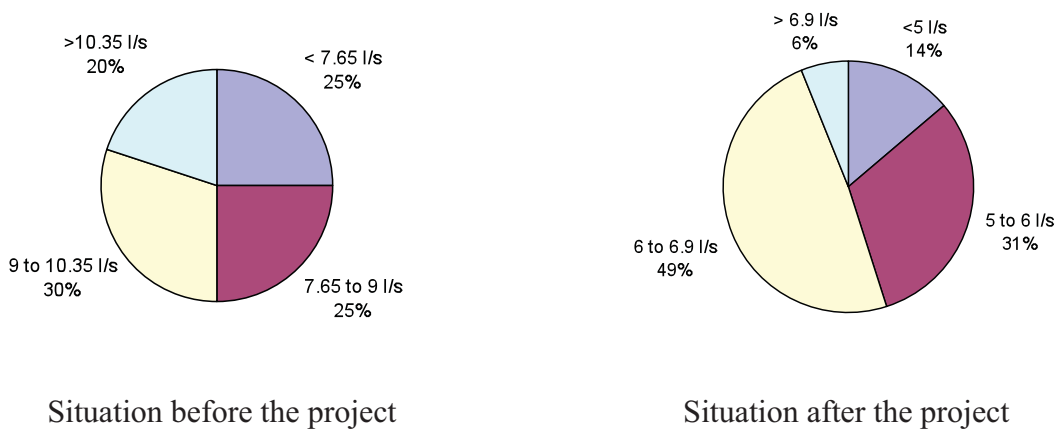


correct functioning of the irrigation systems at plot level, in compliance with the project recommendations. Thanks to such a result, farmers – even those who invested in more modern systems requiring additional pressure – can receive their allocation and irrigate under good conditions by being connected directly to the collective network. Figure 31 confirms that the outflow at the gates is much more balanced after than prior to the project.

Thanks to the new distribution conditions, the farmers in the pilot areas were able to install higher performance plot-level systems, thus reducing the impact of the drastic water allocation cuts they have been enduring since 2000 (Van Aken *et al*, 2007). The pilot projects especially made it possible to re-establish relationships between managers and users, by setting up transparency among the players.

Figure 31

Average outflow received at the gates prior to and after the pilot project (Pilot Project TO2-2002)



3.3 Project scope

3.3.1 Extension of the pilot recommendations to the Northern Jordan Valley

The JVA, convinced by the encouraging results of the pilot projects, has decided to perform a feasibility study – with the support of the Mission – to extend the recommendations to the Northern Jordan Valley, which is irrigated by the fresh water conveyed by the King Abdullah Canal, in other words a 3400 hectare area, regarding 1100 farms. The three-year project aims at standardizing the modernization of plot-level irrigation systems, but especially at committing JVA to implement new sustainable management practices. The new rules should preserve the assets of the pilot areas, extending their benefits to all the command areas concerned. Since water meters are the key to the correct functioning of the system, the project has a strong focus on the JVA maintenance reorganization. The AFD has granted a 2.7 million Euro donation to the Jordanian Water and Irrigation Ministry for the this project that was launched in February 2008.

3.3.2 Cooperation with other projects

The new irrigation management model is based upon transparency and equity. The tense relationship among farmers depending upon the same network does not facilitate the establishment of the system, nor does the progressive reduction of water allocation. Conflicts among users are always latent and "punitive" action in the event of illegal water use has shown its limits for farmers who are ready to shoulder the burden of being fined for obtaining more than their share. To ensure the future of the system, it is indispensable to count on the local community. A GTZ/JVA project is ongoing to improve the participation of water users. Even though this participation is at a very early stage, the MREA pilot projects have strongly contributed towards this approach being taken into account.

3.3.3 A Model for other networks undergoing modernization

The Jordan Valley is an actual laboratory for studying the modernization process of gravity command areas. The urgency of the situation intensifies tensions, making appraisal mistakes even more obvious. Now, an ever greater number of irrigated schemes are facing the challenge of modernization throughout the world, and any reference can be useful. This is why the Mission has diffused this experiment as much as possible within the region and beyond, by means of its publications, but also by participating in several international workshops[54]. Furthermore, thanks to its experience on the Jordanian bank of the Jordan River, MREA has encouraged the launching of a project in the town of Jericho[55], on the other bank. Actually, this town has just pressurized its gravity distribution network (under IFAD funding, May 2005), while the first shortcomings are already becoming evident.

[54] Such as the *International Symposium on irrigation modernization: constraints and solutions* organized in April 2006 by FAO/IPTRID/NOSSTIA/ICARDA in Damascus

[55] Project supported by PFU (*Palestinian Farmers Union*) and funded by the General Consulate of France in Jerusalem

Conclusion

The pilot projects aimed at modernizing the collective distribution networks in the Jordan Valley, which are under pressure, have shown that only an approach shared by managers and users enables a real improvement in distribution conditions. Beyond the strictly technical aspects, trust and transparency are the keys to the sustainable and efficient management of the systems. The context of extreme shortage in the Jordan Valley intensifies tension and encourages individualistic behaviour; however, the project has proven that consensus is possible. In the long term, the sustainable functioning of the systems, and their continuous improvement, is only possible if the local community acknowledges such notions.

4 Creating high added-value export sectors

Example of the *Charentais melon* introduced in Jordan

Jordan has a comparative advantage in exporting fruits and vegetables to remunerative Western European markets, thanks to the Jordan Valley whose mild winter climate enables the production of out-of-season products.

In agreement with the Jordanian Ministry of Agriculture, with the support of the Jordanian association of fruit and vegetable Producers (JEPAFV), MREA has launched a pilot action to analyze the success conditions for such exports and propose practical applications. The Action-Research method described above was used for six years within the framework of the project "Development of High Added-Value Fruits and Vegetable Exports".

The project first focused on the farm level, pinpointing which crops could be produced locally, at the right time, with the quality required for the European market. As shown in Chapter 1 of this section, with the necessary technical support, farmers from different areas are able to produce out-of-season fruits and vegetables. Following the first stage, a system needed to be devised to enable producers to overcome marketing difficulties.

Complementary studies of different sectors made it possible to precisely describe how the Jordanian marketing and exportation systems function. These studies have underscored that the market structure does not allow medium-sized farmers to access the remunerative European markets. Only a few large producers have been able to develop their own channels and establish permanent relationships with European importers (Montigaud *et al*, 2006).

Following the preliminary work, the project selected a single crop, the *Charentais melon*, and worked with about fifteen producers to set up a system with the purpose of enhancing their productions. The producers are farmers of different kinds[56], who used to specialize in market gardening. Some already have experience in exportation through large companies, though most sell their products directly to the Central Market.

Box 13
Why the Charentais Melon?

Stage 1 of the project revealed that the production of the *Charentais melon*, despite its delicateness, is possible in the different Jordanian agro-climatic areas, enabling continuous production during a period in which the European markets require said products. Furthermore, this crop was until then unknown in Jordan, which meant that farmers would be more sensitive to any technical advice. The novelty would also make it possible to market a product without any *a priori*, and to focus on all the difficulties farmers encountered when trying to innovate.

[56] From medium to large size, interested in diversifying their production, their farms are in the Jordan Valley and on the Jordanian Highlands.

4.1 Involving Producers in Developing a Sector

4.1.1 Better market knowledge for producers

There are some market niches for the exportation of certain high added-value fruits and vegetables to Western Europe. These products must be transported by air. Several important French importers were invited to Jordan to study the local production potential and establish contacts with producers. Furthermore, the project financed the visit of Jordanian producers to France, to enable them to have a better perception of market requirements. European markets require the regular delivery, over a sufficiently long time period, of a quality and perfectly conditioned product.

Also bearing in mind that all the production could not be exported to France neither in the short, nor in the long term (lower quality melons, logistical problems, etc.), the project focused on the possibilities of marketing the products on quality-wise less demanding markets, or whose approach conditions are easier (for instance, exportation by lorry towards the Gulf markets or selling the products on the local markets).

These exchanges have made it possible to increase the awareness of the group of producers as to the logistic constraints they were to encounter. They thus admitted that only a common strategy would enable them to respond to market requirements.

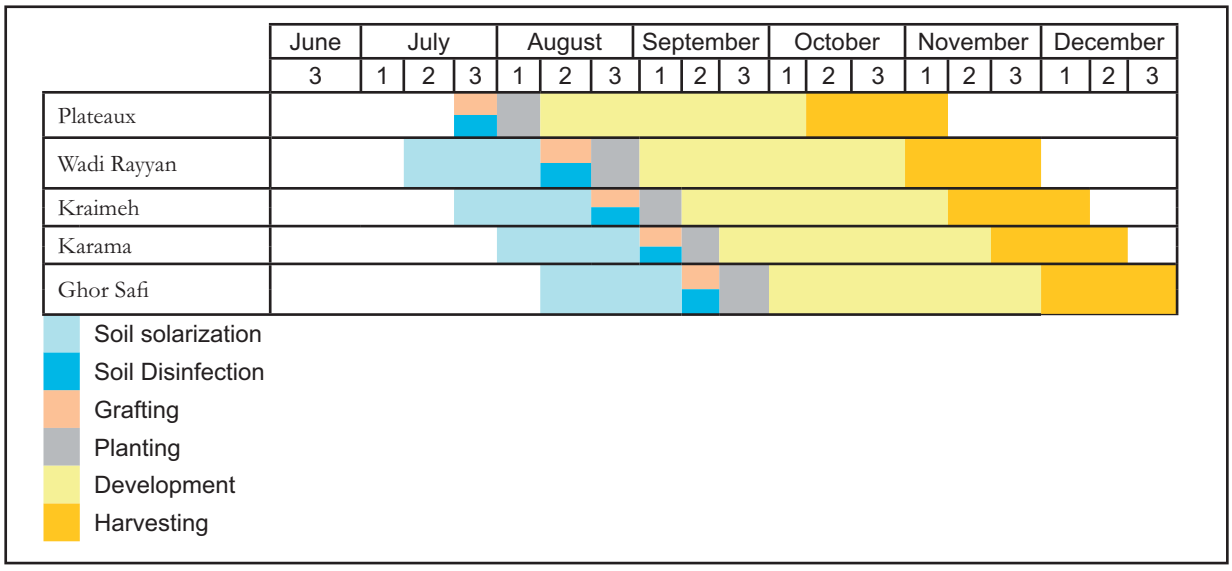
4.1.2 Development of a common production and marketing strategy

The project supported the group of farmers in defining and implementing their strategy.

> ***Spread production during the year according to the demand and centralize it to group expeditions and limit the costs***

Figure 32

Production schedule for *Charentais melons* in the different Jordanian areas (Source: MREA –plot-level experiments from 2004 to 2006).



The wide temperature gradient in the different Jordanian climates makes it possible to spread production during the year. Producers work on lots in different climatic areas. A plantation schedule can be drafted to try and maintain a production continuum from October to November.

