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Assistance in Institutional Strengthening and Agricultural Policy

Final Report
on

Agricultural Water Use

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- Opinions and judgments expressed are the authors' only. FAO proposes the text as basis for starting the discussion among scholars and policy makers on the issues related to the subject of the study.

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EXECUTIVE SUMMARY

This study has a dual objective with the purpose of conforming with the general project's goal of 'Assistance in institutional strengthening and agricultural policy in Syria'. On the one side the study consists in the analysis of the irrigation water sector in Syria and its related water policies for which their specific characteristics have been studied and an explicit methodology has been developed as described in section 3. On the other side, the study has a training component. The databases developed at aggregate and farm levels for the analysis of the water sector in Syria are dynamic and permit to further simulate alternative policy scenarios other than the ones used for this study.

1. Present situation of the irrigation water sector in Syria

From the 18,5 million ha of total lands of the Syrian Arab Republic, cultivated land extends over an area of 5484000 ha of which 1213000 is irrigated land (22%), 3655000 ha is rain-fed land (67%) and 616000 ha is fallow land (11%) (1998 data[1]). Irrigated agriculture has increased steadily in Syria over the last decades, almost doubling since 1985. This mounting pace has been meant to comply with the nation's food security policy objectives and thus to satisfy the food production needs of an increasing population that features one of the largest growth rates in the world (3,50% in 1985 and still 2,54% from 1995-2000). Irrigated lands are not distributed evenly across the country and most concentrate in the governorates of Al Hassake (34%), Aleppo (13%), Rakka (12%), Hama (11%) and Deir-Ezzor (10%).

The size of the irrigated holdings is substantially smaller than the size of the rain-fed holdings and varies distinctively across regions. At nations' level, the average farm for all types of holdings is 9,2 ha and the average irrigated farm is 3,6 ha. For irrigated lands, larger farms concentrate in the governorates of Rakka (9 ha) and Al Hassake (10,5 ha), medium size farms are located mainly in Aleppo (5 ha), and Hama (3 ha) and small farms in Latakia (1.2, ha) and Tartous (0,9 ha). Larger holdings grow mostly extensive crops such as wheat and cotton, as more intensive crops such as sugarbeet, potato, tomato and, maize are grown predominantly in medium size farms. Vineyards are largely grown in reclaimed mountains and hill areas whereas intensive corps such as vegetables are grown predominantly in the coastal smaller farms and in the outskirts of the urban districts. Fruit trees are planted largely in rainfed lands in newly reclaimed territories in Damascus, Homs, Hama, Idleb and Aleppo and also in the coastal area..

2. Water resources

The water resources of Syria are very limited compared to the needs of the country and estimations show that available resources amount to 14589 million m3/year as total uses reach 19162 millionm3/year. In consequence, the water balance for Syria is negative with a deficit of 3104 million m3/year varying distinctively across basins. In fact, the balance per basin shows that only three basins, namely Euphrates, Coastal and Al Badia have a positive balance. The remaining have considerable negative balances: Barada and Awag (-311),

[1] Syria databases GCP/SYR/006/ITA

Yarmouk (-206) and very critical Orontes (-856) and Al Khabour (-3151). The magnitude of the deficit of the Al Khabour indicates that it will be difficult to correct it without special and severe measures. In this context, as water development policies will have distinct effects on the different basins, several scenarios have been simulated in this study to assess their effects at country level and at basins' level as described in section 4.

2.2 Groundwater and surface water

Syria has important groundwater resources and presently exploited are 5395 MM3 which represents 37% of the estimated total water resources of the country. The best aquifers concentrate in the western and northern regions but most of the aquifers have been overexploited except for the Coastal and Al Badia basins. For instance the water table in the Orontos basin has decreased by 57 meters during the period 1990-1999 in Al Ashareneh area and 34 meters in Al Salamieh area which has lead to the prohibition for drilling new wells by recently enacted legal decisions. Total irrigated area by wells is 715509 ha of which 314050ha (44%) are in Al Hassakeh (Tigris and Al Khabour basin) and the total number of wells is 135089 out of which 63078 were not licensed in 1999. The primary source of energy used for irrigation from wells is fuel and only one forth use electricity.

Total irrigated area by surface is 560559 ha of which 396518 ha (71%) correspond to public irrigation systems and the remaining 164041 ha are private. Water consumption in surface irrigated areas are reported to be in the order 15000 to 16000 m3/ha in the Euphrates basin. The reported costs of developing new areas are in the range of 200000- 250000 SP/ha and they are recovered over a period of 30 years.

As water resources are very limited in Syria the construction of dams has received considerable priority. In the last decades construction reached a total of 154 dams but only three of them represent the 87% of the total storage capacity.

2.3 Adoption of modern irrigation technologies

Considering the severe water scarcity in Syria, the adoption of modern irrigation techniques is crucial for the country's development of irrigated agriculture. In fact, the related authorities such as the Ministry of Agriculture and the Ministry of Irrigation are actively encouraging irrigation modernization policies. According to the statistics available average water use in irrigation is 12434 m3/ha and the adoption of modern technologies should reduce it to 8000 m3/ha. The area equipped with modern irrigation techniques in year 2000 was 126719 ha, of which 16087 ha are under drip irrigation and 110631 ha under sprinkler irrigation. Most of these techniques (95%) were installed in areas irrigated by wells. The rate of adoption of modern irrigation techniques from 1999 to 2000 was 37686 ha and for the period 1998-1999 was 19641 ha. However, interviews with manufacturers of irrigation equipment indicated that they are operating below installed capacity. Quality control does not take place systematically and prices of irrigation equipment at present are comparable to international prices and their imports are liberalized.

3. Current policies and action plans

With the objective of reducing water use as stated above, the GOS (Government of Syria) has decided that all irrigated areas will be equipped with modern irrigation techniques in 4 years. This means that 1149349 ha will have to adopt them in 4 years which gives a rate of adoption of 287337 ha/year. Alongside, as a way to control water use, the GOS has decided to promote the installation of measuring devices in all existing wells and is requiring that all wells must be licensed by 1 July 2001. To promote the adoption of modern irrigation technologies among farmers, the Extension Department of the Ministry of Agriculture is broadcasting TV and radio programs to emphasize the advantages of such technologies.

The Co-operative Bank will provide loans to the farmers to purchase modern irrigation equipment under the following conditions: (1) 7 years repayment period and 1 year grace at 5.5% interest for private farmers and 4.5% for cooperatives. (2) The amount of the loan varies according to the following criteria: 100000-85000 SP/ha depending on farm size for drip irrigation of field crops and 45000–33000 SP/ha for fruit trees. 25000–20000 SP/ha depending on farm size for sprinkler irrigation. (3) A 85% collateral for the loan is required. (4) The GOS will provide a 40 000 million SP to finance these loans and related costs.

The development of new irrigation in the public sector has been important increasing from 219273 ha in 1993 ha to 396518 in 2000 at a rate of 25000 ha/year. Most of the new systems are of line canals from the headwork to the farm gate. Unfortunately the use of pressurized networks is still rather infrequent.

3. Scope and method of analysis of the study

3.1 General Aspects

The analysis in this study includes two major parts at different levels of aggregation. One consists in the analysis of the irrigation water sector in Syria at national aggregated level and at regional basin's level. The other part is a disaggregated farm level analysis. In both cases simulations of different scenarios have been carried out to permit short and long term assessments of different policy alternatives for conserving water resources in Syria and their effects at national, regional and farm levels. The complete set of simulations compile a dynamic macro and micro database that can be further utilized for training purposes where alternative water policy scenarios and farm models can be developed.

3.2 Analysis at country and basin's level.

Different scenarios have been defined (section 4) to evaluate the effects of several policy alternatives on the short, medium and long term availability of water resources in Syria. The analysis at basin's level was performed to permit to assess the diverse impacts that those policies may produce on critical high-water-deficit basins with respect to water-surplus basins. This distinction is crucial for water policy analysis and policy recommendations.

3.3 Analysis at farm level. Field survey and information processing

In the second case, a typology of farms was built to represent the Syrian irrigated agriculture in different regional environments. Representative farms were selected based upon the statistical data available, according to farm size, production potential, factor allocation, cropping pattern and type of water source. Different alternatives for adopting modern irrigation equipment were considered to permit to evaluate the financial effects that these investments will have on different farm types and water sources.

A field survey was conducted in set of 48 irrigated farms in the Hama Governorate which permitted to accede to direct farm-based information that was used for the definition of the technical parameters, cropping pattern, farm size, water use and irrigation techniques in the farm models. Field survey data provided also the data base for obtaining the irrigation cost parameters in all the irrigation techniques alternatives in the farm models.

4. Results of the analysis

4.1. Water balances[2]

Scenario 1: Present policy : Combination of irrigation modernization (4 years) and irrigation expansion (15 years)

This scenario represents the official government policy consisting in the modernization of the irrigation techniques and the development of an area compatible with the requirements created by the increasing population. The area to be modernized is 319017 ha/year (for a period of 4 years) and those to be developed are 27800 ha/year (15 years). The evolution of the deficit for the whole country evidence that during the four initial years a large reduction of the deficit is achieved but from the 5th year onwards the deficit starts to increase due to the development of the new areas. Reaching at the end of the period a deficit of 2469 Mm3 which is only 635 million m3 smaller than the initial value. This shows clearly that in spite of the substantial impact that could be obtained with the modernization program the expansion of the irrigated area has a marked counterbalancing effect. The Al Khabour basin recovers and its deficit decreases to nearly 2000 million m3 but it declines later on to values close to the initial ones. This is an indication that in such basin the development of new irrigation should not be promoted if ones desires to re-establish the equilibrium between demand and supply in that basin. A similar conclusion applies to the Orontes basin.

