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WATER RESOURCES IN SYRIA AND THEIR DEVELOMENT PROCEDURES

A. Kaisi *, Y. Mohammad ** and Y. Mahrouseh ***
* GCSAR, MAAR, P.O. Box 113 Douma, Damascus
** Ministry of High Education, Damascus University
*** General Union of Peasants, Damascus

SUMMARY- Water resources (WRs) in Syria are the key factor for the growth and development of economic activities (agriculture, industry and tourism) besides their domestic use. They consist of surface and groundwater with total availability of 14218 m. m^3. Since the agricultural sector is the largest consumer of WRs (nearly 90%) with an efficiency that doesn't exceed 50%. The traditional surface irrigation dominates on more than 80% of irrigated area. The government has purposely adopted a range of legal and institutional procedures conducive to WRs sustainable development and management improvement at farm level. These procedures include: (i) Developing a water plan, including present and future uses until the year 2025; (ii) Establishing an overall research plan and adopting their results for developing a set of resolutions; (iii) Modernizing water legislation by developing the regulations necessary for water management improvement such as WUA establishment and promotion of participatory irrigation; (iv) Establishing an independent directorate that assumes the management of movement from traditional irrigation to modern irrigation project, with an independent support; and (iv) Implementing pilot projects for WRs participatory use and applicable modern irrigation techniques in collaboration with a number of international institutions and organizations.

In general, the conducted studies shows the governmental options for improving on-farm WR management and WUE by adopting the research results for developing resolutions, supporting the process of transfer to modern irrigation technology and adopting the process of WRs improvement, development and protection.

Key words: WRs, WUE, sustainable development, water act, governmental procedures.

INTRODUCTION

Over the last 30 years of socio-economic development, the Syrian natural resources particularly water and land resources had an increasing attention since the agricultural sector will remain the mainstay of development process and a source for people food at a time food security is one of the most complicated problems at national, regional and international levels.

Population growth and socio-economic development for all various activities started to create a growing pressure on WRs, leading to qualitative and quantitative changes of these resources. These resources form the most complicated and difficult circle due to their limitedness as compared to the increasing and rapid demand on water by all human activity sectors (agriculture, domestic uses, industry…etc.), considering that the country as other East Mediterranean countries is characterized by low rainfall with annual and seasonal variations together with low use efficiency in agriculture that consumes more than 80% of total water uses.

Hence, it is necessary to take a range of integrated measures for keeping the equilibrium between the available resources and their demand under the framework of resource conservation from pollution and depletion and in the manner that ensures the sustainable development of all economic activities.

Accordingly, several guidelines and decisions related to water conservation and maintenance, and good operation and utilization of water projects and expansion were issued. Emphasis was on vertical and horizontal expansion by constructing dams and drilling wells in renewable-water areas.

Additionally, great emphasis is given to water use rationalization through the use of modern irrigation techniques, expansion of dam construction, use of closed circuit in industrial water and factories, and use of non-conventional water resources like drainage water and wastewater was largely emphasized.

Due to the growing role of water in Syria's socio-economic development, the government paid attention for unifying the water-sector supervision agencies, so the Ministry of Irrigation had been established since 1982 undertaking the following responsibilities: (i) study of WRs development, protection, pollution control and uses; study and design of irrigation and land reclamation projects and those relating to such projects i.e. irrigation and drainage structures and dams, and implementation or supervision over the implementation of these projects; and operation and maintenance of irrigation and wastewater systems and pumping stations.

In 1986 a law was issued, dividing the country into seven water basins and general directorates were established for these basins accordingly.

To maximize WUE, the Water Research Center was established to conduct specialized research on water resource development and improvement, irrigation projects development and establishment of Administration of Natural Resource Research (ANRR) for implementing research aiming to farm water resource management rationalization and improvement.

NATURAL CONDITIONS IN SYRIA

Location and extent

Syria, having an estimated population of 18.392 million with an annual rate of 2.7%, situated on the eastern coast of the Mediterranean Sea with a longitude between 36 – 42 east and latitude between 32 – 37 north.

Syria's total area is 185180 km^2 from which 32.9% (61000 km^2) is a cultivable land. The rangelands and forests cover about 89000 km^2 (i.e. 48%) and the remained is uncultivable land.

Rainfall

In Syria, precipitations start between October and May. Rainfall varies from one region to another; in the coastal western mountains, the rainfall is regular while it is varied and semi-regular in the inland regions (Fig. 1 and *table 1*).

In general, most Syrian lands are dry or semi-dry and more than half Syria's area has rainfall less than 220 mm/year and this rainfall is irregular from one year to another. Syria sometimes faces dry years. Average precipitation is more than 46.0 billion m^3, one third of which falls on an area of 60% and the second third on an area of 15% and the remained third on 25%.