Shipment by air involves a series of unavoidable costs (customs charges, maintenance costs) that can only be covered if large quantities are sent together. In the sorting centre, the different qualities and sizes are separated. To make sure they were meeting European standards, the producers purchased a size-grader, thanks to the support offered by the project. They also hired a logistics expert in charge of receiving the products and following-up the shipments. Lastly, they contracted a Jordanian, Fresh Fruit Company, specialized in exportation, to deal with the shipments and invoice recoveries.

Taking over conditioning so as to ensure the greatest possible gross margin

Once the product is sorted, it can be sent in bulk form or after having been conditioned. Both options have bee tested. Figure 33 shows that for France, it is much more interesting for the producers to take care of the conditioning, consistently increasing the added-value of their product.

Defining a quality charter and corresponding brands

To ensure customer loyalty, the producers have developed an easily identifiable brand: Sun of Petra. This brand was enhanced thanks to attractive packaging.

Photo 4
Logo of the brand developwd by the association

Photo 5
Packaging boxes of the Sun of Petra Brand

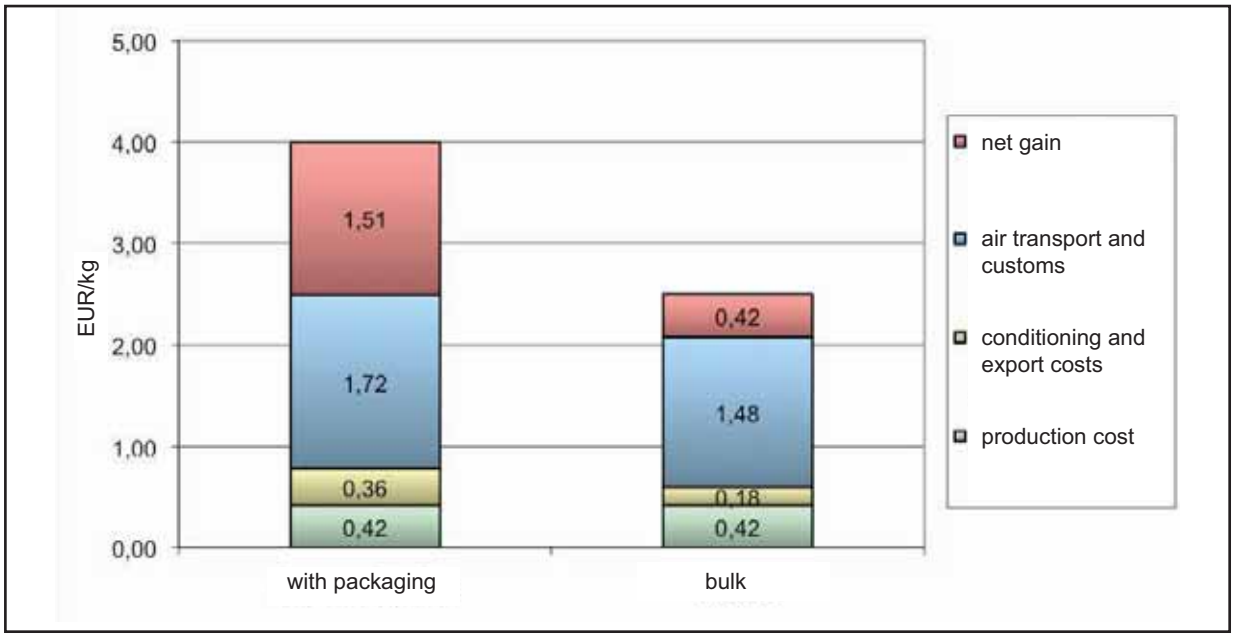
For lower quality melons, destined for instance to the local market, the packaging is different.

To ensure the transparency of their sector, producers have agreed on defining a common quality charter (including the production and conditioning stages), thus committing themselves versus their customers to following a precise list of specifications to guarantee the quality of the product.

The charter is also a good way for settling any conflicts among members: if a producer happens to supply low quality melons, thus hindering group strategy, the objective quality criteria make it possible for the product to be rejected.

Figure 33

Net Added-Value for producers (in USD /kg) for Charentais Melons shipped to France following conditioning or in bulk form (MREA, 2007)



Supply the necessary technical assistance to enable members to comply with the quality criteria

We stated previously that it is not easy to ensure such quality, without the support of specialized technicians. The project hired an agricultural engineer who monitored the farms on a weekly basis. He checked that the production specifications were met, offered advice to farmers in the presence of any difficulties, and reported to the sorting centre the products' degree of maturity.

4.1.3 Registration of an association

To facilitate such approaches and formalize relationships among producers, the project encouraged the Ministry of Agriculture to record the Association of Melon Producers and Exporters. The project initially proposed to record a producers' association, but the strategy of the Ministry of Agriculture was to encourage the creation of associations for different products. Such a constraint was certainly detrimental to the development of association activities that could benefit from product diversification.

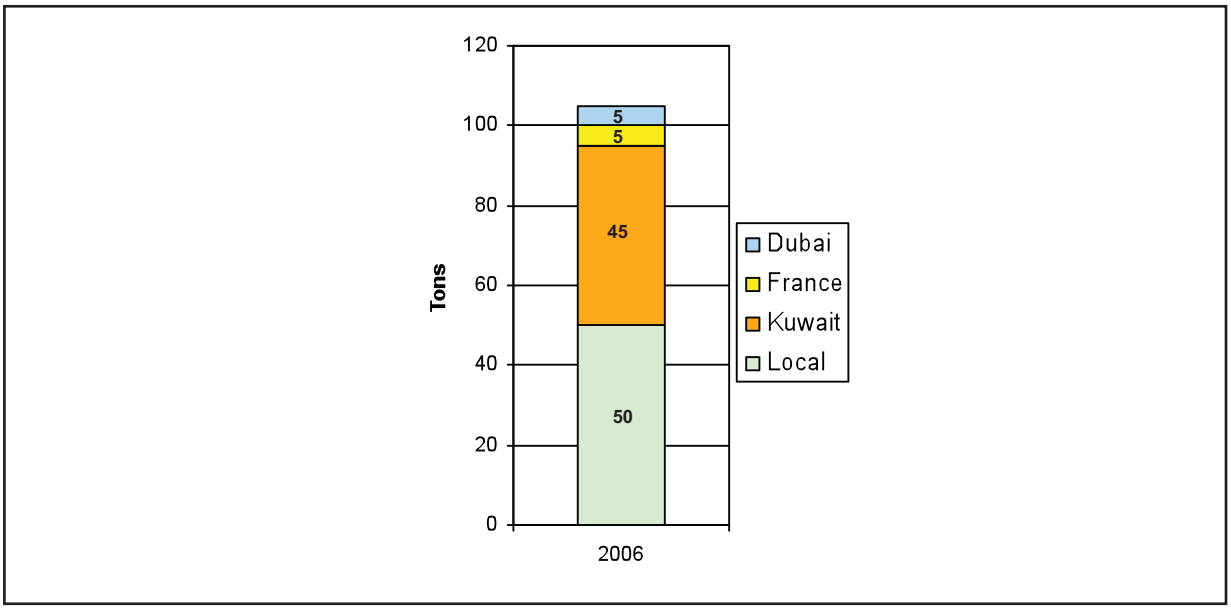
The project supplied the necessary technical assistance enabling producers to become competent in managing meeting and organizational issues. It also supported them in setting up a communications strategy (Web site, introduction pamphlet, participation in fairs, etc.).

Photo 6

Field engineer testing the nitrate level in the plant sap, using the PILazo ® method.

Figure 34

Average Gross Product per dunum for the different crops in the Jordan Valley (Source: Belna and Bouby, 2007; MREA, 2007)



4.1.4 Results of the 2006 season

After a couple of trial seasons, 54 percent of the melons produced were considered of very good quality (Panzani *et al*, 2007), in compliance with the standards of the European markets.[57]. The association therefore produced over 100 tonnes of *Charentais melons* that reached the European, regional and local markets, as illustrated in Figure 34. Persistent logistical difficulties hindered penetration of the European market at that stage, namely because the product volume the second year was still too weak and uncertain to ensure regular shipments. Furthermore, because of the breach of the export contract that was meant to send average quality melons to the regional markets, the part destined to the local market was more important than foreseen.

Nevertheless, notwithstanding the many difficulties, the income received by most of the producers involved in the project largely exceeded the usual margins of traditional productions (cucumbers, aubergines, tomatoes) and was fully comparable to the economic return from exports already known in the region such as fine green beans or seedless grapes.

Photo 7

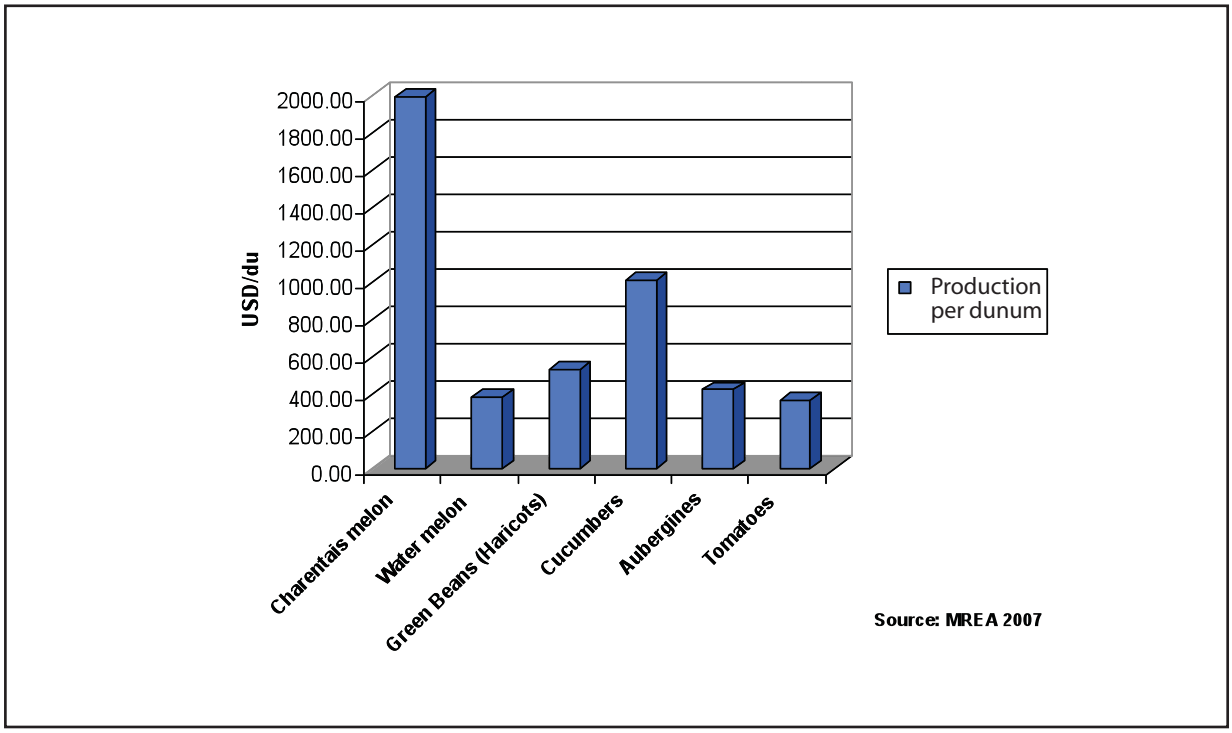
Members of the association

Encouraged by these promising results, the *Charentais melon* Producers Association is functioning without the support of the French Cooperation. Although some members have left the group, the most motivated continue to meet and establish common strategies. They are developing and exporting their brand more specifically to the local and regional markets.

