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PARTICIPATORY MANAGEMENT OF WATER RESOURCES FOR AGRICULTURAL PURPOSES IN SYRIAN ARAB REPUBLIC

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SUMMARY – This work contains the basic information about water resources availability and use in Syrian Arab Republic and illustrates the experiences related to the implementation of participatory approach in the management of water resources for agricultural purposes. In view of that, the following arguments are discussed: climatic characteristics, distribution of agro-ecological zones, water balance at national level, water use in agriculture, establishment of water user associations, their role and experiences, etc.. Particular attention is given to the role of water user associations in the rationalization and conservation of Syrian water resources. Moreover, the experiences of the pilot projects on the joint utilization of water resources are presented. Finally, this work reports a set of general recommendations – priority actions - aiming to further improvement of agricultural production in Syria and to better use of water resources.

Key words: water resources, water balance, water user associations, Syria.

INTRODUCTION

Available natural resources (land, water and work force) and their planning, development and management procedures, starting from a clear-cut strategy and priority, are considered a criterion to build an advanced and hopeful economy. This can lead to a vital and a prominent role in the socio-economic structure since the agricultural sector is still the mainstay of development process as it is a source for people food at a time food security is one of the most complicated problems at national, regional and international levels. Additionally there is a need to assure local manufacturing development of agricultural production in order to increase added-value of gross domestic product.

Population growth and socio-economic development for all various activities started to form a growing pressure on water resources. This led to qualitative and quantitative changes of these resources resulting in the most complicated and difficult circle due to the limited water resources as compared to the increasing and rapid demand on water by different economic sectors together with the low use efficiency particularly in agriculture that consumes more than 88 – 90% of water uses.

Over the recent years, Syrian government strategy along with all policies, procedures, and institutional structure establishment have started to gear toward the concept of resource sustainability, conservation, use efficiency improvement and beneficiary involvement in water resource management at lower reach level. Syria has a strategic location among three continents: Asia, Africa and Europe on the eastern coast of the Mediterranean.

Syria covers an area of 185,180 km^2, of which 110,000 km^2 steppe (Badia) with rainfall about 100 mm. Population number was 18.392 million in 2001. Cultivable area is estimated to 5.98 million ha representing 32.29% of total area, while rangelands and forests 8.83 million ha constituting 47% of total area. The remaining lands are uncultivable.

Syria, from geographical point of view, can be divided into four regions:

1. Coastal plains or coastal region: it is restricted between the Mediterranean and coastal mountains.
2. Range of mountainous heights: extending from the north down to the south and including

mountains and heights in parallel to the Mediterranean coast forming more or less two parallel ranges separated by graben plain.

3. Plains or interior region: including plains of Damascus, Homs, Hama, Aleppo, Hassakeh and Deraa. They are graben plains locating between the western and eastern series to the east of eastern mountains area.
4. Plains and highlands: constituting the largest part of total area (country area). The steppe is considered as desert plains locating southeast of the country or Jordanian-Iraqi borders.

CLIMATE AND AGRO-ECOLOGICAL ZONES

The climate of the Mediterranean Sea generally prevails in Syria: This climate may be characterized by a rainy winter and a dry and hot summer separated by two short transitional seasons.

The coastal region is characterized by heavy rainfall in winter and a moderate temperature and high relative humidity in summer. The interior is characterized by a rain winter season and a hot & dry season during summer.

As shown in Figure 1, Syria's area is divided into five agro-ecological zones according to rainfall amount and distribution.

1st agro-ecological zone

Its area covers about 2.701 million ha constituting 14.6% of total area. In this zone, rainfall is not more than 350 mm/year and it is also divided into two sub-zones:

a) The first has rainfall over 600 mm/year and its rainfed cultivation is annually secured;
b) The second has rainfall ranging 350 – 600 mm and it is not less than 300 mm in two thirds of the surveyed years i.e. two seasons can be secured every three years. Its main crops are wheat, legumes and summer crops.