Relative humidity and evaporation

The main source of humidity in Syria is the Mediterranean Sea. In summer relative humidity is clearly decreases from the west to the eastward whenever we go away from the marine influence, and it decreases from the coastal region toward the east in winter. Relative humidity decreases by increasing elevation above sea level due to low temperature.

In Syria, Evaporation rate varies from region to another due to variation in temperature and humidity. Potential evaporation rate increases from the west to northwest down to east and southeast. It is 1200 – 1400 mm/year in coastal and mountainous regions, while it ranges between 2600 – 3000 mm/year in eastern and southeastern regions.

Table 1. Rainfall rate by agro-ecological zone in Syria

Zone	Area /1000 ha/	Percentage of total country area	Annual rainfall rate	Rainfall amount* billion m^3/year
1st	2682.5	14.5	<350 mm (1)	14.752
2nd	20460.5	13.3	350	8.612
3rd	1332	7.2	250	3.330
4th	1905.5	10.3	> 250 mm	4.763
5th	11119.5	54.7	> 200 mm (2)	15.179
Total	18500	100%	-	46.636

*Rainfall amount is calculated in 1st agro-ecological zone at a rate of 550 mm/year.

WATER RESOURCES IN SYRIA

The surface water in Syria consists of several rivers and lakes. There are 16 rivers and tributaries that flow in Syria. Apart from rivers and tributaries, there are five lakes, the largest being Jabboul Lake near Aleppo. The most prominent lake is Al-Assad Lake. Among them 6 are main international rivers, namely:

- The Euphrates, which comes from Turkey and flows to Iraq over 680 km in Syria.
- The Afrin in the northwestern part of Syria, which comes from turkey to Syria and returns to the Alexandretta region that borders Turkey and Syria.
- The Orontes, which originates in Lebanon and flows through Syria into Turkey.
- The Yarmouk in the southwestern part of Syria with sources in Syria and Jordan and forms the border between these countries before flowing into the Jordan River.
- The Khabour, which originates from Turkey and merges with main Euphrates.
- The Tigris, forming the border between Syria and Turkey in far northeastern part.

The smaller rivers in Syria receive water from springs and, therefore, have seasonal transient flows. There is a strong interaction between groundwater levels and decreasing flow of springs, resulting in groundwater extraction to supplement the needs for different water-use sectors. Therefore, groundwater is used in combination with surface water and in some locations this is the only water resource.

Although most surface water has been developed in the major basins of Syria, there is some potential for further storage through dams. The storage capacity of the existing more than 150 dams is about 18 billion m^3. Al-Tabka, the largest dam, is in the Euphrates-Aleppo Basin with a storage capacity of 14.16 billion m^3. There are more than 40 dams in the Orontes Basin with a total storage capacity of one billion m^3. Dams in other basins provide the remaining storage. Some dams in the Steppe Basin have been built to supply water for livestock. The major share of the stored water is drawn by agriculture.

Studies have revealed that the average total inland water is 10635 $m.m^3$/yr and average groundwater including springs is 5256 $m.m^3$/yr, considering that the total regulated water is 14218 $m.m^3$/yr (*Table 2*).

Table 2. Water resources (surface and groundwater) in Syria

Water source	Hydrological basin							Total ($m.m^3$)
	Barada & Awaj	Yarmouk	Badia	Orontes	Coastal	Tigris-Khabour	Euphrates -Aleppo	
Surface (m. m^3)	19	168	152	1036	1453	735	7073	10635
Groundwater (m. m^3)	774	249	168	1499	726	1493	346	5256
Total (m. m^3)	793	417	320	2535	2179	2228	7419	15891
Regulation degree (%)	90	85	60	85	65	95	98	
Available regulated WR (m. m^3)	714	354	192	2155	1416	2117	7271	14218

Water use and application efficiency in Syria

The volume of total water use in Syria is about 17.6 billion m^3/yr. The datasets on water availability and use have revealed that there is a negative annual balance exceeding three billion m^3 provided by groundwater over-pumping. In most basins, except for Coastal and Steppe Basins, there is a negative balance, which is evident from the enormous decrease in water table depth. For example, water table in Orontes Basin has decreased to 57 m during 1990s (Varela-Ortega and Sagardoy, 2003). In Barada-Awaj Basin, groundwater levels are declining at the rate of 1.1 m^3/yr. Recharge and surface flows in the basin are estimated to 714 million m^3/yr while withdrawal for irrigation from groundwater and surface water resources amounts are of 786 million m^3/yr plus withdrawals of 269 million m^3/yr for domestic and 76 million m^3/yr for industrial purposes. These estimates reveal total withdrawal of 1137 million m^3/yr (i.e. an overdraft of 417 m. m^3/yr).

Nearly 90% of the total water volume is used as an irrigation source for agricultural production, followed by the shares from domestic (9%) and industrial (4%) sectors.