[57] According to Xavier Dubreucq, Agricultural Technician, and Jérôme Jausseran, Director of the company "Force Sud" who visited the farms involved in the project.

Figure 35

Average Gross Product per dunum for the different crops in the Jordan Valley (Source: Belna and Bouby, 2007; MREA, 2007)



4.2 Lessons and perspectives

4.2.1 Concentrating on the Gulf Markets

Though it appears clearly that the producers' association can be a real asset for Jordanian producers, helping them access new markets, its structure is still very fragile. In fact, we noticed that an actual promotional and information budget is necessary for producers to take over markets, and especially to adapt to their at times fast changes.

Furthermore, though the European markets are attractive, they are difficult to access, and increases in kerosene prices will make their profitability negligible for a country such as Jordan that is condemned to export by air. European consumers who are ever more sensitive to environmental issues are likely to be less willing to consume products with such an important ecological footprint. The much more accessible Gulf markets are currently "exploding" and are becoming ever greater demanders for quality and well-conditioned products. It is thus more logical to concentrate on developing these sectors.

During a final workshop on the exportation of high added-value fruits and vegetables, held in Amman in June 2007, several recommendations were made to adjust the reorganization of Jordanian public services, with the purpose of contributing towards setting a more favourable context to the emergence of such initiatives.

[58] *Jordan Enterprise Development Corporation*

4.2.2 Creating a favourable context for quality production

Consolidating Producers Associations marketing capacities

The Charentais Melon Producers Association is not the only specialized Jordanian association. Other attempts have been made either by other projects, or under the initiative of isolated producer groups. These projects are often only partially successful and a lot of time and energy can be wasted. It is important to capitalize on the experience of others, but especially to create a favourable context where the association can be guided and trained. Support to associations of this kind can be supplied by a local body such as JEDCO[58], which is already a partner of other similar associations.

A future project could start by working with farmers who have already formed associations and wish to develop their activities, and then support the creation of new groups.

Establishing a National Market Information System

One of the major constraints of the fruit and vegetable market is the difficulty for producers and traders to have reliable information on market prices and trends. At the end of the pilot project, it appeared to be necessary to establish an independent system to respond to the issues of interest and the questions of both farmers and traders. Such a service should, on a daily basis, gather information from the four main Jordanian markets, thanks to specialized staff (for example minimum and maximum daily prices, quantities, destinations, etc.). The collected data are summarized, analyzed and diffused according to a schedule meeting and the requirements of stakeholders: for instance, on a daily basis for market prices, and weekly or monthly for market trends. This information could be supplied via radio messages, SMS, fax, the Internet, etc.

The establishment of a market information system could be instrumental in balancing the excessive power detained by some of the players along the chain (especially traders), by enhancing producer bargaining power, and supplying tools for autonomously defining marketing strategies. Furthermore, the diffusion of reliable information to all players in the sector could improve trade relationships and contribute towards establishing a sense of trust, which is currently desperately lacking in Jordan.

Conclusion

Although the European markets actually appear to be very promising for exporting high added-value products, it is necessary to first develop solid local and regional distribution channels where most of the products can be sold. The conquest of new niche markets can at a later stage represent an additional enhancement factor for such products.

To achieve product diversification towards high added-value products, it is necessary to set up a more favourable regulatory framework and a well-structured system to support farmer organizations. The current state of Jordanian distribution channels hinders any producer initiatives.

5 Historical transformations of the Lower Jordan River Basin (in Jordan)

Changes in water uses and projections (1950-2025)

The International Water Management Institute (IWMI) has studied more than ten basins in the world in the "Comprehensive Assessment of Water Management in Agriculture". For the Lower Jordan River basin, IWMI worked closely with MREA for this exercise. Several articles and reports have been published based on a long period of work (2003-2007) aimed at better understanding the context (hydraulic, geographic and social) of the most dynamic and populated part of Jordan. This chapter is based on the CA Research Report 9 with the authorization of the authors, Rémy Courcier, Jean-Philippe Venot and François Molle[59].

The Lower Jordan River Basin (LJRB), defined as a hydrological entity, is a region of prime importance for the Hashemite Kingdom of Jordan: this area includes 83 percent of the total population of Jordan, and most of the main industries in the country, 80 percent of irrigated agriculture, and receives 80 percent of the national water resources. During the last 50 years, because of a demographic boom and generalized economic development, the Jordanian part of the LJRB has experienced an intensive and rapid process of mobilization of its rare water resources.

The quantitative analysis of these evolutions has shown that most of the indicators (such as depleted fraction, processed fraction of water resources) varied sharply between 1950 and 1975, on account of both a growth in rainfed and irrigated agriculture, and the quasi interruption of the flows coming from the Upper Jordan.

In the following 25 years, water use became unsustainable because of overdraft of the aquifers (and concomitant reduction of the flow in the Yarmouk). Today 46 000 hectares are irrigated and all surface resources are tapped and committed, and groundwater is being severely mined.

Both the Jordan valley and the highlands, on the one hand, and agriculture and cities on the other, are now interconnected and interdependent. Presently, the available water resources in the LJRB are renewed at a rate of 705 million cubic metres per year (Mm^3/yr including 155 Mm^3/yr of groundwater and 550 Mm^3/yr for surface water). The total amount of water withdrawn within the basin reaches 585 Mm^3/yr (namely 83 percent of the renewable surface and groundwater), including 275 Mm^3/yr in groundwater abstraction (namely a gross overdraft of the aquifers of 120 Mm^3/yr) and 310 Mm^3/yr of surface water diversion (including 60 Mm^3/yr of treated wastewater). The basin also imports each year 30 Mm^3 of groundwater and 45 Mm^3 of surface water. The rest flows uncontrolled to the Dead Sea (215 Mm^3/yr).

[59]http://www.iwmi.cgiar.org/Assessment/Research_Projects/River_Basin_Development_and_Management/Projects_Locations/jordan_rift_valley.htm

The Figure 39 indicates the main water resources development and use of the years 2000. The patterns of water use reflect changes in the wider economy. Extensive rainfed agriculture in the highlands increased before the mid-1970s but later declined with the change in the economy and the growth of cities. The most intensive part of the agriculture sector (cultivation in the highlands and the valley, oriented towards the export of vegetables and fruits) is affected by changes in relative competitiveness with regard to other regional producers and also by changes in market prices.

Population growth also linked to the wider political situation in the Middle East increased pressure on the water resources. Because of the unquestionable priority given to domestic water use and the large share of the agricultural water use, the future of irrigated agriculture is uncertain.

The most questionable part of agricultural use is the low-profitability olive trees planted in the desert plateau that make up half of the highland irrigated area and which consume about a quarter of the total high quality groundwater abstracted for agricultural purposes in the LJRB. The resulting depletion of the aquifers is likely to jeopardize their use for domestic water supply as they become saltier.

Figure 36

Legends utilized for Figures 37, 38, 39 and 40

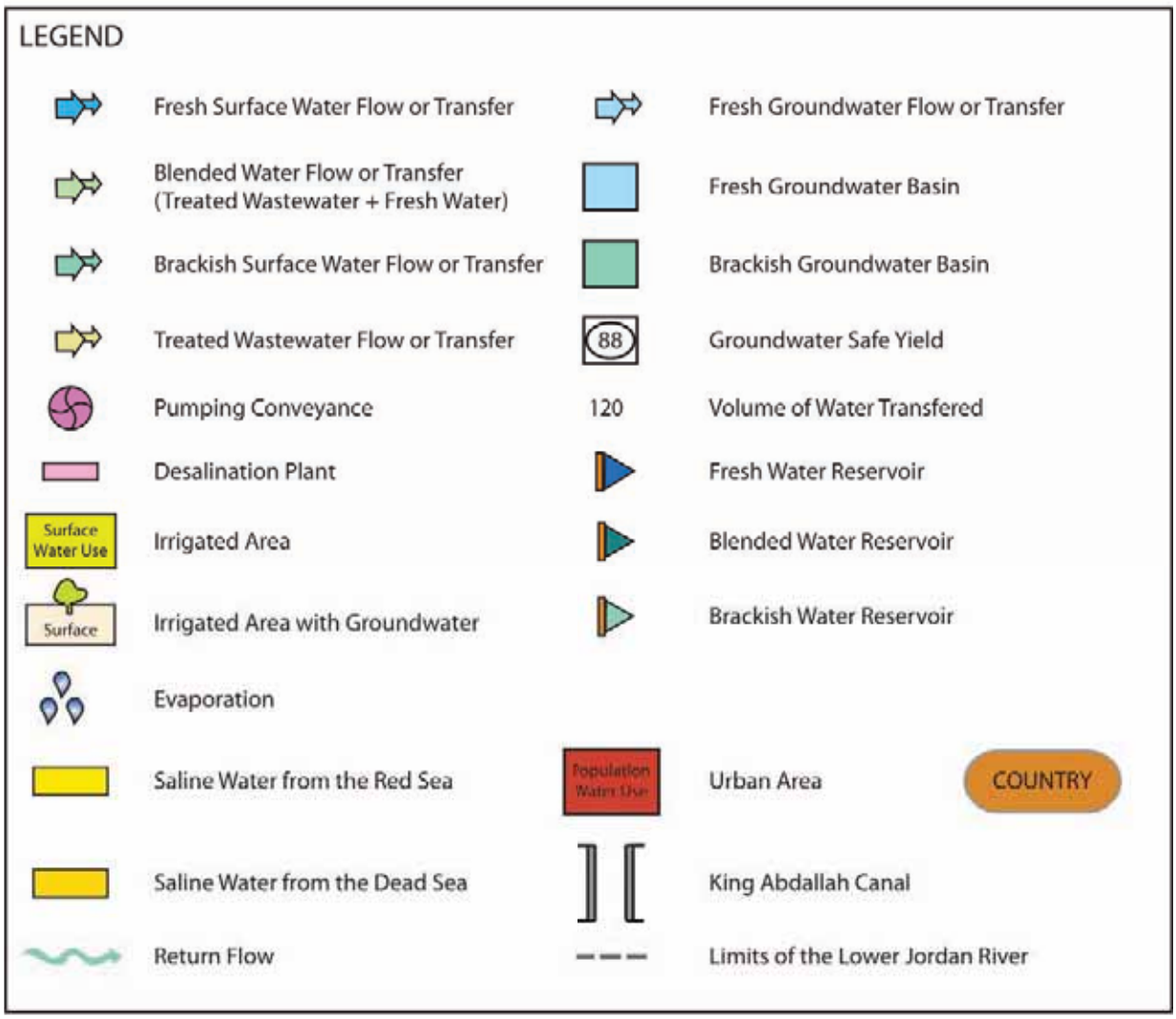


Figure 37

Water resources development in the LJRB around 1950, before the development of major diversion schemes.