2nd agro-ecological zone

Its area is 2.47 million ha constituting 13.3% of total area. Rainfall is ranging 250 – 350 mm/year and it is not less than 250 mm in two thirds of the surveyed years i.e. two seasons can be secured every three years. In addition to barley, wheat, legumes and summer crops are cultivated.

3rd agro-ecological zone

Its area is estimated to 1.308 million ha constituting 7.1% of total area. Rainfall rate is not more than 250 mm/year and it not less than this figure for half of the surveyed years i.e. one out of two seasons. Main crop is barley and it may be cultivated with legumes.

4th agro-ecological zone

Its area is estimated to 1.827 million ha constituting 9.9% of total area. Rainfall rate is between 200 – 250 mm/year and it is not less than 200 mm in half of the surveyed year. This zone is suitable for barley and perennial ranges only.

5th agro-ecological zone

It forms the remaining part of the country and it is not suitable for rainfed cultivation. Its area is estimated to 10.211 million ha constituting 55.1% of total area.

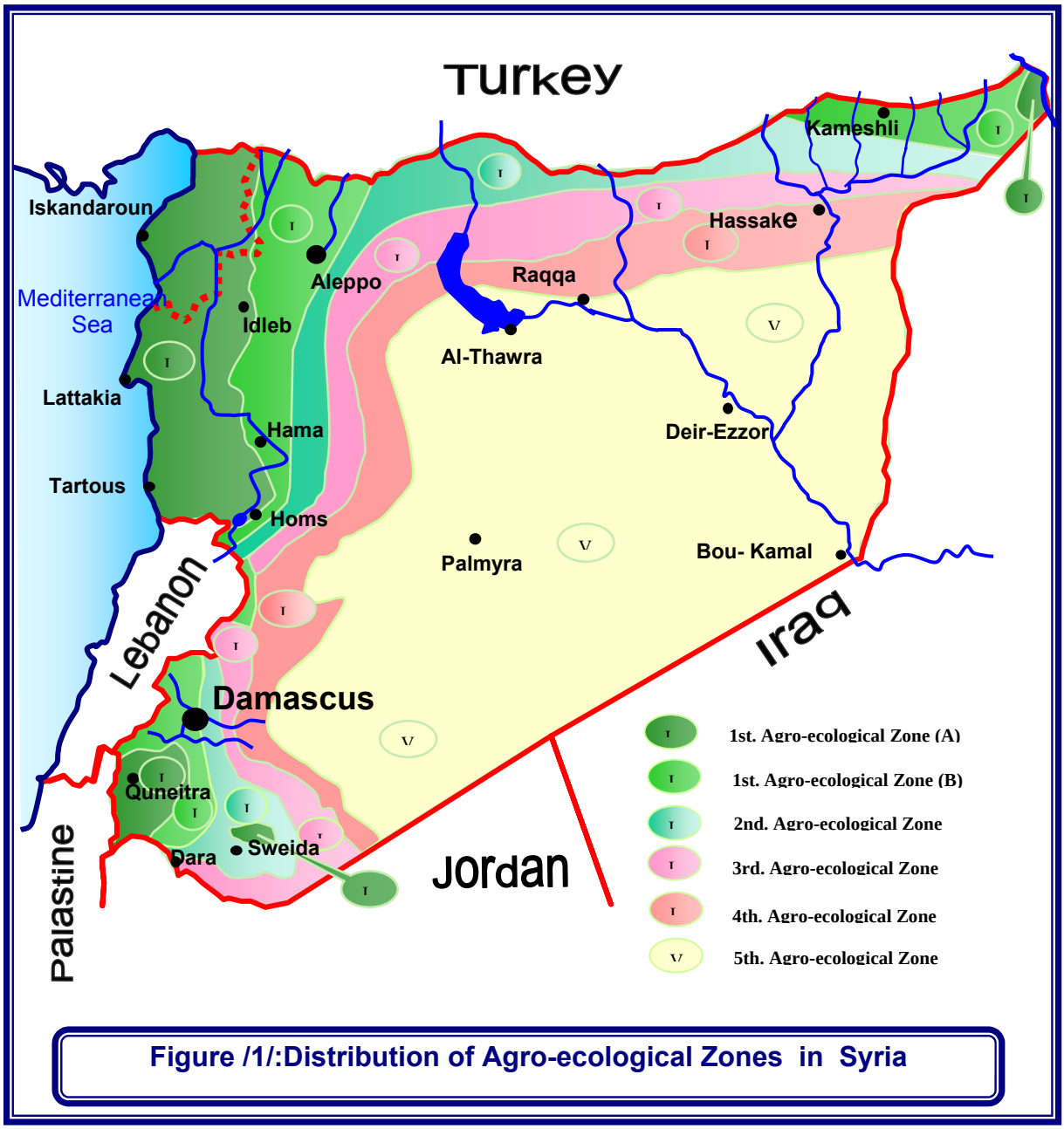

Fig. 1. Distribution of agro-ecological zones in Syria

AVAILABLE WATER RESOURCES

Discussing available water resources by different resources, rainwater supplies are considered as sources for groundwater recharge, and formations of soil moisture storage and surface runoffs together with relevant evaporation. Depending on the prevalent climatic conditions of each basin, average annual water supplies were calculated as follows:

Total traditional water supplies

Total average water supplies are estimated to 16556.0 million m^3/year of which:

- Surface water 10923.0 million m^3/year
- Groundwater 5633.0 million m^3/year

Total natural water resources calculated by taking into account percent surface runoff and groundwater recharge corresponding to rainfall at 50% probability and annual and mathematical runoff averaged 15890.8 million m^3/year were as follows:

- Surface water 10635 million m^3/year
- Groundwater 5256 million m^3/year

However, regular water resources corresponding to rainfall probability 50% taking into account regulation degree in all seven water basins were 14218 million m^3/year.

Here, it is essential to highlight the natural evaporation loss of these resources, resulting from water bodies of rivers and dam lakes, where the annual loss averaged 1850.0 million m^3/year, of which 1550.0 million m^3/year in water systems of the Euphrates basin.