The Euphrates-Aleppo basin accounts for little under half of the total water used in Syria. Other basins provide a range of water supplies, with minor contribution comes from the Steppe Basin, which provides less than 2% of total water use. The government's policy objective of achieving food self-sufficiency, particularly in wheat, has resulted in rapid expansion of irrigated agriculture in the 1990s. Total irrigated area estimated to 652 thousand ha in 1985 has been doubled (*table 3*) during the last 20 years.

Table 3. Development of irrigated agriculture by water source

Year	Surface water-irrigated area	Groundwater-irrigated area	Total irrigated area
	(x 10^3) ha	(x 10^3) ha	(x 10^3) ha
1985	334	318	652
1990	351	342	693
1995	388	694	1082
2000	512	698	1210
2002	583	764	1347
2004	624	815	1439
2005	697	795	1492

The demand for agricultural production is the principal factor underlying groundwater overdraft, which is vital challenge for WR management in Syria. Groundwater extraction provides a reliable supply of water to the farmer compared to government surface irrigation schemes. On-farm application efficiency is in the range of 40 – 60%, which is considered low due to: (i) Over irrigation, (ii) Use of traditional irrigation techniques such as surface irrigation, and (iii) inadequate land leveling.

Table 4. Available WR development and usage for different sectors

Water use		Barada & Awaj	Yarmouk	Badia	Orontes	Coastal	Tigris - Khabour	Euphrates - Aleppo	Total ($m.m^3$)
Agric. irrigation	Ground	785.8	211.8	68	1137.2	99.5	4305	1440.7	8048
	Surface	-	188.6	-	954.9	466.8	-	4314	5925.1
Domestic-drinking		269	76	44	240	81	38	322	1070
Industrial		76	38	2	229	85	45	86	561
Losses		6	31	15	148	16	132	1614	1962
Total use		1136.8	545.4	129	2709.1	748.3	5420	7777.5	17566.1

Off-farm water conveyance efficiency of most canals is around 50%, except for Euphrates-Aleppo Basin where conveyance efficiency is in the range of 60 – 70% as a result of concrete lined canals. These factors suggest that there is a great potential for improving on- and off-farm WUE through the application of appropriate irrigation cost system, use of modern irrigation technologies such as drip and sprinkler irrigation, land leveling, and construction of lined canals or conveyance through pipeline connections from dams to farm gates. These improvements are made to meet water resource deficiency estimated at 3348 $m.m^3$ (*Tables 2 and 4*).

IRRIGATION SYSTEMS AND PRACTICES APPLIED IN SYRIA

Traditional irrigation system

Traditional surface irrigation (flooding irrigation) prevails in irrigated agriculture because it is very early used since it is low-cost, easily implemented and doesn't need skilled labor or advanced techniques. Traditionally irrigated lands are estimated to 82% of total irrigated area, considering that the total engineering efficiency of water uses, expressing the relation between plant consumption from water for physiological processes and water abstraction from the source, is not more than 50% at best as the water is taken from irrigation systems (government & private) by gravity or pumping from wells or rivers via earth canals unsuitable for water conveyance. Gravity irrigated area constitutes 20% of total irrigated area.

Average water application per hectare is estimated at 14 thousand m^3, and this average considerably varies from one region to another or from one basin to another depending on application efficiency, which is identified by conveyance and distribution efficiency and on-farm irrigation techniques.

Project irrigation efficiency is related to its components. If it is possible to achieve canal conveyance and distribution efficiency between 80 and 95%, this figure will decline to 40 – 50% by surface irrigation which is characterized by several negative features: (i) Losing a large portion of irrigation water in conveyance and distribution canals; (ii) Wasting irrigation water at farm level due to low field irrigation application efficiency; and (iii) high water table level and soil salinity as in Down Euphrates basin.

Modern irrigation system

It comprises modern irrigation techniques (sprinkler – localized) in addition to improved surface irrigation (*Table 5*). Using modern irrigation methods started as individual initiatives, then the government paid attention to the introduction of these techniques and encouragement of farmers to possess and use them through the national programme to transfer to modern irrigation which was started late 2000 (depending on the technical findings of irrigation methods and techniques). This program aims to transfer the whole irrigated area from traditional methods to modern ones during a specific time period. The government developed several decisions for facilitating transfer process and ironing out the financial and administrative constraints facing the implementation of this program.

Accordingly, total area irrigated by modern methods (drip – sprinkler – improved surface) reached 261 thousand ha by the end of 2005 (i.e. 17.5% of total irrigated and actually cultivated area) and 28.2% of the total area is irrigated by groundwater by pumping.