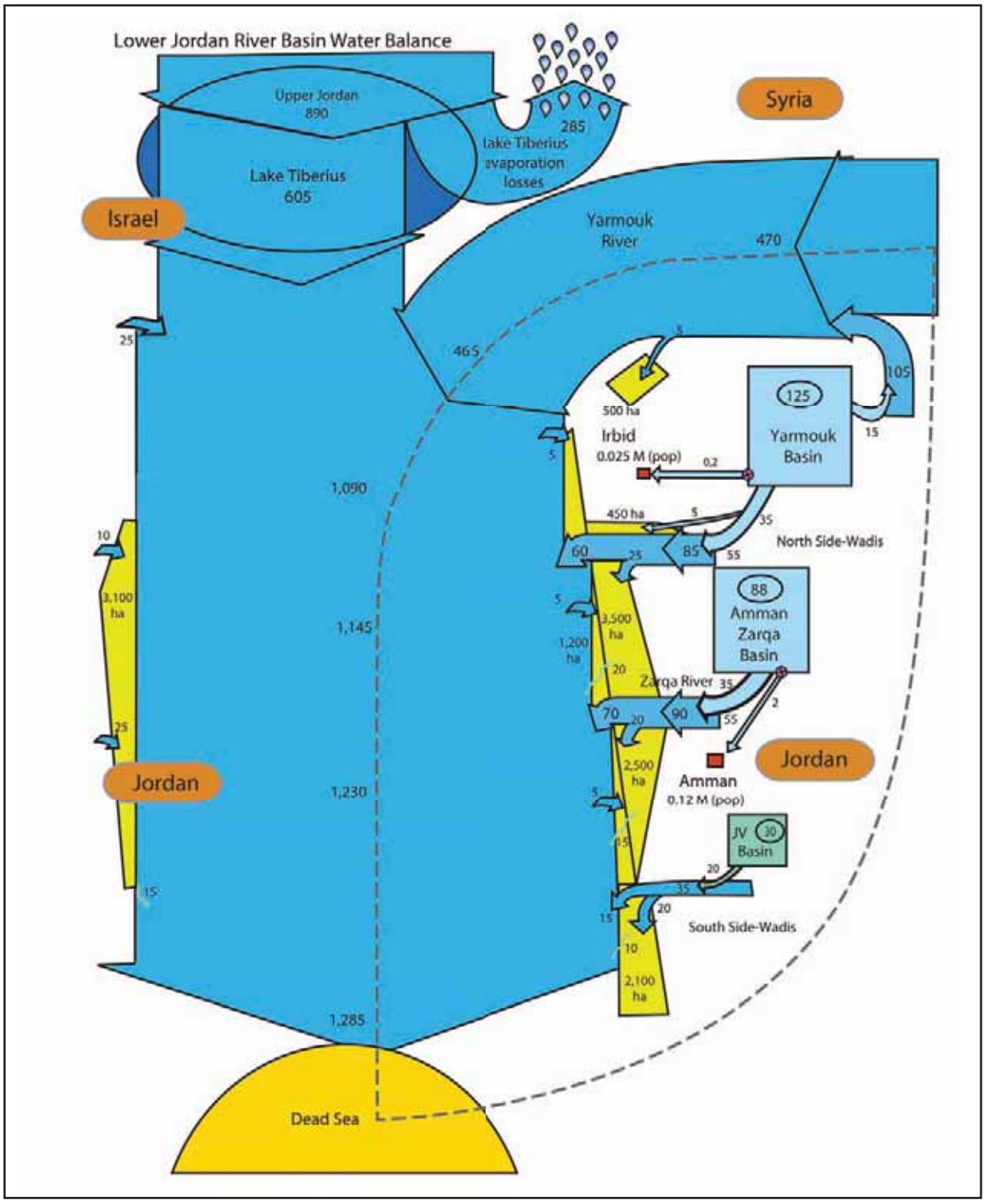


Figure 38
Water resources and uses pattern in the LJRB in the mid-1970s

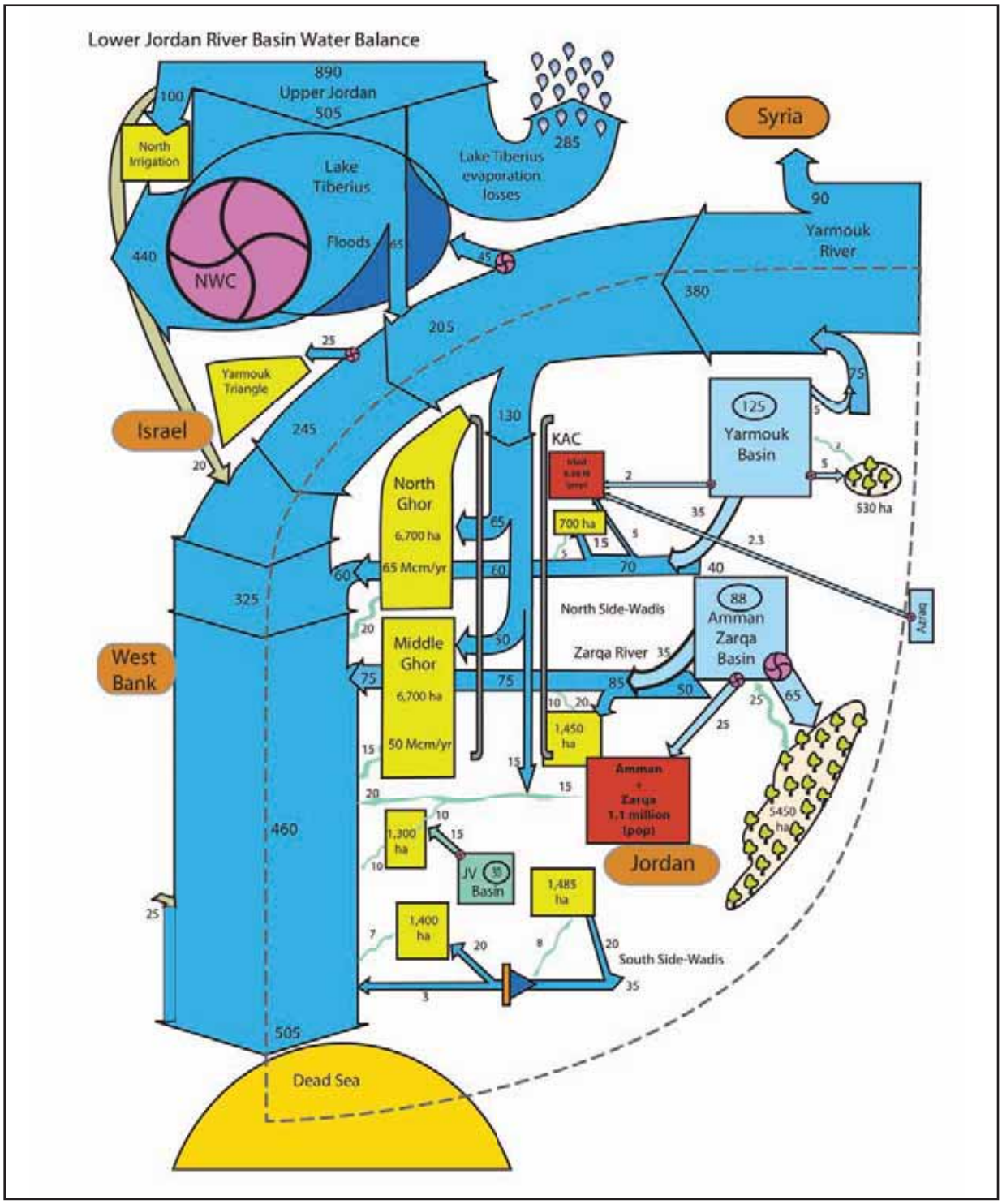


Figure 39

Water resources and uses pattern in the LJRB in the 2000s

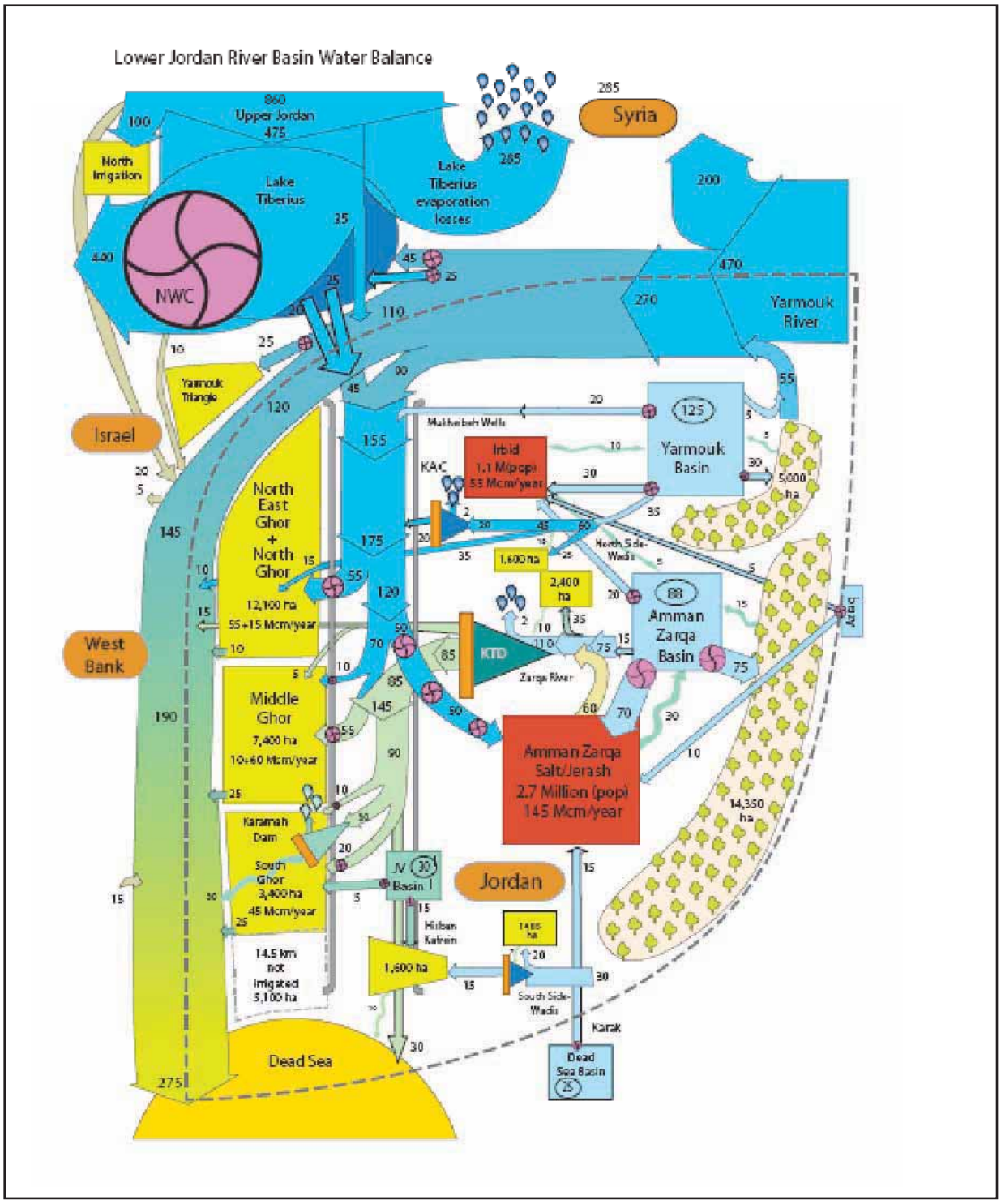
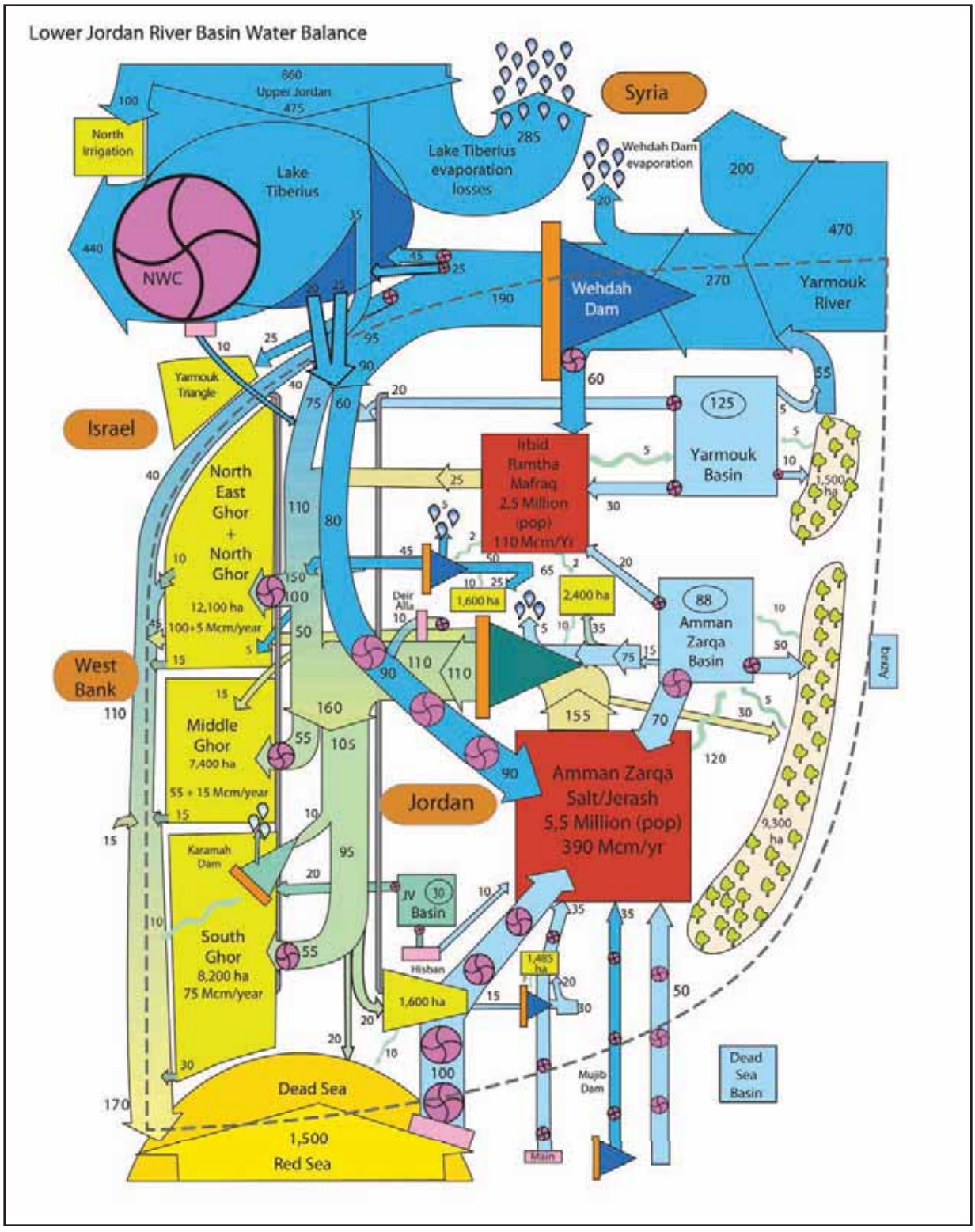


Figure 40

Projected situation of water use patterns by the mid-2020s



Intensive agriculture in the valley relies on surface water uses and is likely to remain stable, even if its water supply is reduced in quantity and quality. Banana cultivation yields high economic benefits but these benefits are artificial, due to protective custom duties. The likely future disappearance of these custom duties due to World Trade Organization (WTO) agreements, and a redefinition of allocation of water prices might encourage a shift towards less-water-intensive crops, such as date palm trees in the southern part of the valley.

Such a reorientation and other measures necessary to achieve better water management are faced with some socio-political difficulties within the Jordanian society. Only a global awareness of the problems that Jordan faces could mitigate these difficulties and allow for the implementation of the measures needed.

Another aspect of the transformations that have occurred in the LJRB is the shift in water policy. Calls for demand management have been only partially incorporated or implemented, mainly for socio-political reasons. The prevailing medium and long term solutions are eventually typical capital and technology-intensive supply augmentation projects, namely large-scale inter-basin transfers and desalinization.

This may be seen as the lasting dominance of the engineering-based approach but this also shows that however desirable they may be, demand-management options may only alleviate the actual situation without providing long-term solutions.

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Annex 1

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Annexe 2

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Annex 3

Results of an FAO Rapid Appraisal Procedure

(Extract from the FAO-IPTRID report by Robina Wahaj - Rapid Appraisal Procedure in the Jordan Valley Irrigation System - Technical Completion Report, October 2008)

INTRODUCTION

Jordan Valley Irrigation System (JVIS) is one of the most water short irrigation systems in the world with a growing gap between the crop water demand and water supply. Scarce water resources coupled with ever-increasing demand from the industries and the cities result in less water available for irrigation. Hence, the authorities have to increasingly reduce water allocation for agriculture and sometimes have to limit the crops that could be grown in the command area. This happens at the expense of flexibility and adequacy of water delivery service.

Performance appraisal of the JVIS was conducted in May-June 2008 as part of the wider study on capitalization of the lessons learnt by the projects implemented by the Regional Mission on Agricultural Water (MREA) in Jordan. The study was financed by the Agence Française de Développement (AFD) and was carried out by the International Programme for Technology and Research in Irrigation and Drainage (IPTRID).

The Rapid Appraisal Procedure (RAP) methodology was used to assess the key external and internal indicators and to establish current level of water delivery service at the different levels in the irrigation system - conveyance, distribution and farm intake. Following the advice of the Jordan Valley Authority (JVA), the RAP was conducted in the North Directorate of the JVIS.

THE RAPID APPRAISAL PROCEDURE (RAP) METHODOLOGY

The Rapid Appraisal Procedure (RAP) is a systematic, quick and focused examination of an irrigation system for diagnosing the bottlenecks and the performance and service levels within an irrigation system. It provides qualified personnel with a clear picture of where conditions must be improved and assists in prioritizing the steps required for improvement.