Non-conventional water resources

Drainage water

Drainage water is partially reused in irrigation regions increasing in number and area. Its total percent constitute 15% of irrigation water amount discharged to surface water streams or going to recharge groundwater storage. Drainage is estimated to 1.5 billion m^3.

Wastewater and industrial water

Wastewater and industrial water constitute nearly 70 – 75% of total water used for industry and domestic use. It is estimated to one billion m^3 that should be reused for agricultural purposes of treatment processes.

WATER USE IN AGRICULTURE

Irrigated land area out of cultivable area in Syria increased during the period 1970 – 2002 from 7.34% to 24.2% due to the governmental economic polices and its continuous support to agricultural production through a range of measures of social and political feature. Irrigated area is distributed by source as follows:

- Governmental irrigation projects: 306,546 ha constituting 21.6% of planned area and less than 77.4% of areas reclaimed under governmental systems whose area increased to 396,000 ha in the season 2002.
- Lands irrigated with groundwater by means of wells: 845,650 ha constituting 59.6% of planned area irrigated by means of 166139 wells.
- Lands irrigated from different sources (common): 68,578 ha constituting 4.8% of planned area. Common sources mean areas irrigated from several sources (rivers or springs and groundwater) simultaneously, of which 29,443 ha depending on groundwater irrigating 70% of the area in Damascus, Rural Damascus and Tartous, while 25% in the other Governorates. Therefore, the planned area to be groundwater irrigated is 875,093 ha equal to 61.63% of planned areas at the country level.
- Other sources: 199,253 ha constituting 14.0% of planned area.

WATER BALANCE AT NATIONAL LEVEL

Total water resources available for use and total estimated demand on water resources were calculated according to actually cultivated areas based on the recent survey and population number at the beginning of water year. Possible water saving or shortage is estimated as follows:

Saving (or shortage) = Total resources available for use – total water resources use

Water balance at national level is synthesized in Table 1 for the probability of rainfall occurrence of 75%. This table indicates an average water shortage of almost 3000 million m^3 of water every year.

