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Water Use Efficiency in Syrian Agriculture

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Introduction:

The limited natural resource of water in Syria is one of the major problems in Agricultural sector. Rainfall, as a source of fresh water, is limited and highly variable where there are frequent droughts. This situation negatively affects both vegetation and land resources. Exploiting ground water by over pumping, using the traditional way of irrigation, in addition to the existing systems of water use rights can be considered the main reasons for non-efficient use of water in Syria, deteriorating this precious source and thus income from agricultural activities which ultimately threaten the livelihoods of Syrian farmers especially in dry areas.

Efficiency of water resource management in the Syrian agriculture:

Many factors contribute to the huge misuse or to the inefficient use of water resources. Despite the government efforts towards increasing available water for irrigation and agricultural use by establishing dams, digging wells, setting up irrigation schemes and other development projects, water shortages have reached the levels that we should get attention to due to inefficient management of water resources, especially at the farm level. Farmers need to develop skills using scientific modern technologies in irrigation methods that lead to raise productivity of irrigation unit.

Irrational use of water resources in Syrian agriculture has negative impacts on the agricultural sector. The annual increase of the total irrigated area in Syria without taking into account the actual available water resource for agricultural purposes has led to water shortages in most of the water basins. Moreover, pumping wells to face such shortages has mainly caused the following:

- Decrease of underground water level in wells and discharges
- Change in water quality.
- Dryings of some springs that feed governmental irrigation projects and drinking systems in upper and lower Orontes, Khabor, Barada & Awaj and Yarmouk basins.
- Unbalance between water supply and demand.
- Deficit in water supply for drinking water.

As the Syrian agricultural sector plays an important role in the GDP as well as it forms a sustainable source of food security, the Syrian strategy has recently gone for insuring sustainability and protection of water resources. The government has followed sustainable management policies to protect these resources by setting rules and criteria for applying modern irrigation technologies (e.g. drip, sprinkle methods, under surface or improved watering). These modern irrigation technologies can fit the climatic conditions, water scarcity situation, size of agricultural land acquisition, and the skill levels of Syrian farmers. Furthermore, the government of Syria has put the mechanisms and procedures that follow up the plan's achievement in terms of time and money.

1. Agricultural water use in Syria (1990-2004):

Irrigated area which is nearly 26.8% of the total invested area contributes largely to the total agriculture production. It produces 100% of summer crops such as cotton and other industrial crops and between 60 and 70% of winter crops like wheat in dry seasons and 45-50% during rainy seasons. Nevertheless, it consumes around 88% of available water resources.

1.1. Increasing demand on water resource for agriculture:

Population growth and improving living standards of people have created a critical issue of water resource scarcity. Although the current supply of water can meet most of the demand, this supply definitely would not meet the accelerating water demand on the long run enlarging the problem in the foreseen future.

At this regard, expanding the irrigated area has been the major factor behind the pressure on water different resources. The real water requirements in the agriculture plan increased from 8.29 billion m^3 in 1990 to 14.22 billion m3. Later on, it went down relatively, but it went up again to 14.6 billion m^3 in 2004 (annex 4). Demand on surface and ground water for agricultural use has increased by 6.31 billion m^3 during the period 1992-2000. Moreover, the intensive depletion of ground water due to over-pumping has also led to water deficit ranging between 2.85-4.70 billion m^3/year.

1.2. Development of irrigated area:

The irrigated area has expanded basically due to the increased number of wells drilled during the period 1990-2004 with the aim at investing ground water (annex 2), attributing to the governmental economic policies that subsidize the agricultural production seeking the achievement of food security and self-sufficiency in strategic crop production. Thus, it has always been against the rational use of the base of the ground water. The irrigated area increased yearly by 47 thousand ha on an average or by an increase of 746 thousand ha where 524 thousand ha are irrigated from ground water (70% of the total increased area) and 223 thousand ha are irrigated from the surface water (30% of the increased area) that have mainly depended on new irrigation projects and land reclamation.