The Rapid Appraisal Procedure (RAP) was originally developed by the Irrigation Training and Research Center (ITRC) of California Polytechnic State University, San Luis Obispo in the mid-1990s for a research programme financed by the World Bank on the evaluation of the impact on performance of the introduction of modern control and management practices in irrigation (FAO, 1999). Since its introduction, the RAP has successfully been used by FAO, the World Bank and other irrigation professionals for appraising projects in Asia, Latin America and North Africa.

The conceptual framework of the RAP for the analysis of the performance of irrigation systems is based on the understanding that the irrigation systems operate under a set of physical and institutional constraints and with a certain resource base. Systems are analyzed as a series of management levels, each level providing water delivery service through the system's internal management and control processes to the next lower level, from the bulk water supply to the main canals down to the individual farm or field. The service quality delivered at the interface between the management levels can be appraised in terms of its components (equity, flexibility, reliability) and accuracy of control and measurement, and depends on a number of factors related to hardware design and management. With a certain level of service provided to the farm, and under economic, agronomic constraints, farm management can achieve certain results (crop yields, irrigation intensity, water use efficiency etc.). Symptoms of poor system performance and institutional constraints are manifested as social chaos (water thefts, vandalism), poor maintenance of infrastructure, inadequate cost recovery and weak water users associations.

Main objectives of the RAP evaluations are:

- assessing the current performance and providing key indicators;
- analyzing the operation and management procedures;
- identifying the bottlenecks and constraints in the system; and
- identifying options for improvements in performance.

The RAP has also been used as a foundation for benchmarking. Benchmarking is defined by the International Programme for Technology and Research in Irrigation and Drainage (IPTRID) as a systematic process for achieving continued improvement in the irrigation sector through comparisons with relevant and achievable internal or external goals, norms, and standards (IPTRID, 2001). The overall aim of benchmarking is to improve the performance within an irrigation scheme by measuring it against desired targets and own mission and objectives. The benchmarking process should be a continuous series of measurement, analysis, and changes to improve the performance of the schemes. Thus the RAP becomes a tool for regular monitoring and evaluation of an irrigation project.

The RAP is now fully integrated as the STEP 1 or the foundation of the new approach developed by FAO for modernization strategy and plans which is called Mapping Systems and Services for Canal Operation Techniques (MASSCOTE).

EXTERNAL INDICATORS: Main findings

The external indicator of the RAP compares input and output of a project or irrigation scheme to describe performance. These indicators are expressions of various forms of efficiency, for example water-use efficiency, crop yield and budget. They do not provide any detail on what internal processes lead to these outputs and what should be done in order to improve performance. However, they could be used for comparing the performance of different irrigation projects both nationally and internationally. Once these external indicators have been computed, they can be used as a benchmark for monitoring the impacts of modernization on improvements in overall performance.