Table 1 - National water balance for rainfall supply probability at 75%

Annual regulated water resources	12049 Mm^3/year
Total actually-irrigated area	1353.93 thousand ha
Total water requirement for agricultural purposes	13973.1 Mm^3/year
Domestic uses	1070.0 Mm^3/year
Industrial water requirements	561.0 Mm^3/year
Agricultural drainage effluents	1536 Mm^3/year
Industrial wastewater effluents	1000.0 Mm^3/year
Evaporation losses from water bodies	1962.0 Mm^3/year
Shortage (or saving) in Mm^3/year =12049 – (13973.1+ 1070.0 + 561.0) – 1962.0 + (1536 + 1000.0) = -2980.7	

IRRIGATION METHODS

Actually, total irrigated area is about 1350 thousand ha, of which 832 thousand ha depend on groundwater by pumping from wells and this area constitutes 61.62% of total irrigated area (Table 2).

Table 2. Development of total irrigated areas and areas irrigated from groundwater sources during the period 1985 – 2002

Year	Total irrigated area [1000 ha]	Increase of irrigated areas [1000 ha]	Groundwater irrigated areas [1000 ha]	Percent groundwater irrigated area [%]
1985	652.0		318.0	48.8
1990	693.0	41.0	342.0	49.4
1994	1082.0	389.0	694.0	64.1
2000	1210.0	128.0	698.0	57.7
2002	1350.0	140.0	832.0	61.6

By the end of 20th Century, the government started, depending on technical results of irrigation techniques research, the implementation of the national programme for converting most agricultural irrigated areas from traditional irrigation to modern irrigation. The government also adopted several decisions to facilitate conversion process and to overcome all difficulties and constraints facing this process.

Accordingly, total areas irrigated by modern irrigation methods (drip and sprinkler) till the end of August 2003 exceeded 244 thousand ha as a whole, constituting 18% of total actually irrigated area. This area represents 27.7% of irrigated area by groundwater because most areas using modern irrigation methods are irrigated by groundwater sources.

The efficiency of traditional surface irrigation methods, applied on 82% of total irrigated area, is ranging 45 – 50%, while modern irrigation methods efficiency is ranging 72 – 78% for sprinkler irrigation and 80 – 90% for drip irrigation. The latter is mainly used for irrigating vegetables and fruit trees.

THE SYRIAN EXPERIENCE OF WATER USER ASSOCIATION

The joint utilization of water resources in Syria (historical overview)

The majority of Syrian lands locate in the dry and semi-dry area, so the utilization of available water resources is playing an important role in the agricultural sector particularly the part that relates to irrigated agriculture. Since the production of an additional and sufficient value that enable farmers to compete other economic productive sectors is one of the main conditions of agricultural production development, the farmers' awareness over past years toward wide irrigated agriculture played and is still playing the key role for the re-utilization of surface and groundwater resources which had developed utilization system during Omayad and Abbasyyen's prosperity. Moreover, there were tens of Roman channels raising up groundwater to land surface for drinking and irrigation purposes in North Damascus (Qallamoun), Huran, Salamieh, North Aleppo plain. On these channels ten of villages and irrigated agricultural projects were established and characterized by group and joint utilization of water resources within conventions and traditions that later became a base for the established laws of water legislation.

The irrigation systems operating over hundred of years in Western and Eastern Damascus Ghouta (Douma, Daria and Kasweh regions), water resource distribution system via main and secondary channels with up-to-date operating surface drainage networks using surface of groundwater, agricultural drainage reuse and the distribution of irrigated areas on consecutive terraces had the most prominent role in the improvement of water use efficiency available for all the whole system to reach approximately 70 – 75%.