2. Research on irrigation methods and their impacts on water use efficiency:

The Syrian government has given priority and special attention to the irrigation research, aiming at setting proper scientific standards and criteria of water use in agriculture through the introduction of modern irrigation technologies including drip, sprinkle and the improved surface watering. General results of the specialized agricultural research stations in Syria for the years from 1993 to 2000 on water use efficiency development and their influences on irrigation efficiency that show water saving as well as crop yields increasing are shown in Annex 3. Figures illustrate water saving on some crops under the study (wheat, maize, sugar cane, cotton, olives, eggplant and grapes), where they proved a total of water savings, at the national level, of 2.878-4.053 billion m^3/year.

2.1 Economic impacts of irrigation research on rational water use

Technical and economic indicators where used in different specialized stations and extension fields in various areas of the country to get the most of the technical empirical studies comparing the modern to the traditional methods of irrigation. There, the cost of water unit (SL/m^3) was estimated in addition to calculating the capacity of the pumping groups for each water source and method.

2.1.1. Technical performance indicators:

- Total amounts of water provided to the unit of area in each technology and crop (m^3/ha).
- Total water consumption by area unit in each technology and crop (m^3/ha).
- Yield in each irrigation technology (kg/ha or ton/ha).
- Efficiency of water use in each technology and crop (kg/m^3 or SL/m^3).

- Yield increase in each technology and crop (kg/ha or %).
- Water savings in each technology and crop (m^3/ha or %).

2.1.2. Economic performance indicators:

Cost/benefit analysis is estimated by defining the total returns and costs of area unit, and this will define the economic feasibility for each irrigation technology adopted according to the following criteria:

- The practical state of the production cost, wages, and product value in local prices.
- Irrigation fees and the cost of operation and maintenance (3500 SL/ha/year in the public schemes projects).
- Land rent (15% of the production value).
- Cost of water for irrigation according to the technical characteristics like monometer and discharge of the pumping group work.
- Value of costs: Fixed costs (depreciation, maintenance and repair), ordinary costs (fuel, oil, or wages), and well preparation (drilling, equipment, operation and value of the pumping groups).
- Cost of setting up the modern irrigation scheme (drip, sprinkles, pumps, filters fertilizers, and other accessories).

All the mentioned estimation (cost/benefit analysis) was done at irrigated area level in all areas irrigated from ground and surface water as well as in the public governmental projects. Annex 4 shows the benefit cost ratio of each water source and the impacts of different used technologies on water saving.

3. National plan for Irrigation Modernization:

The Syrian government, presented by the higher agricultural Counsel, declared during the year of 2001 the national plan of water use rationalization in order to eliminate depletion of the available water resources. This plan was based on the technical and economic researches in addition to the current situation of water shortages, aiming to face the problem of water in term of quantity and quality, especially problems related to ground water depletion. This plan included the following points:

- Give first priority to provide safe drinking water and good quality of water for household use in addition to increase the efficiency of water provision by 80% till the year of 2015.
- Increase water use efficiency, at the national level, for agricultural purposes to 75% till the year of 2015.
- Set the plan for irrigated areas with a possibility of 75% of rain fall.
- Set the national plan for irrigation modernization for the next four years. Group of decisions were taken during (2000-2001), aiming to facilitate the switch process and to eliminate obstacles of irrigation modernization. Group of ministries (agriculture, irrigation, industry, and economic) were specialized in the following procedures:
    - Set a plan for the irrigated areas in accordance to the renewable water resources and take the appropriate actions needed for switching to irrigation modernization;

- Prepare studies that aim to rehabilitate old irrigation projects in order to be ready for applying more rational irrigation methods;
- Design and implement all new irrigation projects by using technologies and infrastructure which are able to achieve the plan of efficient use of water resources;
- Prepare studies needed for establishing irrigation projects associations that based on ground water resources;
- Define the requirements of irrigation modernization in addition to provide loans that fund and support all such requirements;
- Set the needed mechanisms and procedures that monitor the quality and the measurement standards of irrigation equipments.

3.1. Implementation during 2000-2004:

At the end of 2004, the increase of agricultural irrigated area based on irrigation modernization was slow and less than what have been set in the national plan for irrigation modernization where it was only applied on 15.3% of planned irrigated area. Moreover, the percentage of irrigation modernization based on ground water resources did not exceed 27.3% considering that most of irrigated areas are based on ground water resources.