The project data regarding water supply, agricultural production, climate and hydrology were compiled in order to compute the external indicators. The external indicators will be particularly helpful

for the JVIS authorities to assess the potential benefits of any further modernization. These indicators can also be used to compare JVIS with the other projects appraised by FAO in the world. However, most of the projects appraised by FAO until now are mainly gravity fed canal systems, it will still be useful to compare. Moreover, as FAO is expanding its work on irrigation system appraisals and irrigation modernization to the Middle East, these external indicators will be useful for comparing irrigation system performance in the region, in the near future.

Data from the year 2007 was used to compute external indicators presented in Table 1. The table also includes values of confidence interval revealing the reliability of the information used for this analysis. The most important result revealed by this analysis is high level of irrigation efficiencies showing no room for improvement. The command area efficiency is 98 percent, whereas field irrigation efficiencies >100 percent, meaning that the water provided by the authorities does not fulfil the potential crop water requirement.

Table 1. Selected external indicators of JVIS-Northern Directorate

ANNUAL External INDICATORS for the Command Area			
Item Description	**Units**	**Value**	**Est. CI %/100**
Peak litres/sec/ha of surface irrigation inflows to canal(s) this year	LPS/Ha	2.23	0.05
RWS Relative water supply for the irrigated part of the command area (Total external water supply)/(Field ET during growing seasons + water for salt control - Effective precipitation)	none	1.51	0.30
Annual **Command Area Irrigation Efficiency** [100 x (Crop ET + Leaching needs - Effective ppt)/(Surface irrigation diversions + Net groundwater)]	%	98	0.30
Field Irrigation Efficiency (computed) = [Crop ET-Effective ppt + LR water]/[Total Water Delivered to Users] x 100	%	115[a]	0.30
RGCC - Relative Gross Canal Capacity - (Peak Monthly Net Irrigation Requirement)/(Main Canal Capacity)	none	0.21	0.49
Water Delivery Capacity – (1/RGCC)	none	4.75	0.49
Total annual value of agricultural production	US$	52,321,074	0.40
Gross value of production according to the area (total annual production/service area)	US$/ha	5,844	
Gross value of production according to the irrigation water supplied (total annual production/irrigation water supply)	US$/$m^3$	0.94	
Percentage of O&M collected as water fee and in-kind services	%	22	
[a.] This value should be considered 100 percent. Irrigation water is not enough to fulfil crop water requirement.			

Figure 1. Annual command area efficiencies in large scale irrigation systems

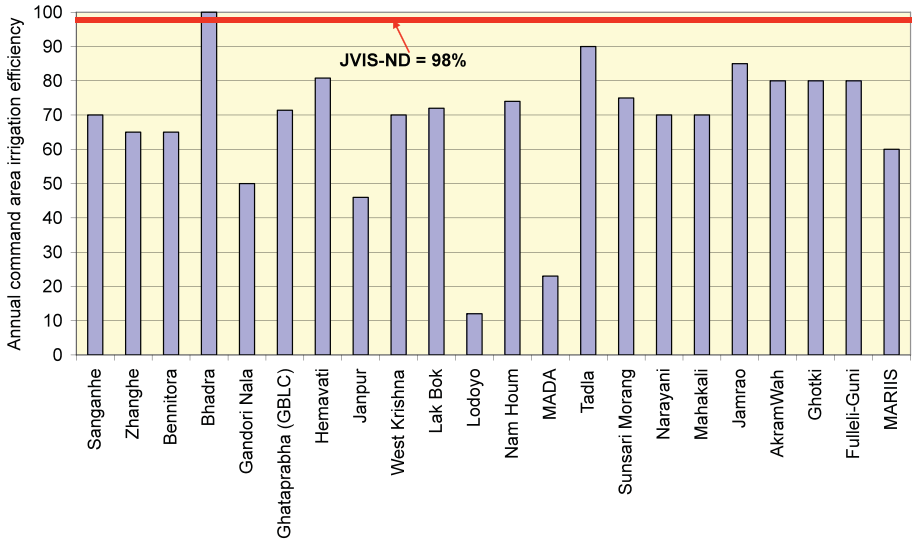


Figure 1 shows that overall efficiency of water supply is one of the highest among the irrigation systems appraised by FAO. In general command area irrigation efficiency is high in the systems with limited and low water availability. Most of these systems, such as Jiamaku in China, Tadla in Morocco and Akramwah in Pakistan, lie in arid and semi-arid regions.

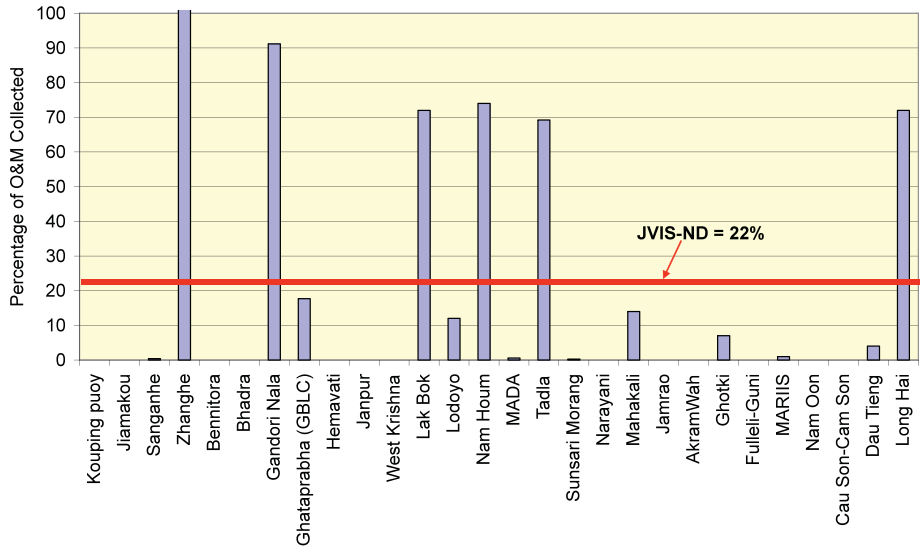
The indicators of RGSS and water delivery capacity (WDC) show more or less the same thing. While both indicators reflect on the capacity of the KAC to supply water compared to the net irrigation requirement in the month with highest irrigation water requirement, which for JVIS-ND is June (and July), RGSS uses flow rate capacity of the main canal in the denominator and WDC uses the same value in the numerator. KAC basically has a capacity to deliver a discharge about five times higher than what is required to meet peak irrigation requirement. It is important to note that the irrigation requirement calculated for this analysis did not consider the water requirement of the city of Amman.

Irrigated agriculture in the JVIS-ND annually generates about US$52.3 million that amounts to US$5 844 per hectare per year. This amount however does not reveal the net profit, which will be less considering high cost of production in the country partly due to high input requirement. The high value of land productivity in the JVIS is due to cultivation of high value cash crops and orchards (Citrus and other fruit trees and vegetables).

The value of production in JVIS-ND in terms of the amount of irrigation water supplied is also very high, 0.94. Extremely limited water availability, coupled with pressurized irrigation distribution network, lead to high value of water productivity.

Water in JVIS is subsidized by the Government which is reflected in the indicator of percentage of operation and maintenance (O&M) collected. Value of this indicator for JVIS-ND is 22 percent, meaning revenue collected from the farmers as water charges cover only 22 percent of the total expenditure on O&M. In JVIS, water is charged according to the volume but the price obviously is much lower than what

Figure 2. Matching collected revenue with actual cost of O&M in large scale irrigation systems



is needed to keep the system running. Another factor is that water supply to the city of Amman without any revenue meaning that irrigation in fact has to subsidize domestic and industrial water supply. When compared with other systems in the world, JVIS seems to be doing worse than many irrigation systems that charge water according to the area and crops (see Figure 2).

INTERNAL INDICATORS: Main findings

The internal indicators of RAP assess the inputs (resources used) and the outcomes (services to downstream users), thus allow an evaluator to:

- identify the key factors related to control of flows and pressure;
- examine specific hardware and management techniques and processes used in the operation and management of the network; and
- define the level of water delivery service provided to the end users and at different levels of the system;

Most of the main internal indicators, called primary indicators, are sub-divided into different components, called sub-indicators. These indicators can be assigned with values of 0-4 (0 indicating least desirable and 4 denoting the most desirable). The ranking criteria are straightforward, objective, well-established and well tested. The ranking criteria are based on a set of pre-defined statements that an evaluator has to verify in the field as well as in the office. Each of the sub-indicators is assigned a "weighting factor". The weighting factors are only relative to each other within the indicator group. The final value of the primary indicator is then obtained based on the weighting factors.

The values of the primary internal indicators reflect an evaluation of the key factors related to water control and service throughout the command area covering details such as the type and functioning of cross regulators, use of measurement structures, delivery schedules and operation rules.

Service indicators

The service indicators quantify the quality of service provided by one level of the irrigation system to the next lower level. Table 2 presents the level of service at the lowest level – that is at the individual ownership units (I-1), and the service provided from the main canal to its offtakes (I-5) in the JVIS-ND. The values show that the service provided from the main canals to its offtakes - which in JVIS-ND are inlets to the pumping stations (or sumps), and the gravity pipelines – is very good (3.0); however the actual service at the final delivery point is well below (1.9) than what is expected in a pressurized network. There are almost no pressure gauges at the FTA, and also the flow rate is not measured. Water metres are provided, which give estimates of volumes, however a significantly high number of them are damaged by farmers. One of the reason for the low values of service indicator to farms is that the farmers and somehow some of the JVA staff (ditch riders, pump station operators) still operate the pressurized network in the same mode as they did when the system was gravity fed.

Water delivery service (WDS) in JVIS-ND, in both cases at the final delivery level and at the conveyance level is among the highest when compared with the other irrigation systems in the world (Figures 3a and 3b). In fact the service indicators of JVIS could improve further if the operation of the distribution network is improved.

Stated versus Actual water delivery service

Irrigation scheme managers often have an inflated view of the irrigation service they provide to the users. The RAP compares delivered level of service - that is evaluated using RAP criteria - with the declared level of service - by the managers of the irrigation scheme. This indicator is called chaos in RAP and is considered important to assess the chances of success of modernization proposals. Higher values of the chaos indicator reflect better performance meaning that the managers are fully aware of the actual field conditions. It is believed that bringing about change will be harder in cases where managers are either not aware of the actual field conditions or refuse to recognize problems.