Scenario 2: Modernization policy: Modernization of existing irrigation schemes with no expansion of irrigation

This scenario permits to visualize the effect of a gradual modernization policy whereby the whole irrigated area (1149349 ha) will be modernized over a period of 15 years at the rate of 80000 ha per year approximately. This scenario permits to reach a positive balance by the 12th year and by the year 15 the balance reaches a positive value of 857 Mm3. Unfortunately this scenario will not permit to cover the needs of the growing population and some commodities will have to be imported. The reduction of the deficit in the critical basins (Al

[2] Graphs 1-8 in the text show the results of the policy scenarios at aggregate level and for the most critical basin

Khabour and Orontes) are close to 40% of the initial values, which is substantial for the period of 15 years, but also indicates that even if all the area is modernized these basins will continue to have an important deficit. Therefore stronger measures will be required to achieve a positive balance in these critical basins such as: reduction of the consumption per well, closing of wells, reduction of irrigated area, limiting the cropping pattern to crops with relative small water requirements or any combination of these measures.

Scenario 3. Long-term combined policy: Combination of irrigation modernization and irrigation expansion (15 years both processes)

This scenario assumes that modernization will be undertaken over the whole irrigated area but at the rate of 80000 ha/year. Expansion of irrigated area will take place at the same rate that in Scenario 1 as modernization will be undertaken at a pace which is more according to other international experiences. The deficit reduces at nearly a regular rate from -3104 Mm3 to -2753 Mm3 at the national level. This is because the annual balance between the new areas that are modernized and those that are added new is positive. This permits the reduction of the deficit but after year 15 the trend will reverse as all the existing irrigated area will have been modernized and only new areas will be added. The critical Al Khabour basin follows a similar pattern until year 11 where all the area to be modernized is covered and from that year on only new area is added producing a reversal of the trend.

Scenario 4. Differentiated policy: Modernization in critical basins and limited irrigation expansion in selected basins.

This scenario simulates different irrigation policies for the most critical basins. For the critical Al Khabour and Orontes basins it is assumed that all the irrigated area will be modernized in 5 years and no new irrigation will be developed. For the remaining basins the existing area will be modernized along a period of 15 years. New irrigation areas will be developed only in the Euphrates and Coastal basins (120000 ha and 45000 ha respectively). The effect of this hypothesis is quite positive as it will permit to reduce the national deficit from –3104 to –451 Mm3 (Graph 7). A special five year modernization plan is needed in the Al Khabour and Orontes basins. In terms of new irrigated area 165000 ha will be developed over a period of 15 years representing approximately one third of the present Government plans. For the Al Khabour basin the effect is also quite remarkable reducing the deficit from –3105 to –1845 Mm3 in a period of 5 years and practically stabilizing for the remaining of the period. This again shows that even if the modernization of the whole irrigated area is carried out in a short period the basin remains with a high negative balance that will eventually lead to the depletion of the aquifers.

4.2 Adoption of irrigation technologies at farm level

Farm models: Farm typology, water source and irrigation technologies (basic features)

A farm typology was defined to represent the irrigation agriculture in Syria of distinctive agricultural regions in the country. It consists on three representative farms according to the data available of size and number of irrigated holdings. A large extensive farm of 14ha (wheat and cotton), a medium size semi-intensive farm of 5 ha (wheat, cotton, sugarbeet and potato)

and a small intensive farm of 1,5 ha (potato, tomato and oranges), which together represent 77 % of all irrigated holdings and 64% of the irrigated surface. Water sources in the different types of farms include surface water from rivers and underground water from wells of 200 m, 100 m and 50m. depth. Irrigation costs were calculated for all the different alternatives using field data information. Irrigation techniques include traditional surface irrigation and modern sprinkler and drip irrigation. The combination of farm types, water sources and irrigation techniques has resulted in an ample number of farm models which has permitted to compare the effects of the adoption of modern technologies for irrigation.

Comparative effects by farm types

The effects of the adoption of modern irrigation on farm profit can be substantially different in the large, medium and small farms evidencing that structural parameters and cropping patterns are determinant and hence regional characteristics. The results on financial returns of water (gross margin/m3 and net margin/m3) show that for all farm types, the adoption of modern irrigation techniques increases substantially. However, differences between these two techniques are evidenced, and in the case of sprinklers increases range from 55 to 125% as in the case of drip irrigation these figures double ranging from 116 to 218%. Across all farm types, the kind of water source (surface or underground water) determines also the profitability of adopting modern irrigation methods. The adoption of water-saving modern irrigation technologies results in larger increases in farm profits when water is extracted from wells as volumetric water costs are substantially reduced.

Adoption of modern irrigation techniques in the large farm

In the large farm irrigated by river water, farm profits increase moderately when modern irrigation techniques are adopted. From a net margin per ha of 18683 Sp/ha in surface irrigation to 23395 SP/ha in the case of sprinkler irrigation and 22387 SP/ha in drip irrigation. If water is extracted from wells of 100 m. depth, modern irrigation results in higher farm profit increases, passing from 10752 SP/ha in surface irrigation to 29127 SP/ha in sprinklers and 28212 SP/ha in drip irrigation. This is due to the decrease in irrigation costs inbuilt in the modern water saving techniques as water costs depend on the volumes of extracted water. This tendency is reinforced as water becomes more expensive in deep wells of 200 m. depth. These results show that in this type of extensive farm sprinkler irrigation is more suitable than drip irrigation although sprinklers cannot be used along the whole growth period of cotton.

Adoption of modern irrigation in the medium size farm

Medium size semi-intensive farms irrigated by river water increase farm profits by 33% when sprinkler irrigation is adopted (from 41911 SP/ha to 55797 SP/ha) and by 36% when drip irrigation is adopted (to 56949 SP/ha). These results evidence that this modern technology is more suited for a more intensive cropping pattern (that includes potato). In medium size farms irrigated by wells, the adoption of sprinkler or drip irrigation results in a double increase in farm profits (64% and 67% respectively) than in the case of river water (from 35627 SP/ha to 58477 SP/ha for sprinklers and 59628 SP/ha for drip). The advantages of drip irrigation are reinforced as volumetric water savings are greater in this type of technology.

Adoption of modern irrigation in the small farm

In the case of the small intensive farm, that grows mainly fruits and vegetables, the comparative efficiency of adopting drip irrigation is further evidenced both for surface river water and for underground water. For surface water, farm profits increase by 38% if sprinkler irrigation is adopted and 67% if drip irrigation is selected (from 153087 SP/ha to respectively 210985 SP/ha and 255962 SP/ha). If irrigation water is extracted from shallow 50 m wells farm profits increase by a double amount, 67% in the case of sprinkler irrigation and 111 % in drip irrigation (from 119164 SP/ha to respectively 206304 SP/ha and 251478 SP/ha).

5. Recommendations

On water resources policy

1. A differentiated water basin policy would offer the best opportunity to reduce the imbalances among basins. Such policy should consist of: an intensive plan of modernization (8 years) in the most critical basins (39000 ha/year in Al Khabour and 16000 ha/year in Orontes) with a lower rate of implementation in those basins where the deficit is smaller.
2. In those basins where the water balance is positive, the development of new irrigation can be restricted to the existing resources (11000-13000 ha/year)
3. The implementation of the above recommendation in the Al Khabour and Orontes basins will no be sufficient to re-establish a positive balance in the time span considered and additional measures will be required to achieve a sustainable balance.

On the modernization of groundwater irrigated areas

4. Such additional measures may be: (i) Limit the amount of water/ha that can be used in every well (aquifers recharge rate) penalizing those that exceed it with a penalty fee. It requires metering devices and strict control. (ii) Establish the maximum amount of water that can be utilized per ha and its equivalence in area planted for each crop under each technology. This is referred to as: Water/crop quota system.(iii) Closing of wells that do not fulfill specified criteria (efficiency, unauthorized, double source of water, unsuitable water quality, etc.)
5. A detailed survey of the use of well water should be carried out to determine the most suitable combination of measures.
6. In the absence of the survey and water measuring devices the most feasible alternative in the short run would be to implement a water/crop quota system. (i) This will permit the farmers to chose their cropping pattern within an established quota of water and have it approved by the government authorities.(ii) To avoid distortion of the national objectives of the strategic crops' production, the government can establish support prices for strategic crops to achieve those objectives. (iii) This system should be implemented gradually over a 5 years period and complemented by other measures.
7. The implementation of these measures should be accompanied by some financial incentives to facilitate enforcement.

8. Partial subsidy of the investment cost in irrigation technologies is recommended in the critical basins (Al Khabour and Orontes). A 50% subsidy will cost some 600 Million SP at national level.
9. Sprinkler irrigation is suitable for wheat but not adequate for all phases of crop development of cotton. The inverse applies for drip irrigation. The water/crop quota system will permit to overcome this serious technical limitation by allowing the farmers to specialize in specific crops or cropping patterns
10. Monitoring and control of the adoption of modern irrigation techniques should be implemented. Statistical information at farm level should be developed as modern irrigation has different financial effects across farm types.

On the modernization of surface irrigated areas

11. It is estimated that some 265000 ha of public irrigation systems were developed in the last 10 years and have acceptable efficiency levels. In these systems: (i) Adoption of pressurized modern irrigation techniques will be limited to canals operating on continuous flow. (ii) Precision land leveling should be adopted in the remaining areas.

12. Measuring of water delivery contributes effectively to reduce water use. It is recommended that in the areas where modernization will not take place in the early years: (i) Measuring devices should be installed. (ii) Water should be delivered in accordance to acceptable water consumption standards of surface irrigation methods.

On training and extension

13. The implementation of irrigation modernization should be accompanied by an intensive training program addressed to farmers, extension agents and professionals from the public and private sector to increase the design and implementation capacity.

14. The number of people to be trained in each category and the related costs will require the preparation of a detailed proposal. The following target is a gross estimation for an initial period of 5 years: 50000 farmers, 500 extension agents, 30-40 professionals from the public and private sectors.

On Water User Associations (WUAs)

15. The establishment of WUAs in public irrigation systems does not appear as an urgent need but a greater participation in the decision making processes is recommended.