The first Syrian Water User Association (WUA) in the modern ages dated back to the year 1928 when Briha farm was established in north Deir Atyah village as a closed cooperative project for a group of farmers (12 land owner). The aim was to search for groundwater and group utilization of agricultural out-rotation lands due to surface water exhaustion and insufficiency, to seek for the rehabilitation of ancient Roman channels, and reclamation of new agricultural lands altogether with this group's attempts to seize the common lands owned by the village inhabitants. And this encourages the group work to search for water and to form a participatory cooperative association including 34 farmers. Later, this association expanded to cover the majority of Deir Atyah people. This association was established on the following bases:

- Voluntary joining and group work according to "of everyone as his own capacity, to everyone's as his work" principle;
- Reclamation of cultivable and early-out-of use lands as a result of irrigation water non-availability (83.0 ha were manually reclaimed and cultivated with fruit trees and cereals without government's interference or assistance);
- Rehabilitation of irrigation channels by groundwater sources using fountains and setting up routine utilization and maintenance programs;
- Linking the cultivated areas and crop rotation with available water amount of water resource.

This specific step for Qallamoun's farmer awareness toward the provision of specialized infrastructure of irrigated agriculture sector and its support on a cooperative base, the best use of technical levels in due time, the achievement of high level for agricultural irrigation practice management had an important role in increasing agricultural production, eliminating migration process from the country to the city by the studied crop rotation and provision of direct market for final product. The success has also helped in the rational management of water source and economic return of productive process by the orientation of other villages people toward the establishment of local cooperative associations for water resource utilization in irrigated agriculture (Saddad and Salamieh villages).

Syrian General Federation of Peasants (GFP) - a Cooperative organization of participatory Resource Management Associations

The Deir Atyah's farmer cooperative (in Rural Damascus) was established, according to the law of cooperative companies, as a water user cooperative association for drinking and agricultural irrigation

purposes. And this success linked to the group utilization of groundwater resources and the solidarity of this association members to face the difficulties and to work together aiming at conservation of water resources and different irrigation channels and rational allocation of available water resources according to the duly optimal systems in 1943. It also encourages the other provinces' farmers to follow the same approach toward the establishment of WUAs at water source domain.

In 1950, the first cooperative law was issued, in which Ministry of Agriculture and Agrarian Reform (MAAR) was entitled to supervise on specialized water-agriculture associations and Ministry of Economy to supervise on the associations operating in other fields. The issuing of new legislation, regulations and decisions provided the different cooperatives with the necessary legal protection and a number of constraints were removed before the establishment of more associations. It also encouraged the crediting from the agricultural bank. On the other hand, these associations became away from being water user associations to become agricultural and sometimes service and cooperative associations within an active cooperative movement. Number of associations belonged to Ministry of Agriculture amounted 475 in April 1964 plus 361 to Ministry of Agrarian Reform. In 14/12/1964, the Legislative decree No. 127 on the establishment of general federation of peasant was issued. Later, the government issued the Decree No. 253 dated 20/10 1969 in which the government avoided the legal gaps of previous decree and promoted the participatory system of association management.

GFP's Objectives and duties

The main objectives and duties of General Federation of Peasants (GFP) are as follows:

- To deepen the farmer awareness and sticking to rights of land ownership and acquired rights related to water sources and their conservation;
- To follow up the recent scientific practices in agriculture especially in irrigated agriculture so as to secure work protection, production development and improving the Syrian farmer's economic level;
- To find out the optimal way for the direct contact between the farmers and peasants so as to gather them and to unify their capabilities and to employ these capabilities to utilize the available environmental resources optimally.

Associations' Role in Agricultural Irrigation Water Management

The main benefits of associations in agricultural irrigation water management can be synthesized as:

A. The positive effect of the joint utilization of groundwater by setting up the optimal system of agricultural plan within the domain of the association's lands, so as to realize the relation between cultivated areas, crop type and available water quantity and amount of the exploited water resources and finally to improve the economic productivity per area unit and water unit.
B. Expansion and activation of farm work in the fields of irrigation channel utilization and maintenance, and the requisites of agricultural and technical extension aiming at dissemination of modern irrigation techniques that control water loss and increase irrigation efficiency and farm work productivity per area unit and exerted effort.
C. Reconstruction of irrigated agricultural sector which is considered the largest user of water all over Syria, so as to attain the safe and optimal utilization of available water sources and to save human and water resources for other purposes.
D. Qualification of specialized staff (farmer' sons) on operation, maintenance and technical and agricultural extension through a continuous training and education plan.