Table 5. Irrigated area by modern irrigation method

Province/Methods	Drip	Sprinkler	Improved surface	Total
Rural Damascus	14460	22681	7	37148
Suweida	1172	-	-	1172
Quneitra	2838	87	-	2925
Deraa	12439	4093	-	16532
Homs	10769	7267	164	18036
Hama	3173	35476	200	38849
Ghab	933	14893	552	16378
Idleb	4636	32289	85	37010
Aleppo	4908	22440	1200	28548
Tartous	6135	467	-	6602
Lattakia	4506	334	-	4840
Raqqa	722	5059	1120	6901
Hassakeh	2607	40724	625	43956
Deir Ezzor	400	400	950	1750
Total	69698	186210	4903	260811

INSTITUTIONS IN CHARGE OF WATER SECTOR IN SYRIA

In Syria, several institutions and ministries manage water sector with slight overlapping in responsibilities.

Ministry of Irrigation (MoI)

MoI and its directorates in the provinces are responsible for water management and development together with routine monitoring of surface and groundwater quality and water provision for irrigation purposes.

(MAAR)

It is in charge of the economic use for irrigation purposes in the agricultural areas, including the search for modern techniques that reduce water losses and growing low-water consumption and salinity-tolerant crops.

Ministry of Housing and Construction

In charge of supplying the rural and urban areas with drinking water as well as wastewater treatment.

Ministry of Environment and Local Administration

In charge of monitoring water quality and developing the criteria necessary for water resource protection.

Each of the above ministries has a number of representative directorates at province or basin level. For example, MoI has General Directorate of the Basin & Directorate of Wastewater Pollution Control in each province. Ministry of Environment has specialized directorates for water protection and waste management. Ministry of housing, in all Syrian provinces, has General Companies for Drinking Water and Sanitation. The same is for the General Company for Sewage Water.

POLICIES AND PROCEDURES FOR WRs SUSTAINABLE DEVELOPMENT

Due to importance of WRs and for their conservation from deterioration and depletion, the government, along with the construction of dams and establishment of irrigation projects, has taken a range of measures to attain the sustainable development of WRs, including:

- Assessment of water sources: This is done to prepare new water budgets showing water movement direction and hydro-chemistry; explore deep aquifers and explain groundwater recharge and discharge.

- Development of an overall water plan aiming at:

  - Identifying current and future uses until the year 2025.
  - Collecting, treating and reusing non-conventional water (wastewater – drainage water, and others).
  - Monitoring water quality and quantity.
  - Developing programs for training and qualification.

- Development of an overall research plan: To improve WR management and on-farm use rationalization, an overall research plan has been worked out and implemented in late 1980s. This plan has been also developed to include five research programs dealing with modern irrigation methods and techniques research as compared technically and economically with traditional irrigation on all irrigated crops. It was possible to get results that formed the scientific basis of government's resolutions in the implementation of the national program on transfer to modern irrigation in most irrigated areas (Fig 1).