Table 2. Level of service in JVIS-ND

Indicator	Level in the system	Rank
I-1	**Actual water delivery service provided to individual ownership units or farms**	**1.9**
I-1A	Measurement of volume	2.0
I-1B	Flexibility	1.5
I-1C	Reliability	1.5
I-1D	Apparent Equity	2.5
I -5	**Actual water delivery service provided by the KAC to its offtakes**	**3.0**
I-5A	Flexibility	2.5
I-5B	Reliability	3.5
I-5C	Equity	3.0
I-5D	Control of flows rates	3.0

Table 3. Actual and Stated water delivery service in JVIS

Indicators	Actual	Stated	(Actual/Stated)
Service provided to the individual ownership units (farms or fields)	1.9	3.0	0.62
Service provided by the conveyance canal to its offtakes	3.0	3.2	0.95

The gap between the declared level of service and delivered level of service at the individual ownership units in JVIS-ND is high at the field level whereas low at the main canal level (see Table 3). It seems that the managers of the main canal system are better equipped to evaluate their own performance and also their perception of how well they are performing is closer to the actual field condition whereas the managers of the distribution networks do not have a good idea about the actual field conditions. These low values are also because there are too many layers of management, the managers of the directorate do not know the way the system is actually being operated, since there is an additional layer, called *stage office*, between the manager of the directorate and the pump operator. The purpose of the *stage office* is not very clear except passing on information about water demand and water distribution schedules, to the next lower level as well as to the next higher level and collecting water charges. All these activities can be performed rather well by the pumping stations and the directorate office. Moreover, the actual pump operators and the ditch riders lack the capacity, tools and incentives to operate the system appropriately.

Chaos at the field level and the main canal level in JVIS is compared with the chaos at these levels in other irrigation systems in the world (see Figures 4a and 4b). It is interesting to note that almost all of the other systems are gravity systems, even then the values of field level chaos in JVIS-ND are lower than the overall average of all the other systems, that is 0.66. This is mainly due to the reason that the managers of JVIS take their hardware for granted and although a lot of attention is given to the operation of the main canal, very little attention is given to the operation of pumping station and distribution network.

Infrastructure, operation and institution

The primary indicators related to the hardware and operation, presented in Table 4, show that while the main canal hardware and operation rank reasonably well, the internal indicators of pumping station and the distribution network are on the lower side. Pumping stations as well as distribution pipelines are quite old and need upgrading or replacement. More importantly, the indicators related to operation of the pumping stations and the distribution networks are quite low and need to be improved.

There are only 3 WUAs in the JVIS-ND, covering less than 30 percent of the command area. These WUAs are legal entities but are hardly functional and do not yet play any effective role in water distribution. GTZ is implementing a project that is mobilizing farmers to form WUAs.

Table 4. Values of selected internal indicators in JVIS

Internal Indicator *Rankings are from 0 to 4 (4 is the maximum possible and 0 is the minimum possible)*	Actual – calculated and assessed through RAP
Main Canal Cross Regulator Hardware	2.8
General conditions of the main canal	2.5
Turnouts of the main canal	3.7
Operation of the main canal	3.7
Pumping station hardware	1.5
Operation of the pumping station	2.3
Distribution network hardware	2.2
General conditions of the distribution pipeline	2.5
Operation of the distribution pipeline	1.5
Water User Associations	0.7

PERSPECTIVE and IMPROVEMENTS

There is virtually no solution for the limited water resources situation in Jordan and JVIS has to cope with it. However, there is a lot of room for improvement in terms of system operation and management and to a certain extent the infrastructure of the distribution network. While capacity development of the gate/system operator will help achieve improved operation, provision of irrigation advisory services to farmers will improve the operation of the on-farm network.

Operation and Management

RAP indicator shows that operation of the main canal, based on the volume control method, is reasonably good. However, because of the limited water availability, even with dynamic regulation very often the increased outflow from a canal pool cannot be compensated with the increased inflows, resulting in problems with water supply to the offtakes. As, irrigation managers are not responsible for managing the reservoirs, they have to request the authorities to release additional water from a reservoir into the network which may take from 2 to 24 hours. Irrigation managers should be able to manage the system as a whole, including the reservoirs, so they can take timely decision regarding release of water from the reservoirs. Another alternative could be to temporarily suspend water delivery to sensitive offtakes when volume in a pool is reduced to a minimum pre-established threshold level. These offtakes should then be compensated later on. In other words, options for rotation among the canal offtakes/turnouts should be explored.

Operation of the pumping station and distribution network are currently well below standards. In response to overdraw of water at pumping stations discharge into the network is often reduced by using the control valve at the pump outlet, which is incorrect. The right thing to do would be to check if a farmer has opened his FTA out of turn, which often is the case. This as well happens when the control centre is alerted by the SCADA system that a pumping station is overdrawing water and informs a pump operator.

Procedures to develop water distribution schedule need to be improved based on optimization that can be done using any computer software. In fact the IOJoV project is already doing it in their project area but this needs to be done on a wider scale and the practice needs to be institutionalized into JVIS management.

Simple improvements in water distribution scheduling and operation of the pumping station and distribution network will result in much better service delivery at farm-gate. Inclusion of some key indicators to monitor operation of the pumping station and the distribution network will help managers to keep a reality check on the system performance. In this regard, indicators like annual or six-monthly efficiency of each pumping station and water delivery service to the final delivery point will be very useful. Currently, water accounting is carried out at the KAC level considering the inflows and outflows into KAC. Similar exercise can be carried out at the distribution network level, considering the water supply/use and crop water requirement. This could help assess the situations in the different networks and allow the managers to focus on critical problems and problematic areas, for example inefficient water use within a distribution network.

Finally, JVIS must stop subsidizing Amman. The City of Amman must pay a price for the service provided by the JVA. This is a policy decision that actually would have great implications on the management of the JVIS.

Hardware

In general, the type and the condition of the hardware of JVIS is much better than many irrigation systems appraised by FAO in the world. However, upgrades are needed to improve the performance of distribution network. Theoretically, JVIS is an on-demand system, but in reality, it is on-request, not only because of the limited water availability but also because the capacity of pumping stations and distribution networks are not enough to run the system on-demand. Pipes are old and most of them have problems of concretion. Other equipment, such as water meters, is also damaged and need repair or replacement. An inventory of the damaged infrastructure and asset management plan can help prioritize the upgrading.

When upgrading pumping stations, high efficiency pumps with variable speed must be considered as these pumps can adjust automatically to the required flow rate and pressure.

The water meter is a critical item of irrigation infrastructure as the water bills are based on them. Also, water meters are the only way for farmers to verify water delivery service. More than half of the water meters in JVIS-ND are not functioning and need repairs or replacement.

The solution to improve water availability for irrigation mainly lies outside the irrigation network and reach of irrigation managers. Apparently, inefficiencies in the distribution network cost a significant amount of water through leakages and head losses. While Amman does not pay any money for receiving water, it gets the priority for water supply. Modernizing the distribution network in Amman will save some water that can be reallocated to agriculture.

Capacity Development

Although middle and senior level staff receive frequent training, field staff has virtually no opportunity for any training in optimal operation and good practices. Pump operators seem to have been provided with a kind of instruction manual, and also receive training when they join the JVA. Field staff does not even have transportation to go to the fields for operation - even in hot weather - they have to use their private vehicles. There is no reward for good work and there are no penalties/consequences for bad operation. Performance based evaluations are needed but more importantly capacity development of field staff is required to improve operation and maintenance of the network. In particular pump operators and ditch riders need good knowledge of what not to do, they seem to operate the system in the same manner as they operated thye gravity canal system. Field personnel/ditch riders need to be mobile in order to be able to operate (and monitor) the system appropriately.

Although some projects, for example MREA, trained JVIS field staff of the TOs?? included in the project, the procedures developed by them and practices followed were not institutionalized. Hence the improvements gained during the project were lost afterwards. The results of RAP carried out in the system shows that there is no difference in performance between the areas under MREA project and other areas. Having said that the results also show that there is a genuine need for capacity development and improvement in operation at each level but in particular at pumping stations and at the farm level. Therefore, the IOJoV project that has started recently and which is the extension of the MREA project is very timely. Nevertheless, institutionalization of the procedures followed as part of the project activities is a must if any impact is to be achieved once the project stops.

Irrigation Advisory Services

Like the field staff of JVIS, the majority of farmers are also facing difficulties to change the mindset from gravity irrigation to pressurized irrigation system. They still think in terms of the (high) flow rate required for irrigation, pressure is not a big issue for them. This is due to the fact that capacity development of farmers did not accompany the large scale conversion from gravity irrigation to pressurized irrigation. Farmers were mentally as well as technically unprepared for a huge change in the way the irrigation system works. Even now, JVIS does not provide irrigation advisory services to farmers. Projects such as IOJoV are helping but a better institutional set-up is needed to sustain the impact and upscale the activities.

RAP and MASSCOTE

The RAP was carried out mainly in the northern part of the JVIS, with some field visits to the KAC south. It is highly recommended to carry out a RAP in the entire JVIS to assess performance of the system as a whole and MASSCOTE to prepare improvement plans in the different sections of the system.

Figure 3a. Actual water delivery service at farm gate in large scale irrigation systems

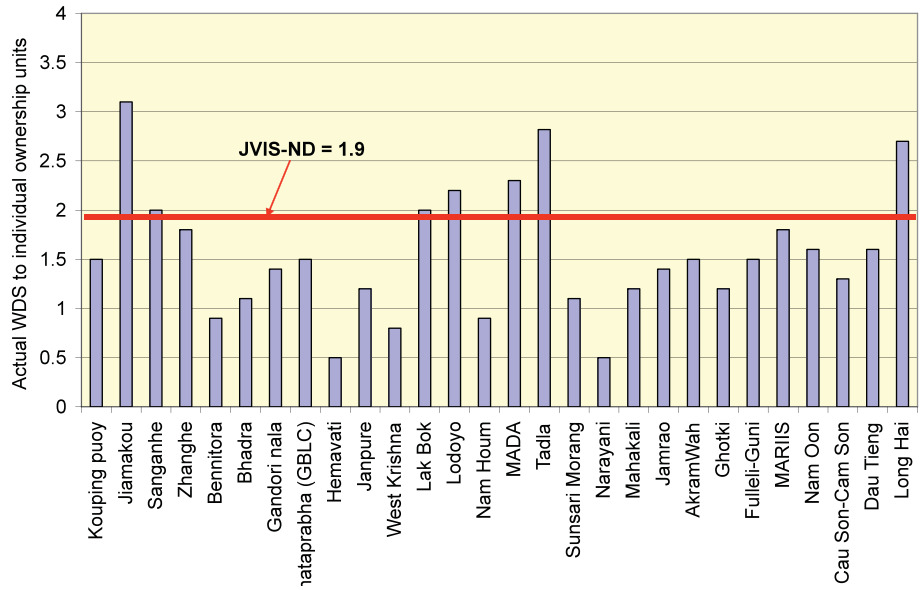


Figure 3b. Actual water delivery service provided by the conveyance canal to its offtakes in large scale irrigation systems