3.2. Modernization Constrains:

Financial, technical and institutional are the group of constraints that have blocked irrigation modernization. These constrains can be summarized as the follows:

- Inability to provide the needed loans due to regulation conflicts.
- High interest rate on loans that create direct financial burdens on farmers.
- Incompatibility of some of the government irrigation projects with modern irrigation techniques and low inability to renew them.
- Producing irrigation equipments which do not meet the standard specification.
- Institutional constrains such as inherit system that contributes to fragmentation of agricultural land.
- Tradition and religious beliefs toward loans from banks.

3.3. Modernization Plan Decrees and laws:

Due to the difficulties in the modernization plan several specialized technical committees were established during the period 2003-2004 to study difficulties and problems facing the plan and provide suitable solutions. A joint memorandum was released by the ministries of irrigation and agriculture including all the recommendations in order to speed up the irrigation modernization process. The economic committee at ministers' cabinet ratified on March 1, 2005 the recommendations. A follow up decisions and decrees were released:

- A decree number./26/ dated on May 2005, was released by the Ministry of Agriculture and Agrarian Reform. This decree includes establishment of the Directorate of National Project for Irrigation Modernization to supervise the modernization of all planned irrigated areas during a ten years period starting from 2006;
- A decree number/2817/ dated on May 2005, was released by the prime minister which includes establishment of higher committee for irrigation modernization

headed by the prime minister to approve the yearly plan and solve the problems have been raised during application;

- A presidential decree number./91/ dated on Sept. 2005 includes establishing a fund for financing the national plan for modern irrigation with a capital of 53 Billion Syrian pound which will be provided to farmers as easy loan with no interest and grants.
- Establishment of central committee headed by the deputy Minster of Agriculture with branched committees in governorates headed by the governors to follow up the national plan, fund, and solve the problems.
- A plan was approved to rehabilitate Irrigating and land Reclamation Projects with an area of 165 thousand hectare with an estimated cost of 21 billions Syrian pounds during a 5 year period starting from2005.
- In accordance with integrated management approach, participatory approach and encouraging water use associations, the water legislation is released.
- Tenth fifth plan included an investment project on irrigation modernization by allocating a budget of 22 billion Syrian pounds during the plan years as, starting execution in 2006.

4. Suggestions:

According to what has been mentioned above and what we think is good for supporting water use rationalization, it would be wise to adopt the methods of irrigation modernization, by getting scientific help from all research centers and drawing funds from different donors and banks in order to achieve the following:

- Increasing farmers' awareness in water resource management and encouraging participatory approach.
- Financing and establishment of pilot project for collective irrigation especially in ground water resources.
- Getting benefits from the investment project that support national project for irrigation modernization.
- Financing the rehabilitation of government irrigation projects with easy and grace period loans.
- Capacity building in the field of designing, operation, and maintenance in addition to preparing trainers to put strategies for modernizing and managements of irrigation projects.
- Developments of Syrian standard specification to include all irrigation equipments and in accordance with government specifications.
- Development of industrial and research lab and contributing to establishments of labs to monitor the quality of irrigation equipments productions in governorates.

5. Conclusion:

Unfortunately, water use efficiency for irrigation in Syrian agriculture is still low. The traditional irrigation methods are practiced in most of the irrigated lands which contribute to 84% of total irrigated lands where the average irrigation efficiency does not reach 40% with a loss that may exceed 60%. Moreover, research has shown that saving of water by using new irrigation methods may get around (30%-40%).Therefore, water use

rationalization and irrigation modernization are very critical to increase water use efficiency in addition to develop irrigated agriculture which in turn would increase the economic profit , pushing forward the wheel of economic growth.