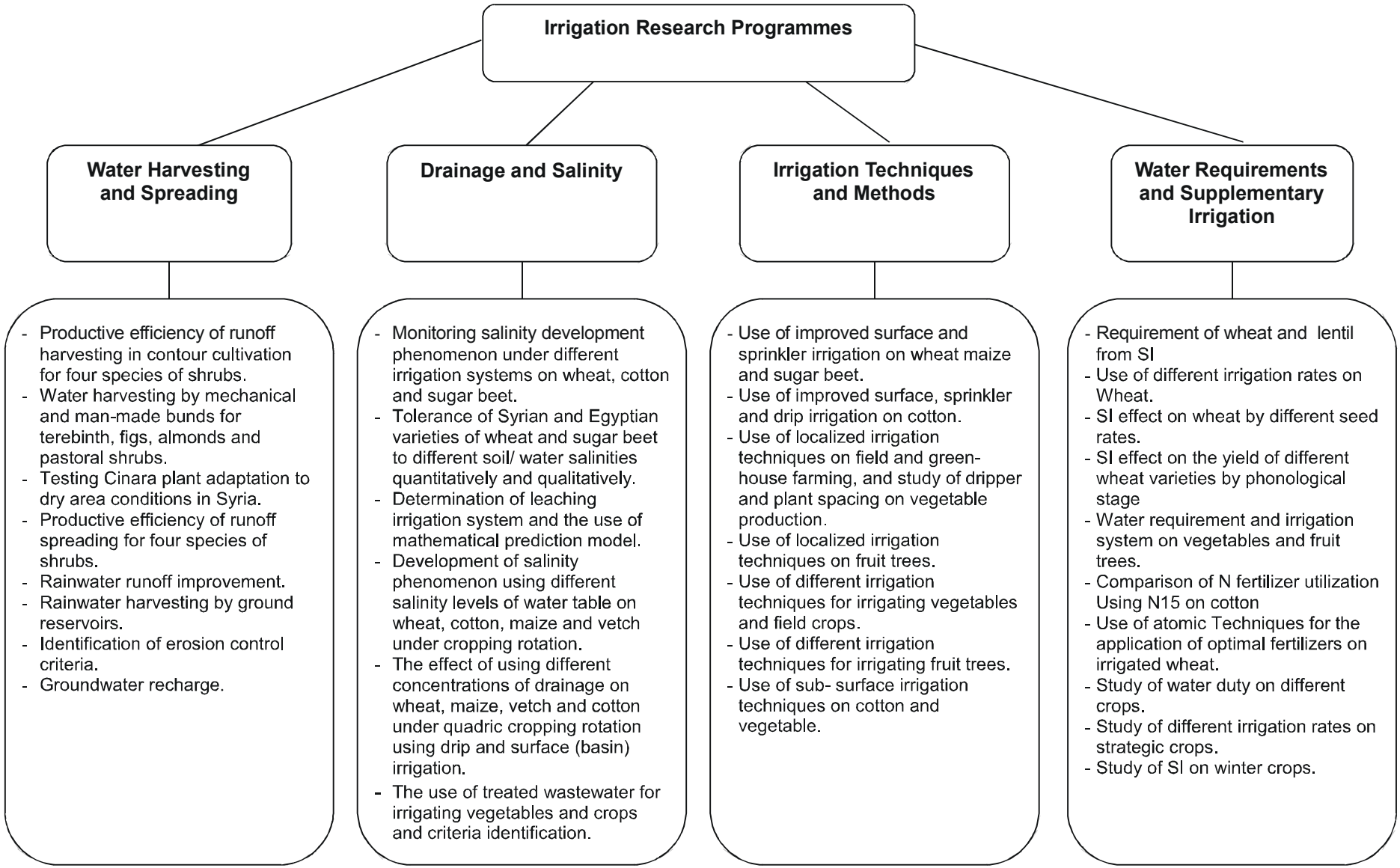

Fig. 1. Irrigation research programmes

Technical results of the research plan

Results of research centers

It was possible to get favorable results by comparing modern irrigation techniques to traditional ones on all following crops:

- Sprinkler irrigation on strategic field crops (cotton, wheat, sugar beet and maize) has led to:
- Irrigation water saving averaged 40%.
- Yield increase averaged 37%.
- WUE increase from 0.38 to 2.42 kg/m^3.
- Localized irrigation on different cultivations including fruit trees and excluding wheat:
- Irrigation water saving averaged 48.5%.
- Yield increase averaged 35.7%.
- WUE increase from 0.86 to 3.5 kg/m^3.
- Improved surface irrigation on strategic field crops has led to:
- Irrigation water saving averaged 29%.
- Yield increase averaged 26%.
- WUE increase from 0.38 to 1.89 kg/m^3 (*Tables 6 and 7*).

Table 6. Technical comparison among irrigation methods applied for fruit tree irrigation at country level

Statement	Tree		Irrigation method	
			Localized	Surface
Total water requirement m^3/ha	Almonds		7194	11678
	Grapes		5318	8646
	Olives		2697	5669
Water saving as compared to surface irrigation - %	Almonds		38	-
	Grapes		28	-
	Olives		52	-
Yield kg/ha	Almonds		10590	8690
	Grapes		35753	25320
	Olives	Fruit	5120	3974
		oil	958	678
Yield increase %	Almonds		22	-
	Grapes		41	-
	Olives	Fruit	29	-
		oil	41	-
WUE kg/m^3	Almonds		1.470	0.74
	Grapes		607	209
	Olives	Fruit	1.9	0.7
		oil	0.36	0.12
Application efficiency %	Almonds		95	57
	Grapes		92	60
	Olives		94	50

Table 7. Technical comparison among irrigation methods applied for crop irrigation at country level

Statement	Crop		Irrigation method			
			Drip	Sprinkler	Improved surface	Traditional surface
Total water requirement m^3/ha	Cotton		6113	8920	10612	14446
	Wheat		-	5807	7527	9092
	Sugar beet		7500	9581	10488	13995
	Maize		3572	4491	5065	8844
Water saving as compared to surface irrigation - %	Cotton		58	38	24	-
	Wheat		-	36	17	-
	Sugar beet		50	37	31	-
	Maize		59	49	43	-
Yield kg/ha	Cotton		4516	4376	3952	3337
	Wheat		-	6329	6699	5141
	Sugar beet	Roots	60830	63830	56170	44170
		Sugar	7430	7800	6230	5040
	Maize		7090	6640	4578	3290
Yield increase %	Cotton		35	31	19	-
	Wheat		-	23	30	-
	Sugar beet	Sugar	38	44	27	-
		Roots	47	54	24	-
	Maize		53	50	28	-
WUE kg/m^3	Cotton		0.74	0.49	0.40	0.23
	Wheat		-	1.09	0.89	0.56
	Sugar beet	Sugar	8.1	6063	5.4	3.2
		Roots	0.99	0.81	0.59	0.36
	Maize		1.98	1.48	0.90	0.37
Application efficiency %	Cotton		88.5	78	62	51.5
	Wheat		-	79	64	49
	Sugar beet		93	73	63	49
	Maize		92	79	67	42

Results of demonstration plots and farmers 'fields

A number of farmer fields using modern irrigation techniques were put under extensionists and irrigation specialists' supervision, control and following-up. In doing so, good results on the use of advanced techniques for irrigating different crops as compared to traditional irrigation have been obtained.