Natural and environmental factors, in the absence of water extension, played a key role in the weakness and disappearance of some Syrian WUAs, which were established on groundwater use base. The unbalanced interference of man in dealing with the environmental element, stress of desertification, qualitative and quantitative changes of water and socio-economic changes in the Syrian society had a helpful role in threatening the cooperative agricultural sector and participatory associations. And this promoted the reduction of agricultural yield based on cooperative farming, small area and hand manpower.

MAIN CONSTRAINTS FACING WUA DEVELOPMENT AND DISSEMINATION

The constraints related to the development of Water User Associations in Syria can be categorized as follows:

I. Technical and technological constraints
- Weakness of scientific research resources and extension staff in the field of agricultural water;
- Lack of infrastructure efficiency of used irrigation systems and networks;
- Traditional agricultural practices; and
- Small agricultural land-holding size.

II. Economic constraints
- Low farm-income level;
- Price variations in the markets of agricultural products and manufactured materials; and
- Limited energy sources.

III. Institutional and human constraints
- Weakness and dispersion of institutional bodies concerned with water resources;
- Governmental interference in the orientation of agricultural production process at the local level;
- Prevalent values and beliefs; and
- Lack of extension staff working in the field of agricultural irrigation.

IV. Legal and legislative constraints
- Agricultural land-holding regulations;
- Nature and bases of the setting-up of agricultural production and water utilization plans; and
- Legislation and laws governing the agricultural production.

THE PILOT PROJECTS OF THE JOINT UTILISATION OF WATER RESOURCES

A number of projects for farmer associations were implemented based on technical and economic studies in Rural Damascus. They include:
- Al-Makser water use cooperative association (cooperative) for agricultural purposes in Deir Atyah village on an area of 83.0 ha during the period 1943 – 1947;
- The project of the joint utilization of water for drinking and irrigation purposes (local cooperative) in Deir Atyah village on an area of 45.0 ha in 1985; and
- The project of groundwater use for group irrigation in Nabek region (local and private) on an area of 180.0 ha during the period 1997 – 1998.

Joint utilization of groundwater using advanced techniques in Abo Kalkal region (Aleppo province)

The project was implemented in 1994 and became under actual exploitation and all its intended goals were properly achieved including the following:
1. Reduction of the on-site wells from twenty-one to eight wells that meet water requirements for existing cultivation;
2. Cultivation of the whole project area amounting at 64.0 ha - the irrigated area before the provision of the project with modern techniques was about 24.0 ha irrigated by twenty-one wells;
3. The above led to a remarkable improvement whereas wheat productivity increased from 2535 kg/ha in 1994 to 3206 kg/ha in 1996 – 1997 season for the whole area;
4. Irrigation water saving was estimated to 35% as compared to surface irrigation, while yield increase ranged 21 – 25% positively affecting farmers' financial conditions.

Due to Abo Kalkal project's positive results (Tables 3 and 4) with the emphasizing that productivity improvement is related to the goodness of agricultural services provided by the farmers,

environmental changes and care resulted within the project.