16. This could consist in the establishment of Irrigation Committees in every irrigation system integrated by a mix of farmers representatives and government officials.

17. It would be advisable to establish WUAs by grouping wells located in the vicinity to discuss the implementation of the measures mentioned before. This could be tried out in some specific areas and, if the results are positive, the experience can be expanded

1. INTRODUCTION

1.1. Background

According to the terms of reference the consultants were requested to undertake two missions (later extended to three) in the Arab Republic of Syria whose main objective was to complete a study-report on "The Utilization of Water Resources for Agriculture: Analysis of the Current Regime and Policy".

The consultants undertook their first mission to Syria from 4 to 20 February 2001. The purpose of this mission was fulfilled and consisted in firstly to identify the main issues concerning the study and secondly to organize the collection of information that enabled the preparation of the study. Numerous interviews were arranged along this first mission with concerned national authorities that provided relevant information. A field trip of four days duration was organized and proved to be extremely useful to gather first hand information.

Along the three missions, the international consultants had profited from the support of a national task force made up of two national consultants and a group of 6 trainees (later extended to 12 due to field work requirements) for collecting the necessary information.

The need for organizing, reviewing and completing the collection of information, both from statistical sources, reports and field work data, required an extra follow-up mission prior to the last final mission which permitted a greater interaction with the consultants and trainees. Therefore, after the first initially programmed mission a second one-week follow-up mission was organized (March 29-April 8, 2001) during which the revision of the data collection that had been assigned to the trainees and the national consultants in the precedent mission was completed. A qualitative and quantitative analysis of the information was carried out during this second mission.

The study was completed during the third and last mission (May 3-30, 2001). As planned, a methodological training session was conducted for the project trainees and a presentation of the main contents and conclusions of the study was organized for high government officials under the auspices of the Ministry of Agriculture and was chaired by the Ministry's Deputy Minister.

1.2. Objective and Scope of the study

In Syria as in many other countries in the region, water is becoming a scarce resource as future demand is coming close to the available resources and hence water use efficiency in all sectors is becoming a matter of economic, social and political concern. This crucial issue is particularly relevant for the agricultural sector, which uses up to 85% of the nation's available water resources.

The main scope of this study is to propose a set of policy recommendations aimed at increasing the efficiency of water use in agriculture and reducing future consumption. Of major importance in this context is the adoption of modern irrigation technologies at farm

level that is already profiting from considerable support by the GOS. However, its wider adoption may require additional incentives and other supporting measures. On-farm improvements must be accompanied by similar policies at network level to increase their efficiency but such measures need to be evaluated in technical and economic terms at national and system level. The study has also considered institutional changes and strengthening of the supporting services (e.g. water user associations and research and extension) targeted to increase the sustainability of the recommended policies.

This study has a dual objective with the purpose of conforming with the general project's goal of 'Assistance in institutional strengthening and agricultural policy in Syria'. (i) On the one side the study consists in the analysis of the irrigation water sector in Syria and its related water policies for which an explicit methodology has been developed (chapters 3 and 5). The analysis includes two major parts at different levels of aggregation. One is devoted to analyzing the irrigation water sector in Syria at national aggregated level and at regional basin's level. The other part is a disaggregated farm level analysis. In both cases simulations of different scenarios have been carried out to permit short and long term assessments of different policy alternatives for conserving water resources in Syria and their effects at national, regional and farm levels. (ii) On the other side, the study has a training component. The complete set of simulations developed at aggregate and farm levels for the analysis of the water sector in Syria compile a dynamic macro and micro databases that can be further utilized for alternative water policy scenarios and farm models other than the ones used for this study.

1.3. Contents of the report

The report is divided into 10 chapters. The introductory chapter of the report, ***Chapter 1***, summarizes briefly the background and objectives of the study as well as the development of the three subsequent missions. ***Chapter 2*** comprises the situation of the water sector in Syria focusing on the current situation of the nation's water balance and the water balance across basins with special attention to the most critical high-water-deficit basins. The second part of this chapter is devoted to analyzing at national and basins' levels the projected water demand trends over a period of 15 years based on the simulation of four water conservation policy scenarios. Results are discussed for the nation's aggregate as well as for the water-deficit and the water-surplus basins. This section is amply documented in the annexes.

Chapter 3 follows with the analysis of the structure and performance of the irrigation sector in Syria and it covers the development of the public-owned surface irrigation networks as well as the private-property groundwater irrigation systems. This chapter is further completed with the next chapter, ***Chapter 4***, which is devoted to the analysis of the policy framework that affects irrigation water. This part compiles in a matrix format the water related legislation enacted during the last years in Syria for attaining the policy objective of conserving water resources and achieving a more efficient use of irrigation water. ***Chapter 5*** includes the financial analysis of the adoption of modern irrigation technologies, one of the major policy objectives for the irrigation sector in Syria. This part is the farm-level counterpart of the aggregate analysis carried out in Chapter 2 and consequently it is based on policy simulations for the adoption of different types of irrigation technologies (sprinkles and drip irrigation) in various types of farms and water sources (river and well). This chapter is also fully

documented in the annexes. ***Chapter 6*** is dedicated to the conclusions and general observations of the aggregate, regional and farm level analyses and lastly, ***Chapter 7*** is devoted to compile all the policy recommendations that emerge from the study divided into six different headings. ***Chapter 8*** includes the proposed project profile, references are presented in ***Chapter 9*** and finally, all annexes are included in ***Chapter 10***.

1.4. Acknowledgements

The mission enjoyed full support from the project staff and it is gratefully acknowledged here. The project's National Director, Mr. Atieh El Hindi, provided to the consultants a continuous support, interesting discussions and a very efficient organization of meetings and field visits. The project's Agricultural Economist Dr. Ciro Fiorillo was always supportive and his interesting views in policy discussions were greatly appreciated. Dr. Emad El Hawary, the project's CTA, organized the trainees field work and his support a well as the other members of the project staff is acknowledged here. Especially, the assistance of Ms. Asma Matar with the interpretation and translation was essential during all meetings and was done with great professional competence. Of the two national consultants Mr. George Somi, Director of the Department of Irrigation and Water Use at the Ministry of Agriculture, was available from the beginning of the mission and was a continuous and efficient source of technical information, field visits organization and valuable advise. His support and competence was greatly appreciated. The other national consultant, Mr. Munther Kustantine, Deputy director of the Directorate of Maintenance and Exploitations at the Ministry of Irrigation, was nominated at a later stage in the mission and although there was a limited possibility for interaction with him, the information he provided at the end of the mission is also acknowledged. The trainees that had been assigned to this study performed their work with seriousness and rigor and we are thankful for their collaboration, especially to Mr. Tareq Jawabra, Ms Samira Zeghbi and Mr. Abdul Hadi Reffai.

Along the three missions, the international consultants profited form the interaction with other international consultants in discussing the overall situation of the Syrian agriculture as well as exchanging more detailed information on specific aspects of common issues. Especially, discussions with Dr. Nadia Forni (land tenure), Prof. Gareth Edwards-Jones (environment), Prof. Héctor Maletta (private investment), Prof. Peter Wehrheim (taxes and subsidies) and Prof. Donato Romano (training in water institutions) are greatly appreciated. Discussions and exchanges of information with Prof. Alexander Sarris in charge of the final agricultural development policy strategy for the SAR, provided to the consultants the opportunity to focus on specific issues of water management policies lo elaborate for this final study-report and are greatly acknowledged.

2. CURRENT AND PROJECTED DEMAND, SUPPLY, AND BALANCE OF WATER RESOURCES

2.1. Available water resources

The water resources of Syria are very limited compared to the needs of the country. Estimations of the available resources vary considerably depending of the sources of information. The following table finds considerable concordance from the information received from the Ministry of Irrigation and the Ministry of Agriculture.

Table 2.1: Available Water Resources

	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos (Al Asi)	Coastal	Al Khabour	Euphrates and Tigris	Total
Rain fall (Actual /average)	%	59	49	30	60	80	40	100-40	
Water resources (surface)	Million m3	12	88	49	666	1246	315	6818	9194
Water resources (underground)	Million m3	490	131	54	964	622	640	2494	5395
Water resources (total)	Million m3	502	219	103	1630	1868	955	9312	14589
Utilization rate	%	0,90	0,85	0,60	0,85	0,65	0,95	0,98	-
Actually available	Million m3	452	186	62	1386	1214	907	9126	13332
Domestic & Industrial waste water	Million m3	257	50	8	214	0	36	130	695
Agricultural drainage	Million m3	568	36	-	231	43	428	725	2031
Total available for use	Million m3	1277	272	70	1831	1257	1371	9981	16058

2.1.1. Groundwater and Surface Water

Syria has important groundwater resources estimated at 5395 MM3 which represent 37% of the total water resources of the country. The best aquifers concentrate in the western and northern regions where basaltic and limestone formations concentrate. In the extreme north-east , paleocene limestone are highly productive artesian aquifers. The great springs of Ras El Ein and Ain El Arous use to carry large flows (40 m3/s and 6 m3/s respectively) but now due to overexploitation of the aquifers their flows are very small. Most of underground water holding layers are of suitable quality.

Most of the aquifers have been overexploited except for the Coastal and Al Badia basins. For instance the water table in the Orontos basin has decreased by 57 meters during the period 1990-1999 in Al Ashareneh area and 34 meters in Al Salamieh area. This has lead to the prohibition for drilling new wells in the mentioned areas (see the Ministers' Council circular no. 13/T of 31/8/1999 related to wells drilling licensing ban and decision no. 3 of 3/5/2000 issued by the Ministers' Council and circular no. 31 of 3/6/2000 issued by the Minister of Irrigation related on the same issue).

2.1.2. Dams and Reservoirs

As water resources are very limited in Syria the construction of dams has received considerable priority. In the last decades were constructed totaling 154 dams but only three of them represent the 87% of the total storage capacity. A complete data base with all the characteristics of these dams is available at the Directorate of Water management of the ministry of Agriculture. As the information is very large and not directly related to the scope of this report it has not been included but it is available in the Project files.