* Sprinkler irrigation has led to:
  - Irrigation water saving by 31%.
  - Yield increase by 27.7%.
  - WUE increase from 0.31 – 1.1 kg/m^3.

* Localized irrigation has led to:
  - Irrigation water saving by 45%.
  - Yield increase by 32%.
  - WUE increase from 0.31 – 1.24 kg/m^3.

* Improved surface irrigation has led to:
  - Irrigation water saving by 22%.
  - Yield increase by 25%.
  - WUE increase from 0.31 – 0.58 kg/m^3.

Utilization and maintenance of irrigation projects

- Giving attention to exploitation and maintenance in terms of provision of necessary equipment and staff.
- Developing and rehabilitating old irrigation projects

Water use rationalization

This is attained by:

- Applying scientific research results to reduce losses in on-farm water distribution systems using advanced irrigation techniques.
- Selecting good lands and applying appropriate irrigation techniques and crop rotation by soil quality and properties.
- Stopping violations and encroachment on water structures.

Modernization of water legislation and institutional system

With the aim of:

- Optimal management of WRs for several activities.
- Discussions of water use rights and water protection from pollution.
- Keeping pace with technological advance and its reflections on WRs.

New water act

Presidential Resolution N˚ 31 dated 06/11/2005 was developed and adopted by the Peoples Assembly after it had been studied for a long period by relevant technical, legal, legislative and scientific committees, in order to avoid gaps made in last legislation and setting controls for water usage and water structure protection.

This resolution included 58 articles, distributed to 12 chapters:

- First chapter: includes definitions, terms and names, water structures, and water committees and their mandate.
- Second chapter: deals with public water.
- Third chapter: deals with the fixation of property rights of public water.
- Fourth chapter: deals with liquidation of public rights by forming specialized committees.
- Fifth chapter: deals with state irrigation systems /components – utilization – maintenance.
- Sixth chapter: deals with well-drilling licenses, pumping units and creation of a specific mechanism for logic utilization of groundwater.
- Seventh chapter: deals with water protection from contamination and creation of work mechanism for the Directorates of Public-water Pollution Control in the governorates and monitoring of water sources.
- Eighth chapter: deals with penalties on violators and enforcement mechanism.
- Ninth chapter: deals with water police, mechanism of police assignment and responsibilities for controlling water source encroachments.
- Tenth chapter: deals with groundwater drilling from legal and institutional point of view.
- Eleventh chapter: deals with WUAs (definition – responsibilities – formation mechanism).

This will be discussed in detail in paragraph 4.

- Twelfth chapter: deals with general provisions and technical & administrative aspects of water resource utilization.

General Commission for Water Resources

This commission was established according to the government orientations toward improvement of water resource management and development in Syria, based on Legislative Decree N° 90 passed by the President on 29/09/2005.

Its responsibilities are:

- Management, development and protection of WRs in the seven hydrological basins in Syria.
- Supervision on utilization and monitoring of WRs and water structures in hydrological basins all over the governorates.
- Coordination between Ministries of Irrigation and Housing for assessing drinking water sources and utilization of treated wastewater.

** The Commission will take the place of General Directorates of Hydrological Basins established by Resolution N° 17 on 07/07/1986 and MoI's Technical Directorates and Irrigation Departments at General Establishment of the Euphrates Dam.

** This Commission will have a separate budget with an independent branch annexed to MoI's budget and included in the State's balance sheet with all costs and revenues.

** The Commission's council consists of specialists representing concerned ministries (MoI – MAAR – Housing – Municipalities and Environment).

** Commission's directorates were established in the governorates. Centers belonged to the Commission were also established. The responsibilities of the Commission and its Directorates are specified by Resolution N° 1916 on 27/11/2005 including the executive instructions of the Decree N° 90.

GOVERNMENT PROCEDURES FOR ON-FARM WATER MANAGEMENT IMPROVEMENT

Due to the prevalence of traditional surface irrigation, characterized by low-cost, easy-implemented and high on-farm water loss as a result of its low efficiency that may not exceed 50% at best, in the Syrian agriculture and the importance of limited and exhaustive water resources that experience an increasing pressure for economic sector (agriculture – industry – tourism), the government has adopted several measures during 2000 – 2005 including:

Converting to modern irrigation

Since 2000, the government started to implement an ambitious plan to convert most irrigated lands to modern irrigation, depending on the technical results of irrigation method and technique research that proved to be economically and technically feasible under different ecological conditions, as compared with traditional irrigation prevailing in Syria.