Table 3. Changes of the irrigated hectare productivity of the group irrigation project in Abo Kalkal (Aleppo province)

Period	Season	Productivity kg/ha		Applied water amount m^3/ha	
		Wheat	Grain broad bean	Center pivot	Mobile sprinkler irrigation
Prior to the project	1989 – 1990	3400	2500	Traditional flood irrigation with an annual water ration of 4000 - 5500 m^3/ha	
	1990 – 1991	3500	2700		
	1991 – 1992	3500	2700		
	1992 – 1993	3600	2500		
	1993 - 1994	3600	2510		
During the project	1994 - 1995	2535	-	1166	650
	1995 – 1996	2902	2245	1365	1166
	1996 – 1997	3206	1581	1611	2407
	1997 - 1998	4968	2137	2670	2670

Table 4. Changes of the irrigated hectare productivity of the group irrigation project in Abo Kalkal – Aleppo province

Season	Crop	Center pivot kg/ha			Sprinkler irrigation kg/ha		
		Highest yield	Lowest yield	Average	Highest yield	Lowest yield	Average
1994 - 1995	Wheat	3287	1786	2535	3000	1016	2126
1995 – 1996		4062	2167	2902	3750	1375	2398
1996 – 1997		3405	2216	3206	3542	1875	2459
1997 - 1998		6250	2562	4968	5208	2562	3555
1996 – 1997	Grain broad bean	2141	534	1581	2333	700	1409
1997 - 1998		3587	1225	2137	2940	525	1617

A new joint irrigation pilot project was implemented in Aleppo (Tal Atya – Tal Aisha) on an area of 128.0 ha (center pivot sprinkler irrigation on an area of 64.0 ha, front-move sprinkler irrigation on an area of 64.0 ha). This project started actual exploitation from 1998 – 1999 season. It is noteworthy that Ministry of Agriculture and Farmers' Union are in charge of these projects in spite of their high costs where Abo Kalkal project's cost exceeded US$ 300 thousand excluding land rent, but project persistence and its tangible and environmental reflections can compensate what is paid as cost.

In addition, there are several group irrigation joint water utilization implementation/study or waiting for funding projects carrying out in collaboration between Ministry of Agriculture and Agrarian Reform (MAAR), local associations and Arab or European funding agencies. These projects are:

- Palmyra Save project – first phase on an area of 200 ha by drip irrigation for fruit trees and

vegetables;
- Irneh orchard project (northern of Al-Sheikh mount, 45 km south – west Damascus) on an area of 34 ha in which localized irrigation techniques (drip0 were used for fruit tree irrigation;
- Irneh – Rimah project on an area of 180 ha using localized irrigation and micro-sprinklers.

The above projects are supervised by the government and of local and cooperative nature, and they can be considered the main base for reconstruction and development of WUAs in the agricultural irrigation in Syria.

WUA's role in the rationalization and conservation of Syrian water resources

General conclusions on the role of WUA's in the rationalization and conservation of Syrian water resources may be synthesized as the following:

a. The necessity to create institutional bodies gathering the institutions responsible for water resources, public organization and social categories from different sectors benefited from water, the involvement of water users in the planning and implementation of irrigation projects and in making the decisions related to the optimal utilization and saving of water, and the support of joint planning within different economic sectors (agriculture, industry, housing).
b. The necessity to unify the water sector and to create a central mechanism as a national water-authority that will be able to provide and coordinate the national socio-economic benefits of water resources. This authority should undertake the following duties:
   - To assess the water policy priorities ,approaches and planning objectives;
   - To achieve the effective integration of the policies and programs related to water resource development
   - To improve the technical and scientific staff in the field of water.

RECOMMENDATIONS

A set of general recommendations – priority actions - can be drawn from this analysis, each of them aiming to further improvement of agricultural production in Syria and to better use of water resources. They include:

1. Support to the scientific research centers and institutions for conducting integrated applied water studies and researches since these centers will be an integrated part of the institutional bodies responsible for water resource management, improvement and utilization;
2. Support of the governmental efforts in the field of technical and scientific qualification and to give more importance to the its knowledge development, performance promotion and permanent efficiency improvement;
3. Support of the technology transfer programs especially those related to accurate laser-land leveling by increasing the number of programs and technical experience and encouraging the establishment of relevant national companies working in this field; and, finally,
4. Support of governmental activities (land reclamation, manufacturing of modern irrigation equipment etc.) that may be the main base for the creation and development of specialized water associations.

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