2.1.3. Non conventional water resources (sewage water reuse)

In Syria the non conventional water resources are limited to the reuse of sewage water. For the time being Only Alepo and Damascus have treatment plans but there are definitive plan for implementing one at lest per each governorate.

2.2. Present water use

The present water uses are summarizes in table 2.2.

Table 2.2: Present water uses (Year 1999 – 2000)

Water use									
Irrigated area	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Irrigation requirements	m3/ha	16000	10500	11000	9100	6000	10600	16700	12429
Irrigation water use	million m3	**1207**	**360**	**43**	**2306**	**433**	**4283**	**7228**	**15860**
Population	million persons	4,0890	0,9430	0,1130	2,5280	1,8290	0,6690	4,1050	14,2760
Requirements per person	m3/per capita	0,2000	0,2000	0,2000	0,2000	0,2000	0,2000	0,2000	0,2000
Domestic water use	million m3	298	69	8	185	134	49	300	1042
Industry water use	million m3	77	18	2	48	35	13	78	315
Evaporation	million m3	5	31	15	148	16	132	1643	1 990
Total uses	million m3	1588	478	68	2687	617	4477	9249	19162

2.3. Present water balance

The water balance for Syria is negative with a **deficit of 3104 million m3/year**. This assumes that the share of Syria from the Euphrates river is 210 m3/s i.e. 6622 Million m^3 per year, which is the most conservative hypothesis. In this case the total water resources for the country are 16058 million m3/year while the total uses are 19162 million m3/year.

The balance per basin shows that only three basins, namely Euphrates, Coastal and Al Badia have a positive balance. The remaining have considerable negative balances as shown below:

Table 2.3: Present Water Balances

Barada & Awag	Yarmouk	Al Badia	Orontes (Al Asi)	Coastal	Al Khabour	Euphrates and Tigris	Total
-311	-206	2	-856	640	-3105	732	-3104

The case of the Al Khabour basin with a deficit of -3105 million m^3 is of extreme gravity as evidence by the annual increase in pumping depth due to the depletion of the aquifer. This is followed by the Orontes basin with a deficit of –856 million m^3. The magnitude of the deficit of the Al Khabour indicates that it will be difficult to correct it without special and severe measures.

2.4. Projected water demand and definition of scenarios (2000-2015)

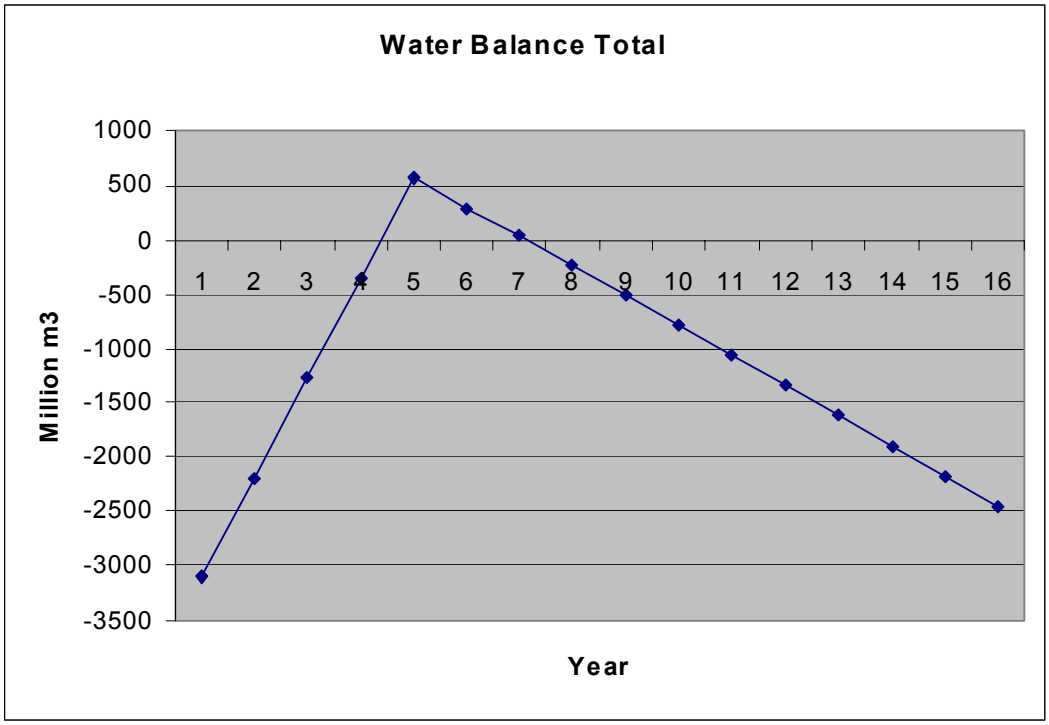
Different scenarios have been simulated to evaluate the effects of several policy alternatives on the short, medium and long-term availability of water resources in Syria. The analysis at basin's level was performed to permit to assess the diverse impacts that those policies may produce on critical high-water-deficit basins with respect to water-surplus basins. This distinction is crucial for water policy analysis and policy recommendations. A methodological scheme at the end of this chapter summarizes the methodology used in this section.

Scenario 1: Present policy: Combination of irrigation modernization (4 years) and irrigation expansion (15 years)

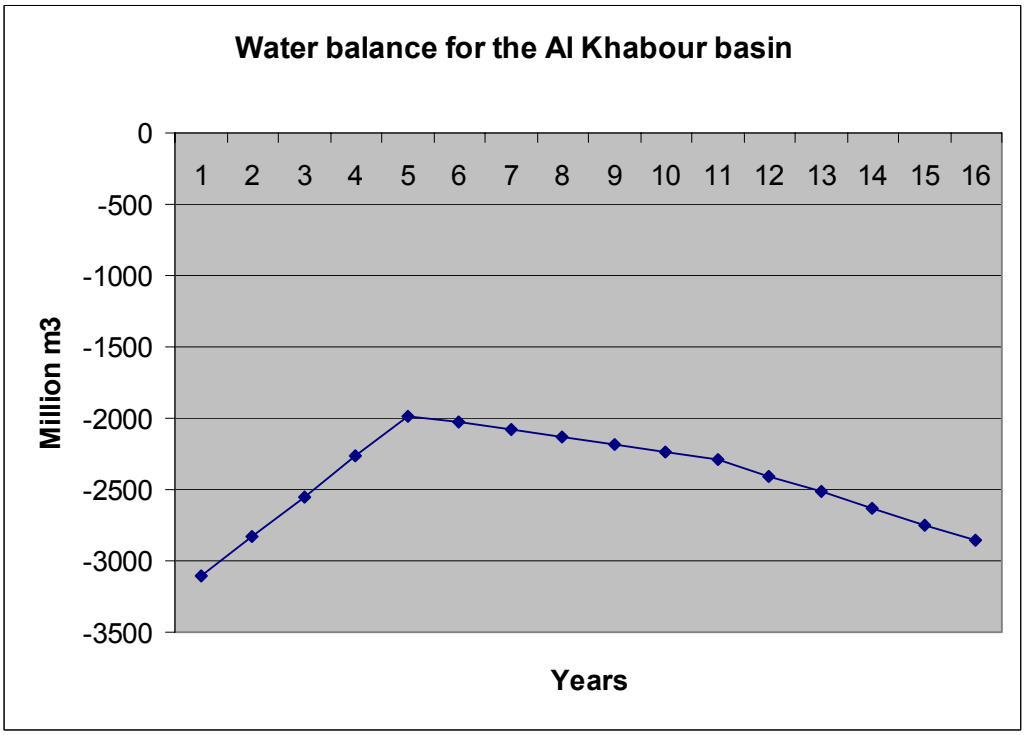
This scenario represents the official government policy in term of modernization of the irrigation techniques and the development of an area compatible with the requirements created by the increasing population. The area to be modernized is 319017 ha/year (for a period of 4 years) and those to be developed are 27800 ha/year (15 years). Details are given in Table 2.4.

Graph 1 shows the evolution of the deficit for the whole country and it is clear that during the four initial years a large reduction of the deficit is obtained but from the 5^{th} year onwards the deficit starts to increase due to the development of the new areas. Reaching at the end of the period a deficit of 2469 Mm3 which is only 635 million m3 smaller than the initial value. This shows clearly that in spite of the substantial impact that could be obtained with the modernization programme the expansion of the irrigated area has a marked counterbalancing effect. The Al Khabour basin (Graph 2) recovers up to a deficit of nearly 2000 million m3 to decline later on to values close to the initial ones. This is an indication that in such basin the development of new irrigation should not be promoted if ones desires to re-establish the equilibrium between demand and supply in that basin. A similar conclusion applies to the Orontes basin.