The Higher Agricultural Council (HAC) developed a considerable number of important resolutions during 2000 – 2001 to facilitate transfer process and plan implementation. Concerned ministries (MAAR – MoI – Industry – Economics…) were commissioned to undertake the following measures:

- Planning of irrigation areas according to the renewable water.
- Preparation of studies for the rehabilitation of old state irrigation projects, in line with the use of modern irrigation techniques.
- Determination of transfer requirements and provision of loans for funding all requirements.
- Preparation of studies necessary for establishing communal irrigation projects on wells.
- Free preparation of studies and designs of modern irrigation networks for farmers.

In spite of governmental resolutions and facilities, the area transferred to modern irrigation (drip – sprinkler) doesn't exceed 18% of irrigated area and this is attributed to several constraints including:

- Slow rehabilitation of state irrigation projects and inability to apply modern irrigation methods and practices under the conditions of unfeasible state irrigation projects.
- Non-enforcement of some HAC's resolutions related to transfer process as they are contradicted with effective laws, for example inability to finance previously indebted farmers and those who have unlicensed wells.

Total amount of loans is estimated to be SP 920.1 million equal to US$ 17.69 million, covering 27% of transferred area. Under this situation and due to the slow transfer to modern irrigation, several technical committees, depending on governmental orientations, were set up to: (i) evaluate state irrigation projects; and (ii) address the issues relating to the national programme implementation.

The above committees comprised representatives of concerned ministries and State Planning Commission (SPC). The following are the most important resolutions passed by these committees:

- Resolution N° 28 on 28/05/2003 to accelerate the rehabilitation of state irrigation projects.
- Resolution N° 71 on 08/10/2001 to provide funds necessary for covering the interests of loans that will be provided by the agricultural bank.
- Resolution N°13 on 10/02/2003 to provide farmers with grants at different percentages of field irrigation equipment costs (according to irrigation system).
- Resolution N˚ 1785 on 18/08/2004 to set up a central committee to follow-up on the measures necessary for transfer process to modern irrigation.
- In addition to the formation of several central and secondary committees to study the transfer process from financial, economic, legislative and institutional aspects, several studies and solutions were submitted to the government to promote transfer process. In turn, these committees developed a number of resolutions.

Directorate of the National Project of Movement to Modern Irrigation

Based on Ministry of Agriculture's resolution N° 26 on 19/05/2005, the following had been done:

a. Establishing a directorate at MAAR, named "Directorate of the National Project for Transfer to Modern Irrigation, with branches in the governorates.
b. Commissioning this directorate with the supervision on shifting planned irrigated lands from traditional irrigation methods to modern ones according to the adopted technical and scientific bases, taking several measures:
   - Prepare and supervise studies, designs and technical books of conditions necessary for the project beneficiaries' field irrigation networks;
   - Supervise the provision of loans from the special fund of beneficiaries financing;
   - Coordinate with relevant institutions (MoI – Industry – GCSAR) to formulate plans necessary for project implementation; and
   - Deepen the concept of water extension and participatory irrigation by adopting different training levels and conducting training course on modern irrigation for technicians, extensionists or farmers.

A fund for financing the national project of transfer to modern irrigation

Depending on the legislative decree N˚ 91 approved by the President on 29/09/2005, a fund was established at MAAR to finance transfer project at a capital SP 53 billion to be recovered during five years with the aim of ironing the financial difficulties and constraints encountered transfer process in the first phase.

Those who invest in agriculture whether they are owners, leaseholders, beneficiaries or farmers can benefit from this fund through free-interest ten-year loans to be recovered by equal annual payments.

The activities of the above directorate and fund have started since early 2006 after releasing the executive regulations of decree N° 91 and resolution N° 26.

Higher Committee of Transfer to Modern Irrigation

With the purpose of scientific and smooth implementation of the national program and to iron out the difficulties encountered, the government issued the resolution N° 2827 on 25/05/2005 to form Higher Committee of Transfer to Modern Irrigation comprising ministries of (agriculture – industry –

irrigation), SPC's Head, Chairman of General Union of Peasants (GUP), and Project National Director.

Its Responsibilities are:
- Approve the annual plan and follow-up on implementation of the national program; and
- Approve the annual plan of the special fund of project financing.

In addition to:
- Set up a central technical committee for following-up on the implementation; and
- Set up secondary committees in each governorate, headed by the governor and membership of all technicians and stakeholders in the governorates.

Water Users Associations (WUAs)

Historic overview

- The first water users' society in the modern age in Syria is dated back to the year 1928 when Al-Breika farm in Rural Damascus was established as a cooperative project for groundwater drilling.
- Communal use of unusable agricultural lands as a result of surface water exhaustion
- Rehabilitation of irrigation canals and developing program for utilization and routine maintenance.

The establishment of Al-Breika association encouraged other village farmers to establish cooperative community association for the utilization of water resources in agriculture and irrigation, and it also encouraged farmers in other governorates to gear to WUA establishment within the domain of water source.