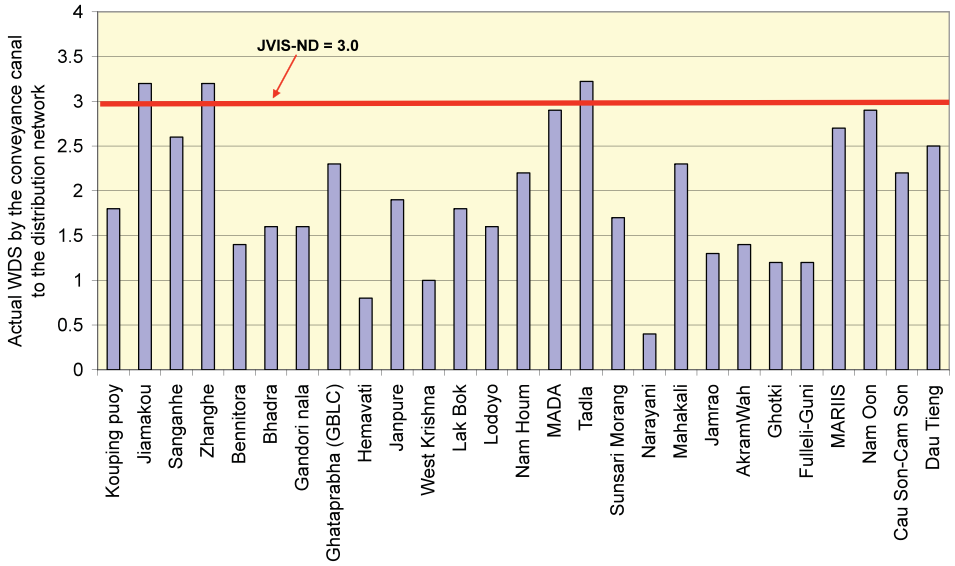


Figure 4a. Actual/Stated water delivery service to individual ownership units in large scale irrigation systems

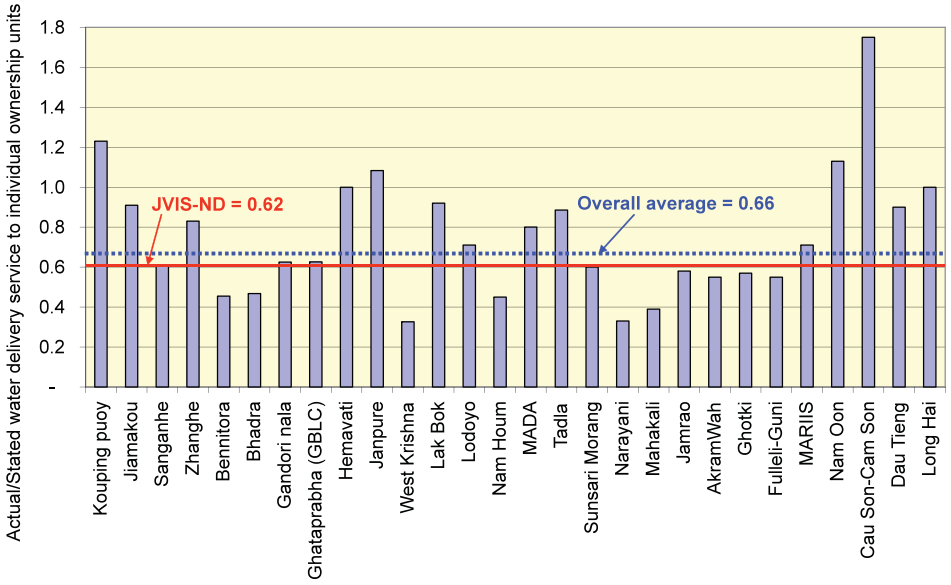
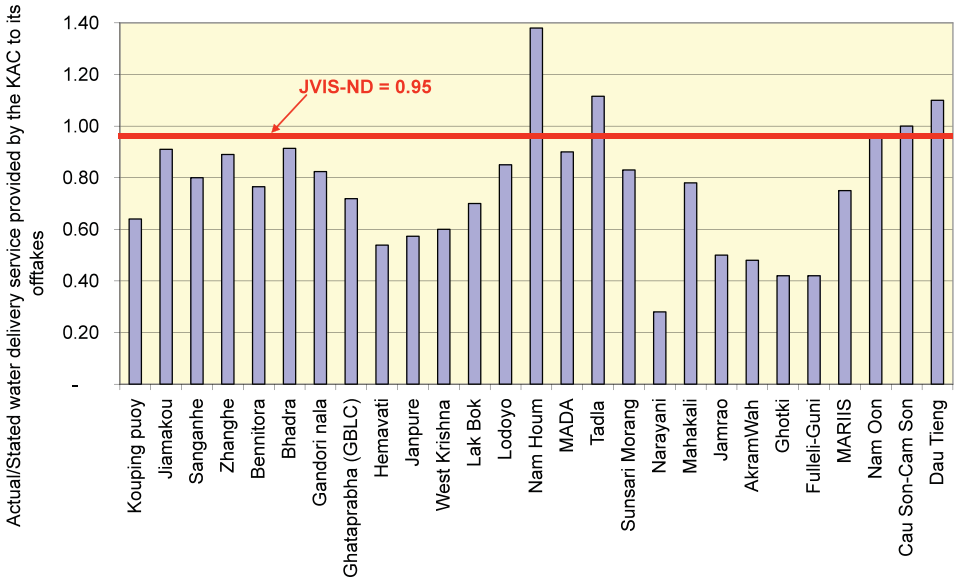


Figure 4b. Actual/Stated water delivery service provided by the main canal to its offtakes in large scale irrigation systems



CONCLUDING REMARKS

The Kingdom of Jordan is one the most “water poor” countries. Dwindling water resources, increasing population and competition from other sectors has significantly reduced water allocated for agriculture, which remains the highest consumer of water. As the situation of limited water resources is not expected to improve in the near future, and the priority is given to supplying water to the big cities, JVIS must look inside to improve the situation of water supply to the farmers, in order for them to take full advantage of high efficiency pressurized irrigation networks.

RAP results show that there is hardly any room for improvement in overall efficiencies of water supply at the command area. However, efficiencies of pumping stations and on-farm networks can be improved through proper operation and some upgrading of the hardware. However, the managers should be very careful in assuming that this will free up some water as the current operation results in inequitable water service (in terms of flow rate and pressure). Improvements in efficiencies in the distribution network will enhance the water delivery service at the farm level and allow farmers to make better use of their resources. This in turn will reduce water siphoning from the KAC.

In theory, pressurized irrigation networks are supposed to be highly flexible on demand systems but this is not the case in JVIS. Water distribution in JVIS, because of the water shortage, is on request. Sophisticated infrastructure has to be supported by good operation to improve the water delivery situation at the field level. The setting up of irrigation advisory services for farmers and capacity development of the ditch riders and capacity development of pump operators and ditch riders are key elements for improved operation.

Annex 4

Summary of the MREA evaluation in 2007

An external evaluation of the FSP and the MREA was conducted between June and July 2007, in conjunction with a forward-looking study conducted by GRET. Two experts from IPTRID went to Jordan and the Palestinian Territories from 9 to 23 July 2007 to interview nearly 100 partners (in over 30 institutions). Lebanon was not visited for security reasons and interviews have been conducted also by telephone. The Gaza Strip was also inaccessible at the time of the mission and a video conference was held from Ramallah. The following conclusions can be drawn from this evaluation.

1) There is no doubt concerning the relevance of MREA activities during this FSP. Both the themes and the approach of MREA are highly appreciated by most of the stakeholders involved. MREA occupied a unique niche in research and consultancy in the area of agricultural water. The involvement of the *Société du Canal de Provence* (SCP), main private operator under MREA contract, has been extremely satisfactory. SCP has provided very appropriate analysis and suggestions. People have recognized both the high quality of its experts and the good preparation of its short missions thanks to support from the MREA team. MREA is often defined as a pioneering institution, engaged in original experiments. However, for some partners, there was too much dispersion with a too broad domain of intervention geographically and thematically, which may have affected the impact of the programme.

2) The coherence with other donors was very correct**.** This is perceptible in thematic donor platforms like the Donor/Lender Consultation Group in Jordan. However, a lack of a precise definition of the mission of the MREA was noted. If, for most partners the mission makes sense, some others would have welcomed some clarification on the precise mandate of this service based at the French Embassy. Similarly, there have been some criticisms with regard to the selection of beneficiaries. Some of the chosen farmers had very high technical background and sometimes were even relatively prosperous.

3) The guidance was insufficient : neither Paris nor the partners from the steering committees had sufficiently interacted with MREA, giving the Head full autonomy in its choices. However, the effectiveness (and the subsequent production of expected results) is remarkable since MREA delivered outputs with very reasonable delays.

4) The efficiency (use of the available resources) is considered as good, especially as the conditions of implementation have been very hard, whether in terms of lack of funds in the early years of the FSP or since there were many troubles in the region (especially in the Palestinian Territories). It can be said that "good value for money" has been achieved thanks to short missions, the intervention of many students and international volunteers and the use of local resources at a very reasonable cost.

5) The results are particularly convincing when it comes to training: more than one thousand people have been trained, prompting other donors such as JICA and the EU to request the services of MREA. It went beyond even the circle of the three countries targeted with the training of 30 Iraqis.

6) The flexibility of MREA has been permanent. The agricultural expert (Head of MREA) has always found solutions, even in tense budgetary periods.

7) The impact of MREA activities on national policies is however fairly small. The reason lies in the positioning far from governmental offices. Similarly, the impact in terms of regional cooperation between the three countries is unfortunately limited, except through training or seminars. However, the impact at farm level in the Jordan Valley and in the Gaza Strip is considerable.

8) MREA was judged very positively by professionals of the region, mainly because of the devotion, the ability and the enthusiasm of its staff. Many partners said they were very worried about the termination of MREA which some did not believe or did not know. The overall impression is that MREA was under a "too exclusively" French management.

9) The dissemination of the results is quite satisfactory through the magazine "Water and Irrigation News" available in three languages, reports and brochures and a good Web site. However, many partners hope that an extra effort could be made by MREA or its successor MIRRA for the organization of a final workshop, the publication of a manuscript and the sharing of tools and databases.

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Knowledge Synthesis reports - Collection synthèse de connaissances

Knowledge Synthesis reports represent the outcome of a synthesis activity, having the objective of making available new knowledge to researches and practitioners in irrigation as well as avoiding that important information and experience is lost over time.

This issue No7 has been supported by AFD (Agence Française de Développement) with the agreement of the French Ministry of Foreign and European Affairs. This publication is an experience feedback. It relates the work of the French Mission for Water and Agriculture in the Near East (in French : MREA) from 1993 to 2007. The report describes the action-research methodology that was promoted by MREA and gives concrete examples of interventions aimed at bringing innovations to farmers and managers and enhance knowledge of water issues in the region.

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