Graph 2.1. Scenario 1: National Water balance



Graph 2.2 . Scenario 1: Al Khabour basin water balance



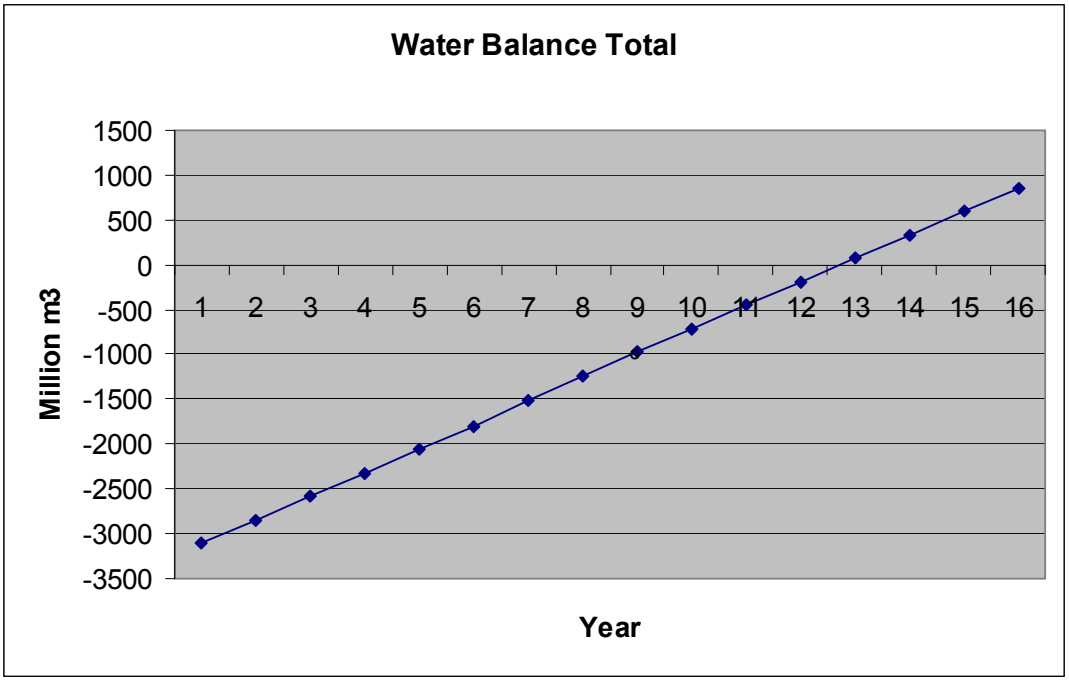
Scenario 2: Modernization policy: Modernization of existing irrigation schemes with no expansion of irrigation

This scenario permits to visualize the effect of a gradual modernization policy whereby the whole irrigated area (1149349 ha) will be modernized over a period of 15 years at the rate of 80000 ha per year approximately.

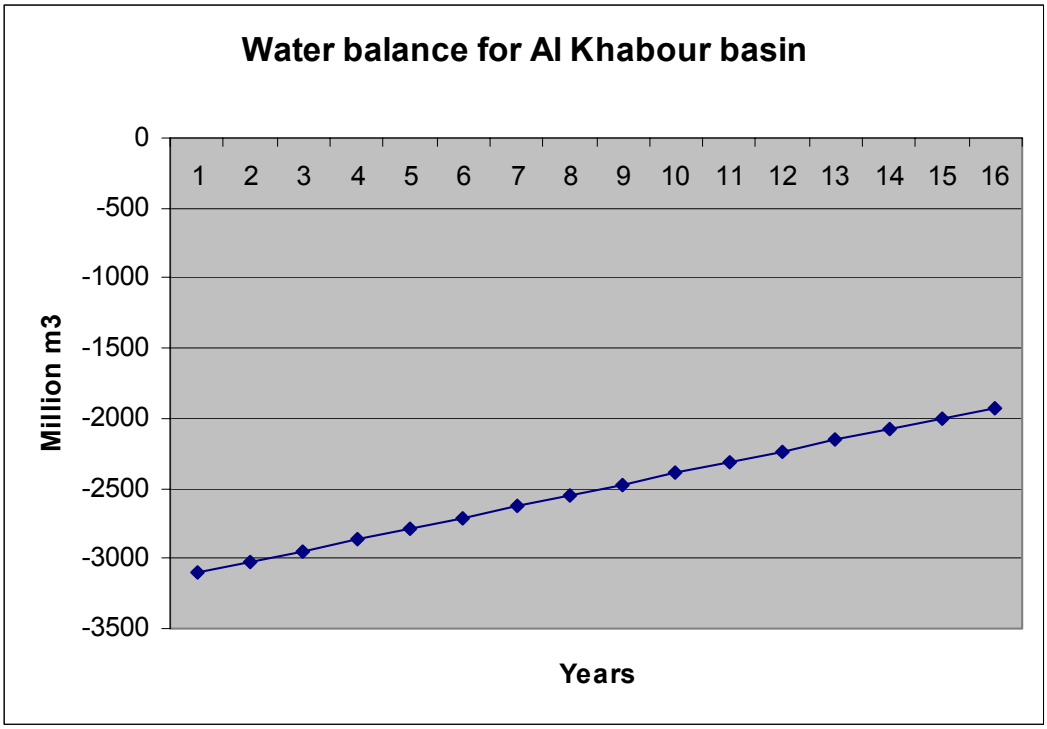
Graph 3 indicates that this scenario permits to reach a positive balance by the 12th year and by the year 15 the balance reaches a positive value of 857 Mm3. Unfortunately this scenario will not permit to cover the needs of the growing population and some commodities will have to be imported. The amounts to be imported will depend much on the yields reached as result of the modernization process.

The reduction of the deficit in the critical basins (Al Khabour and Orontes) are close to 40% of the initial values (Graph 4), which is substantial for the period of 15 years, but also indicates that even if all the area is modernized these basins will continue to have an important deficit. This indicates that this measure is not enough to restore the balance to a positive value. Therefore stronger measures will be required to achieve a positive balance in these critical issues and such measures could include: reduction of the consumption per well, closing of wells, reduction of irrigated area, limiting the cropping pattern to crops with relative small water requirements or any combination of these measures. The selection of the most suitable measures or the proper combination of them would require a greater in depth investigation of the hydrological and water use characteristics which is not available at present. It is recommended that before adopting rigid measures a detailed study should be made of the mentioned characteristics in order to asses different water policy options.

Graph 2.3. Scenario 2: National Water balance



Graph 2.4 . Scenario 2: Al Khabour basin water balance



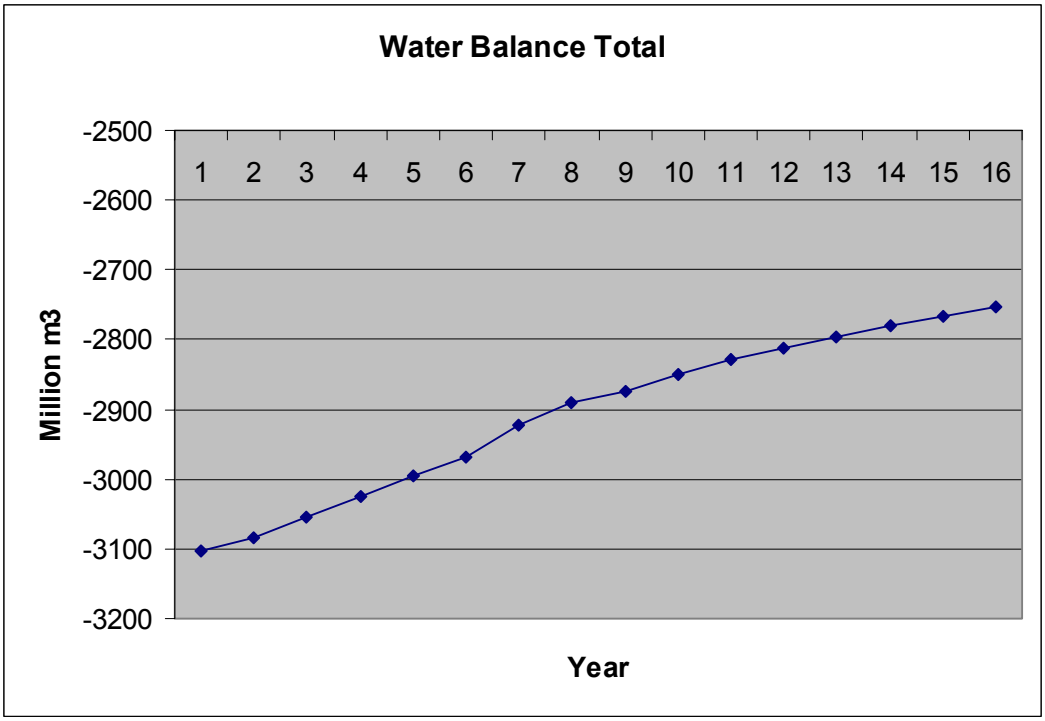
Scenario 3. Long-term combined policy: Combination of irrigation modernization and irrigation expansion (15 years both processes)

This scenario assumes that modernization will be undertaken over the whole irrigated area but at the rate of 80000 ha/year. Expansion of irrigated area will take place at the same rate that in Scenario 1, i.e. 27800 ha/year (according to government plans). Therefore the only essential difference is that modernization will be undertaken at a pace which is more according to other international experiences.

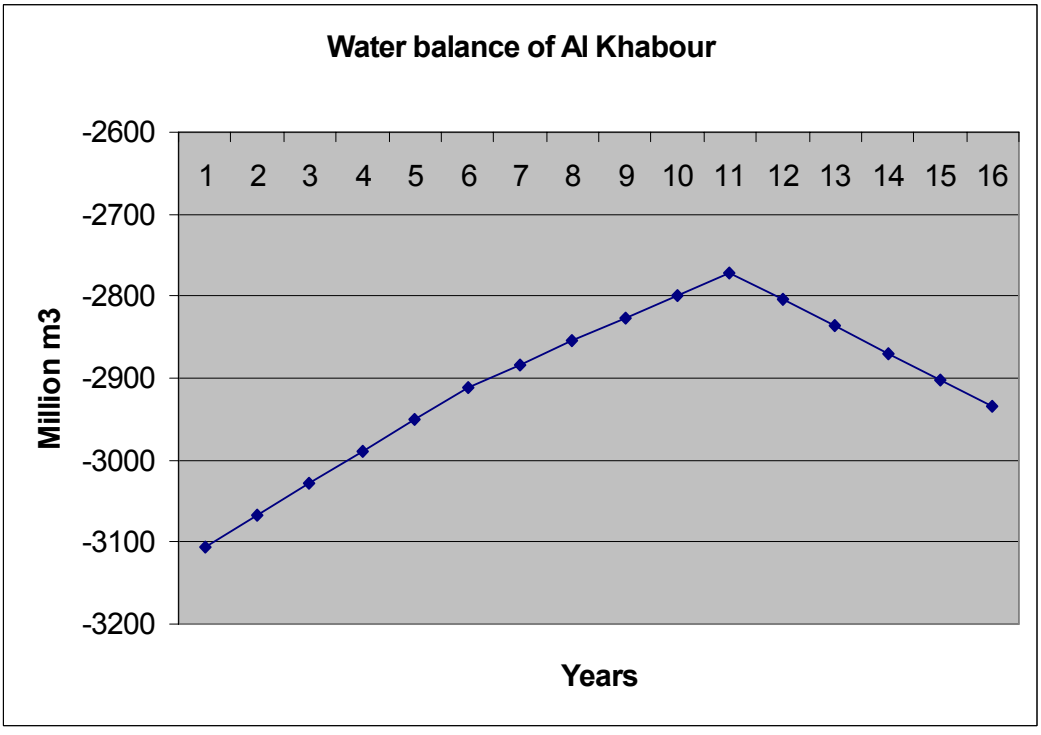
Graph 5 shows that the deficit reduces at nearly a regular rate from -3104 Mm3 to -2753 Mm3 at the national level. This is because the annual balance between the new areas that are modernized and those that are added new is positive. This permits the reduction of the deficit but after year 15 the trend will reverse as all the existing irrigated area will have been modernized and only new areas will be added.