Annex (1)

Water demand changes during (1990-2004)

Year	Water requirement 000cm/hec	Water requirements Billion cubic meter /year		
		Ground water	surface water	Total
1990	11.954	4.09	4.20	8.29
1991	13.452	5.66	4.94	10.60
1992	13.466	7.15	5.05	12.20
1993	12.438	7.59	5.01	12.60
1994	11.996	8.32	4.66	12.98
1995	12.084	8.28	4.88	13.16
1996	11.830	8.09	5.23	13.32
1997	11.781	8.27	5.49	13.76
1998	11.723	8.48	5.74	14.22
1999	11.649	8.21	5.60	13.81
2000	11.602	8.10	5.95	14.05
2001	9.667	7.30	4.96	12.26
2002	9.787	7.99	5.05	13.04
2003	9.972	8.52	5.05	13.57
2004	10.1500	8.77	5.83	14.6

Source: Irrigation Modernization, 2005, MAAR, GCSAR, MAAR, Syria

Annex (2)

Irrigate area changes during (1990-2004)

Year	Total invested area (hec)	Irrigated Area (hec)		
		Ground water	Surface water	Total
1990	5626013	341951	531026	692977
1991	5576180	420802	367529	788331
1992	5554219	530884	375399	906283
1993	5425652	610057	403216	1013273
1994	5486720	693621	388486	1082107
1995	5501777	685497	403394	1088891
1996	5469767	683773	442323	1126096
1997	5521183	701634	465999	1167633
1998	5484030	723696	489412	1213108
1999	5502290	704905	480774	1185679
2000	5352397	698151	512499	1210650
2001	5449980	574282	512607	1266889
2002	5420654	817271	515510	1332781
2003	5478350	854655	506556	1361211
2004	5525574	864743	574391	1439134

Source; Agricultural Statistic 2004

Annex (3)

Economic Impact (Benefit Cost Analysis)

Crop	Information	Irrigation Methods			
		Traditional	Developed	Sprinkler	Localized
Wheat	water use efficiency (kg/m^3)	0.56		1.08	
	Irrigation efficiency (%)	49		79	
	Irrigation saving (%)	-		43	
	Yield increase (%)	-		23	
Maize	water use efficiency (kg/m^3)	0.48		1.10	
	Irrigation efficiency (%)	60		84	
	Irrigation saving (%)	-		30	
	Yield increase (%)	-		59	
Sugar beet	water use efficiency (kg/m^3)	0.73-7.13		1.47-14.26	
	Irrigation efficiency (%)	-		80	
	Irrigation saving (%)	-		29	
	Yield increase (%)			29/24	
Cotton	water use efficiency (kg/m^3)	0.23	0.37	0.49	0.74
	Irrigation efficiency (%)	51	65	78	88
	Irrigation saving (%)	-	27	38	58
	Yield increase (%)	-	19	31	35
Egg plant	water use efficiency (kg/m^3)	4.1	-	-	7.32
	Irrigation efficiency (%)	50			86
	Irrigation saving (%)	-			23
	Yield increase (%)	-	-	-	37
Olive	water use efficiency (kg/m^3)	0.13-0.74			0.36/1.90
	Irrigation efficiency (%)	50			94
	Irrigation saving (%)	-			50
	Yield increase (%)	-			41/29
Grape	water use efficiency (kg/m^3)	2.93			5.77
	Irrigation efficiency (%)	60	-	-	91
	Irrigation saving (%)	-			33
	Yield increase (%)	-			31

Source: MAAR, GCSAR, ANR, Damascus, 2002

Annex (4)

Economic Impact (benefit cost Analysis)

Crop	Irrigation Method	Profit/cost				
		Govt. Irrigation Projects	Pumping from 50m	Pumping from 100m	Pumping from 150m	Pumping from 200m
Wheat	Traditional	161	121	94	73	56
	Sprinkler	**235**	215	188	166	147
Maize	Traditional	37	11	5	Negative	Negative
	Sprinkler	123	103	78	60	44
Sugar beet	Traditional	79	65	53	44	35
	Sprinkler	125	118	108	99	91
Cotton	Traditional	34	16	5	Negative	Negative
	Improved	64	37	28	23	15
	Sprinkler	80	60	50	43	33
	Drip	86	68	60	54	47
Egg plant	Traditional	68	62	56	51	46
	Sprinkler	97	94	89	86	81
[1]Olive	Traditional	4/25	Neg./18	Neg/13	Neg/9	Neg./4
	Localized	43/57	41/54	38/51	35/48	32/44
Grape	Traditional	**68**	60	54	48	42
	Localized	**101**	97	92	88	82

Source; MAAR, GCSAR, ANR, Damascus, 2002

[1] Olive fruit production /Olive oil production

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