The first cooperative legislation was released in 1950, in which Ministry of Agriculture was entrusted to supervise specialized agricultural cooperatives, and Ministry of Economy to supervise the associations working in the other fields.

The release of such set of laws, legislation and regulations provided the necessary legal protection for different association, but these associations were far from their mandate as WUAs to become farm cooperatives (service and retail) with cooperatively active movement. In 1964, the number of associations was estimated to be 475 for Ministry of Agriculture and 361 for Ministry of Agrarian Reform. On 14/12/1964 GUP was established as per the legislative decree N°127 of the year 1964.

Present situation

The government geared to the promotion of WUAs by releasing appropriate laws and resolutions with a view to: (i) identify water beneficiary structure; identify WUAs role in water distribution and identify WUAs role in project maintenance.

A full chapter in the new water legislation was assigned to WUAs including several items addressing WUAs establishment, structure, mandate, management and their role in water and irrigation system management and participation in decision-making and implementation. In addition, this chapter addresses the administrative distribution and specialization of WUA field of work and the steps of WUA formation and development.

It was possible to benefit from the Tunisian and Moroccan experiences in WUA establishment by dispatching technical teams from the concerned ministries in Syria during 2002 – 2004 to advise on the experience, legislation, measures and policies of both countries in implementation the national program of water saving and grants provided to farmers to accelerate the implementation of such program. In addition, there was an opportunity to advise on the Turkish experience in the field of WUAs formation and GAP project and to get benefit from WASAMED project's activities.

Awareness and technology transfer programs

Ministry of Information gives great attention to development media, so that a special directorate of development media was established to follow-up on the development information plans on population and environment in coordination and collaboration with government, popular and international bodies and organizations.

The General Organization typifies consideration of developmental information at Ministry of Information level for Radio and Television in which Directorate of Developmental Programs was established. This directorate, in coordination and collaboration with the ministries of: Municipalities and Environment, MAAR, MOI, follows up on the production and broadcasting of environmental materials and programs, workshops, and radio and TV meetings.

General Organization also represents interest in developmental information at the Ministry of Information for TV and Radio Broadcasting (GOTRB) where Developmental Program Directorate was established. This directorate, in coordination and collaboration with environment-concerned ministries viz., Local Administration and Environment, MAAR, MoI, follows up the production and broadcasting of environmental materials and programs and holds TV & radio seminars and workshops, aiming to a national behavior development at three levels: cognitive, conscientious and know-how. Syrian TV broadcasts several weekly programs on agriculture and natural resource use rationalization (particularly water). These programs are (Our Green Land – Agriculture World – Agricultural Extension). Material is prepared at MAAR's Directorate of Extension in collaboration with Syrian TV. These programs deal with different environment/extension issues and topics including field visits and interviews with farmers as well as educational and extension workshops.

Informational material is often simplified and placed in informational form, so that the goal of informational mission is largely realized. Through these programs especially TV ones, General Union of Peasant, which is a popular organization concerned with affairs of Syrian farmers and coordinates via relevant cooperatives to realize the agricultural plans at national level, is involved. Dissemination of environmental awareness among farmers is made through direct meetings and coordination and cooperation with MAAR's Directorate of Extension that spreads some extension posters and fliers via routine meetings held at these associations or at research and extension centers.

Articles published in the Syrian press play a key role affecting decision-making related to the promotion of the role of research institutions and dissemination of methods and techniques of high-saving natural resources (water and energy) at higher government levels.

It is essential to mention that Ministry of Municipalities and Environment via both Directorates of Education and Environmental Information & Water Safety participates in radio and TV programs and educational field activities conducted by different agencies whether they are at media level or at ministries, popular organizations and NGOs.

CONCLUSIONS

- Limited Syrian water resources as compared to the increasing demand size by different economic sectors.
- Agricultural sector is the largest consumer of water resources.
- Syrian government’s attention to water resources and considering it a natural resource that should be saved to meet the necessary needs by constructing dams and governmental irrigation projects.
- Increase of water loss percent due to:
  - Evaporation
  - The dominance of low-efficient traditional irrigation on 80% of irrigated areas.
  - The use of earth canals in on-farm water distribution (quadric canals).
- The necessity to rehabilitate old irrigation projects and development of modern ones by transferring them to piped canals in conveyance and distribution, conducive to the use of modern techniques in on-farm irrigation.

- Adoption of a range of measures and polices by the government, aiming at the sustainable development of water resources and the orientation toward WUAs establishment and the activation of existing ones.
- Establishing and supporting the scientific research centers working in the field of water management improvement.
- Taking a range of legislative and institutional measures conducive to water saving and rational management, including the development of water legislation that fully support WUAs establishment.
- Establishing The General Commission of Water Resources and the Directorate of National program for Movement to Modern irrigation.
- Cooperating with international institutions and organizations to implement pilot demonstration research projects with the aim of disseminating modern irrigation techniques via water education and technology transfer programs.

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