The Al Khabour basin (Graph 6) follows a similar pattern until year 11 where all the area to be modernized is covered and from that year only new area is added which produces a reversal of the trend.

Graph 2.5. Scenario 3: National Water balance



Graph 2.6 . Scenario 3: Al Khabour basin water balance



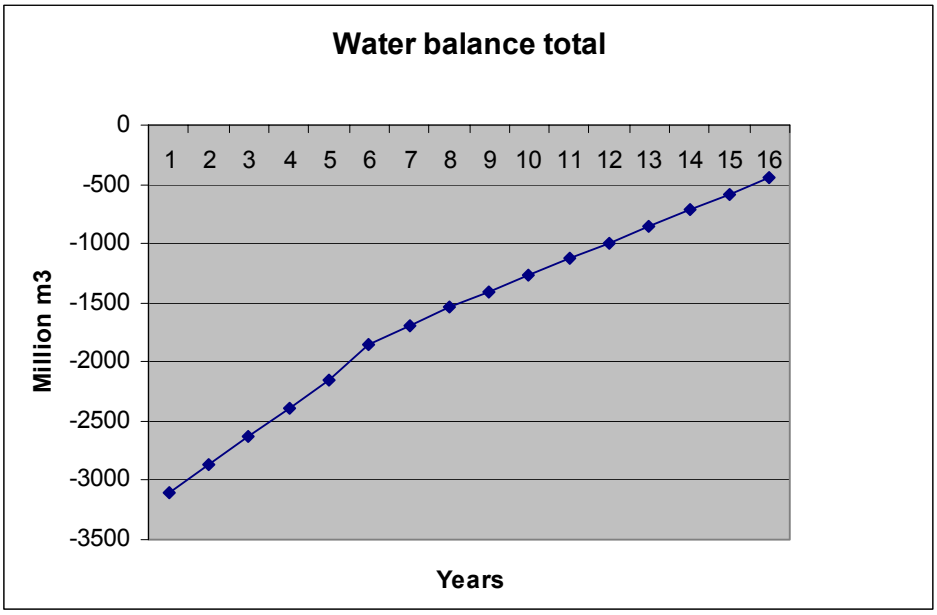
Scenario 4. Differentiated policy: Modernization in critical basins and limited irrigation expansion in selected basins.

This scenario simulates different irrigation policies for the most critical basins. For the Al Khabour and Orontes basins, which are the most critical ones, it is assumed that all the irrigated area will be modernized in 5 years and no new irrigation will be developed. For the remaining basins the existing area will be modernized along a period of 15 years. New irrigation areas will be developed only in the Euphrates and Coastal basins. In the Euphrates basin 120000 ha will be developed which represent the maximum area that can be developed with the existing resources. In the Coastal basin 45000 ha will be developed but there are still resources for the development of a considerable amount of newly irrigated areas.

The effect of this hypothesis are quite positive and permits to reduce the national deficit from –3104 to –451 Mm3 (Graph 7). In terms of modernization it means that a special plan is needed in the Al Khabour and Orontes basins that will permit their modernization in five years. In terms of new irrigated area 165000 ha will be developed over a period of 15 years representing approximately one third of the present Government plans.

For the Al Khabour basin (Graph 8) the effect is also quite remarkable reducing the deficit from –3105 to –1845 Mm3 in a period of 5 years and practically stabilizing at this level for the remaining of the period. This again shows that even if the modernization of the whole irrigated area is carried out in a short period the basin remains with a high negative balance that will eventually lead to the depletion of the aquifers.

Graph 2.7. Scenario 4: National Water balance



Graph 2.8 . Scenario 4: Al Khabour basin water balance

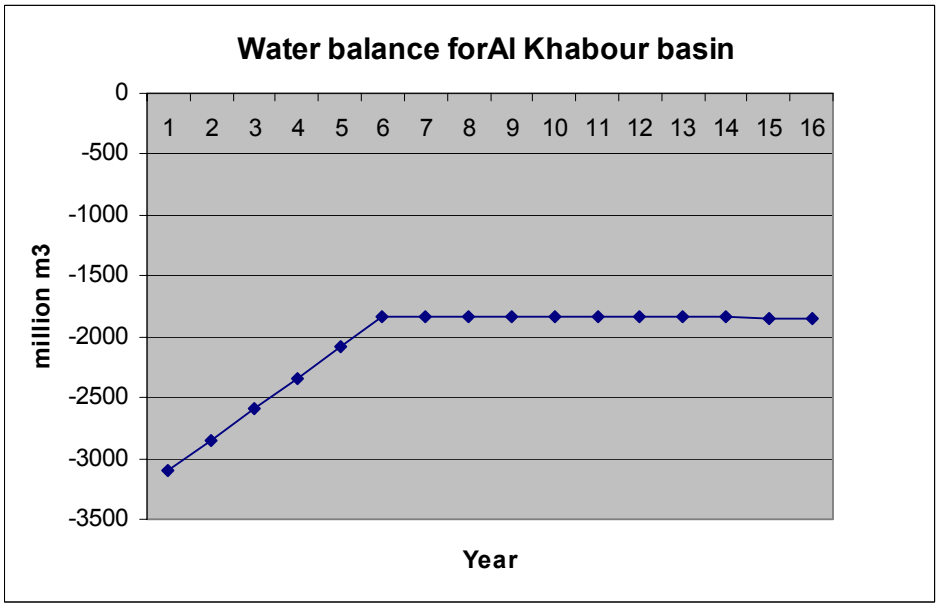


Table 2.4: **Scenario 1:** Present policy : Combination of irrigation modernization (4 years) and irrigation expansion (15 years)

New Irrigation areas to be developed by the GOS	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos (Al Asi)	Coastal	Al Khabour	Euphrates and Tigris	Total per year	Total for the period
Years 2001 to 2005	ha/year	0	1987	0	8794	1600	5423	10000	27804	139020
Years 2006 to 2010	ha/year	0	737	0	7600	1852	6886	11000	28075	140375
Years 2011 to 2015	ha/year	0	0	0	1000	0	15000	11000	27000	135000
Total	ha	0	13620	0	86970	17260	136545	160000		414395

Modernization										
Year 2001	ha/year	18857	8575	968	63357	18033	101019	108209	319017	319017
Year 2002	ha/year	18857	8575	968	63357	18033	101019	108209	319017	319017
Year 2003	ha/year	18857	8575	968	63357	18033	101019	108209	319017	319017
Year 2004	ha/year	18857	8575	968	63357	18033	101019	108209	319017	319017
Total		75429	34299	3871	253427	72132	404075	432835	1276068	1276068

Table 2.5: **Scenario 2:** Modernization policy: Modernization of existing irrigation schemes with no expansion of irrigation

Modernization	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos (Al Asi)	Coastal	Al Khabour	Euphrates and Tigris	Total per year	Total for the period
Year 2001to 2015	ha	4729	2150	243	15888	4522	25333	27136	80000	1200000

Table 2.6: **Scenario 3.** Long-term combined policy: Combination of irrigation modernization and irrigation expansion (15 years both processes)

Irrigation areas to be developed by the GOS	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos (Al Asi)	Coastal	Al Khabour	Euphrates and Tigris	Total per year	Total for the period
Years 2001 to 2005	ha/year	0	1987	0	8794	1600	5423	10000	27804	139020
Years 2006 to 2010	ha/year	0	737	0	7600	1852	6886	11000	28075	140375
Years 2011 to 2015	ha/year	0	0	0	1000	0	15000	11000	27000	135000
Total	ha	0	13620	0	86970	17260	136545	160000		414395

Modernization	ha/year	4729	2150	243	15888	4522	25333	27136	80000	

Table 2.7: **Scenario 4.** Differentiated policy: Modernization in critical basins and limited irrigation expansion in selected basins

Irrigation areas to be developed by the GOS	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos (Al Asi)	Coastal	Al Khabour	Euphrates and Tigris	Total per year	Total for the period
Years 2001 to 2005	ha/year	0	0	0	0	3000	0	25000	**28000**	140000
Years 2006 to 2010	ha/year	0	0	0	0	3000	0	0	**3000**	15000
Years 2011 to 2015	ha/year	0	0	0	0	3000	0	0	**3000**	15000
Total	ha	0	0	0	0	45000	0	125000		170000

Modernization	ha/year	4729	2150	243	15888	4522	25333	27136	80000	Total for the period
Irrigated area in 2000	ha	75429	34299	3871	253427	72132	404075	432835		1276068
Years 2001 to 2005	ha/year	5029	2287	258	50685	4809	80815	28856	**172738**	863691
Years 2006 to 2010	ha/year	5029	2287	258	0	4809	0	28856	**41238**	206189
Years 2011 to 2015	ha/year	5029	2287	258	0	4809	0	28856	**41238**	206189
Total	ha	75429	34299	3871	253427	72132	404075	432835	255214	1276068

2.5. Overview and discussion of results

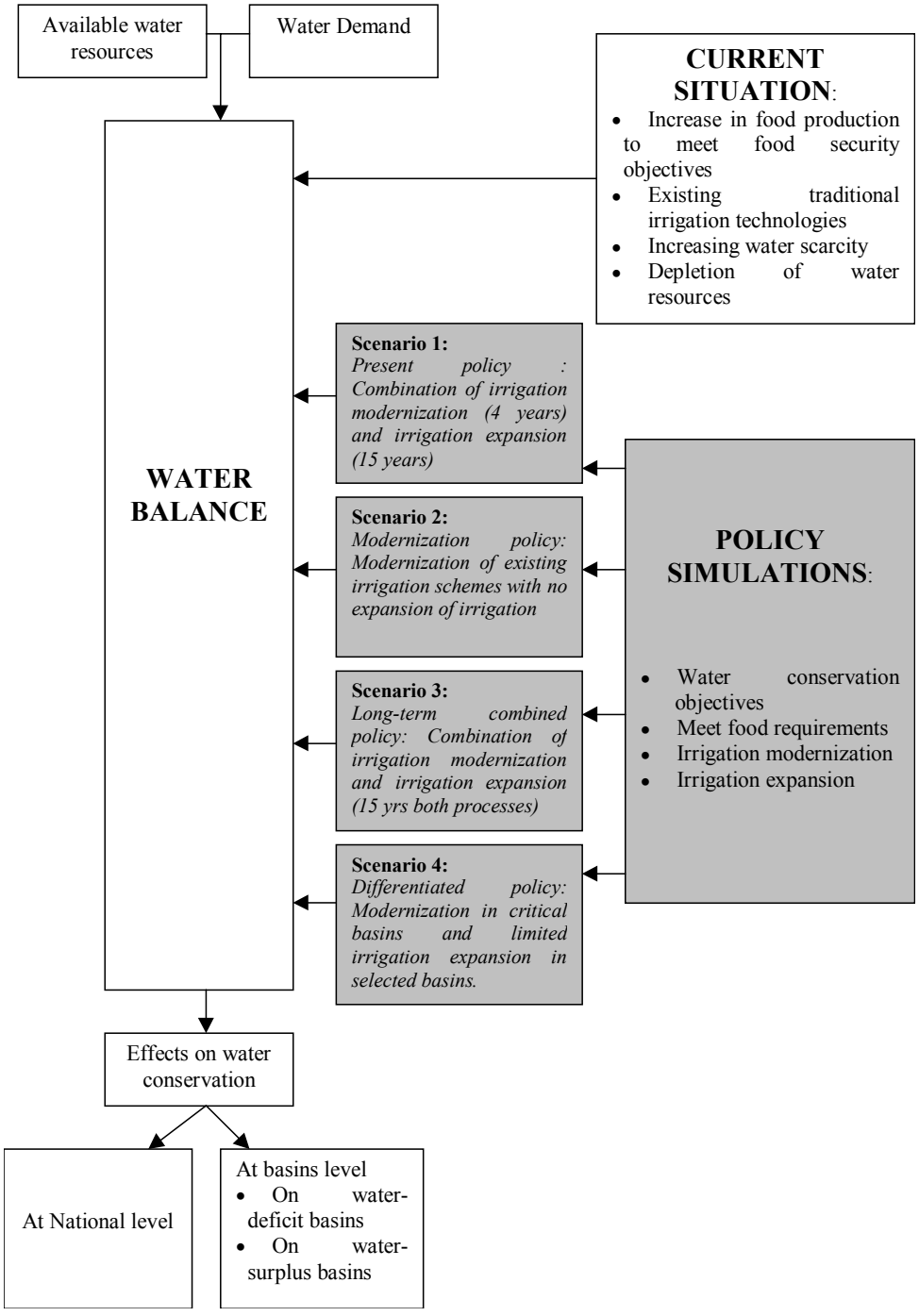
The present water balance for the SAR is negative with a deficit of –3104 Mm3. Growing population at fast rate will put additional demand on the existing resources which are not enough to satisfy existing demand. The development of new water resources seems very limited considering that Syria has developed already 154 dams. Therefore much of the present and future water policy will have to rely on the demand management. Restoring a positive water balance in the future appears as an important policy objective that will require some drastic measures in some of the existing basins where the deficit has reached alarming proportions.

A water policy addressed to modernize the existing irrigation areas will lead to a positive national water balance by the year 2012. However this policy will require the importation of some crops to maintain food security.

When modernization policies are combined with the expansion of irrigated areas in the order of 420000 ha for the period of 15 year period water balances tend to revert to the initial values (Scenario 1) or produce only a moderate reduction of the deficit (Scenario 3).
The fact that some basins have quite large deficits while others have positive balances indicates the need for a differentiated policy whereby modernization will concentrate in those with high deficits while development of new areas will only be permitted in those having positive balances. Scenario 4 presents one of such policies which allows to get relatively close to a positive balance. The expansion of the irrigated area will be limited to some 165000 ha. A possible agreement with Turkey regarding the flow available at the border could provide the basis for additional expansions of the irrigated area in the Euphrates basin.

The scheme shown below summarizes the methodology used in this chapter.

Methodological scheme for the water balance analysis at national and basins' levels



3 STRUCTURE AND PERFORMANCE OF THE IRRIGATION SECTOR

3.1 Development, management and performance of the irrigation sector

From the 18,5 million ha of total lands of the Syrian Arab Republic, cultivated land extends over an area of 5484000 ha of which 1213000 is irrigated land (22%), 3655000 ha is rain-fed land (67%) and 616000 ha is fallow land (11%) (1998 data[3]). Of the irrigated area, 560 559 ha are irrigated from surface water while the remaining 715 509 ha use groundwater resources.

Irrigated agriculture has increased steadily in Syria over the last decades, almost doubling since 1985. This mounting pace has been meant to comply with the nation's food security policy objectives and thus to satisfy the food production needs of an increasing population that features one of the largest growth rates in the world (3,50% in 1985 and still 2,54% from 1995-2000). Irrigated lands are not distributed evenly across the country and most concentrate in the governorates of Al Hassake (34%), Aleppo (13%), Rakka (12%), Hama (11%) and Deir-Ezzor (10%).

Table 3.1 Irrigated land distribution by Governorate

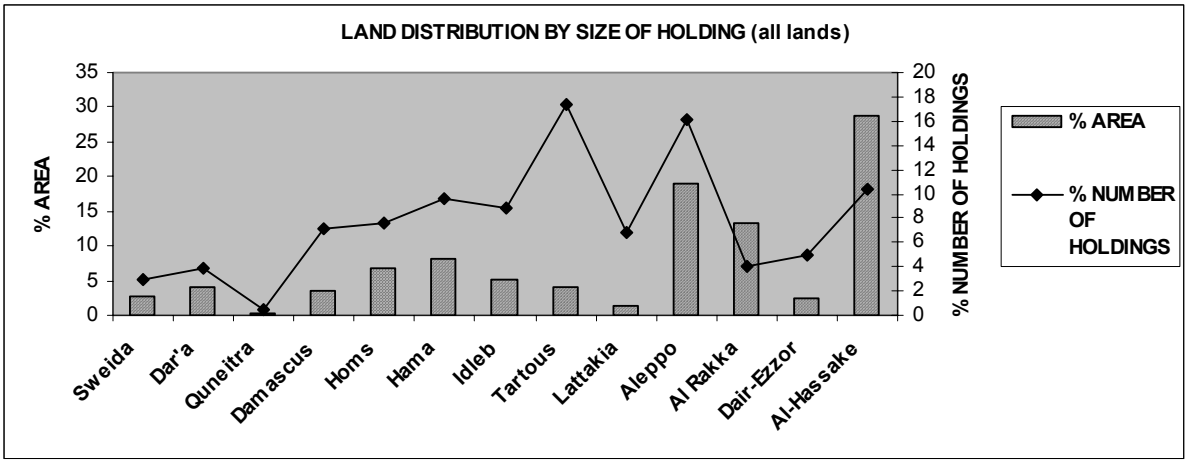
	% IRRIGATED AREA
Sweida	
Dar'a	2
Quneitra	0,3
Damascus	6
Homs	4
Hama	11
Idleb	3
Tartous	2
Lattakia	3
Aleppo	13
Al Rakka	12
Dair-Ezzor	10
Al-Hassake	34
TOTAL	100

Source: Project databases

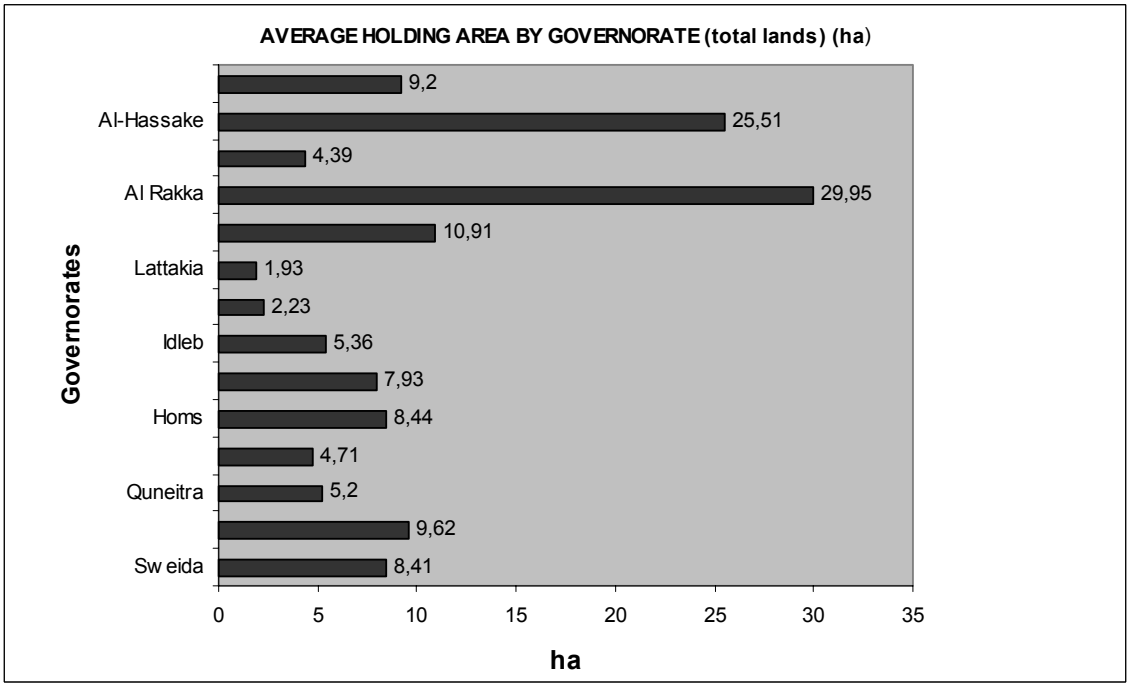
The size of the irrigated holdings is substantially smaller than the size of the rain-fed holdings and varies distinctively across regions. At nations' level, the average farm for all types of holdings is 9,2 ha (graph 2.2) and the average irrigated farm is 3,6 ha (graph 2.4). For irrigated lands, larger farms concentrate in the governorates of Rakka (9 ha) and Al Hassake (10,5 ha), medium size farms are located mainly in Aleppo (5 ha), and Hama (3 ha) and small farms in Latakia (12, ha) and Tartous (0,9 ha). Larger holdings grow mostly extensive crops such as wheat and cotton, as more intensive crops such as sugarbeet, potato, tomato, maize and vineyards are grown predominantly in medium size farms whereas intensive corps such as fruits and vegetables are grown in the coastal smaller farms.

[3] Syria databases GCP/SYR/006/ITA

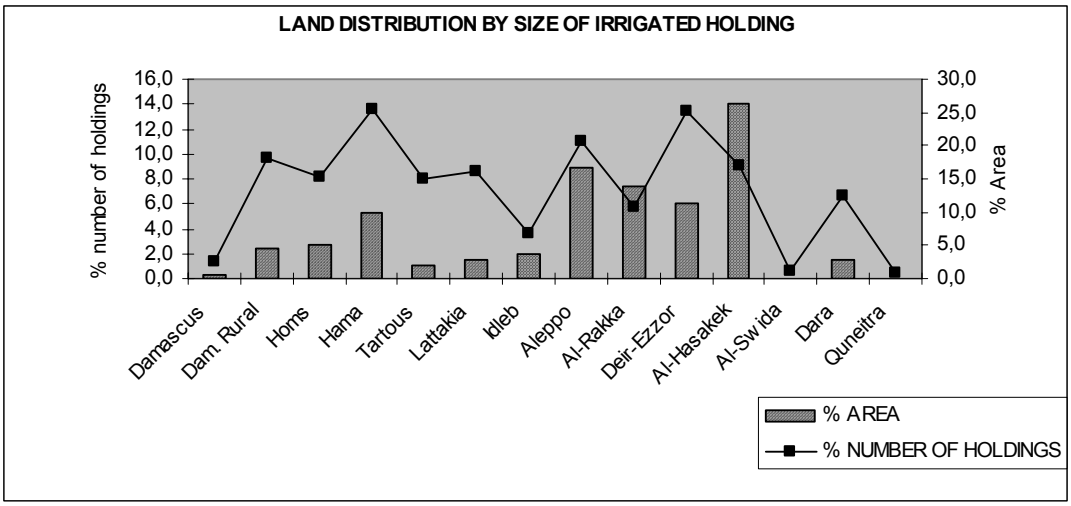
Graph 3.1 Land distribution by governorate (all types of land)



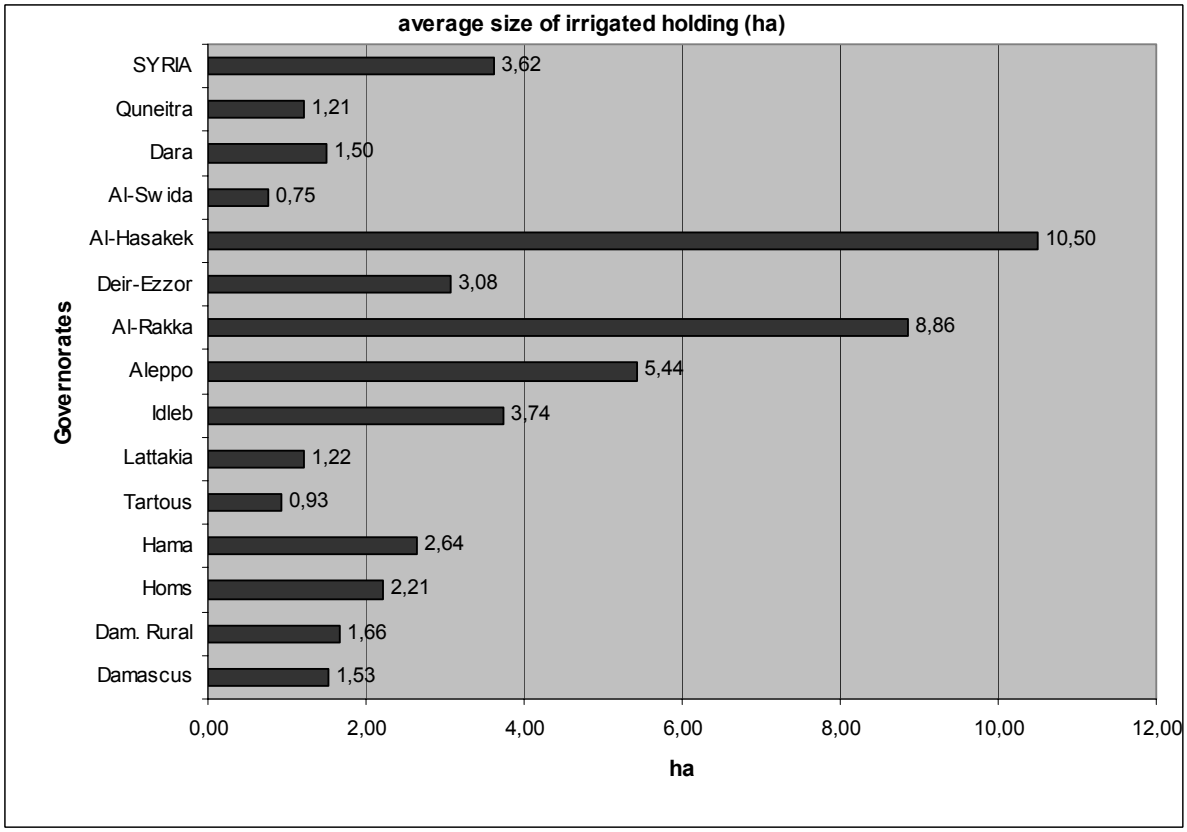
Graph 3.2 Average size of holdings by governorate (all types of land)



Graph 3.3 Land distribution of irrigated lands by governorate



Graph 3.4 Average size of irrigated holdings by governorate



The distribution of the irrigated areas by basins are reflected in Table 3.2.

Out of the total surface irrigated area (560 559 ha) some 400 000 ha have regular irrigation networks that were constructed by the GOS. In these areas water use efficiency differs according to the age of the network. It ranges between 40-50% in the old networks like Al Sen network established in 1949 on the coastal basin and irrigates 8 900 ha., Homs-Hama network established in 1939 in Homs and in 1951 in Hama, on the Orontos basin (19 000 ha) the lower Yarmouk network (7 167 ha.) established in 1949 on Al Yarmouk basin and Tal Manas network (4 000 ha.) established on 1952 on Tigris and Al Khabour basin.

The efficiency of other networks established more than ten years ago (180 000 ha.) mostly developed on the surface water dams, ranges between 50-65%. Whereas that of the networks established less than ten years ago ranges between 65-80% according to the quality of soil and leveling degree. Excluded from this is the Rae'd project networks in the lower Euphrates basin and other open canal networks that irrigate an area of 20 000 ha. where the efficiency does not exceed 35% due to the high content of lime in the soil.

Table 3.2: The Irrigated Area According to the Minutes of the sub Committees for the Irrigation Season 1999-2000 (ha)

Basin	Source/Governerate	Wells	Rivers & Springs	Regular Irrigation Networks	Total 99-2000	Total of the Basin	Remarks
Euphrates	Raqqa	69 073	38 129	76 245	183 447	432 835	Over exploited
	Aleppo	79 118	3 875	41 622	124 615		
	Assad Establishment	-	-	16 927	16 927		
	Deir Ezzor	42 504	53 240	12 103	107 846		
Coastal	Lattakia	4 295	2 270	37 309	43 874	72 132	
	Tartous	8 701	3 592	15 965	28 258		
Khabour	Al Hasakeh	314 050	29 073	60 952	404 075	404 075	Over exploited
Yarmouk	Daraa	8 308	455	20 000	28 673	34 299	
	Quneitera	1 938	92	2 485	4 515		
	Al Sweida	391	-	630	1 021		
Orontos + Al Badia	Homs	24 751	6 623	22 932	54 306	257 298	
	Hama	47 245	4 849	7 679	59 773		
	Idleb	35 558	1 897	6 854	44 309		
	Al Ghab	16 040	93	58 858	74 991		
	Aleppo	5 783	2 179	15 957	23 919		
Barada & Awag	Rural Damascus	57 282	16 685	-	73 967	75 429	Over exploited
	Damascus	473	989	-	1 462		
Total		715 509	164 041	396 518	1 276 068	1 276 068	

3.1.1 Recovery of Irrigation Cost

Beneficiaries from the public irrigation systems are subject to a fee which intends to recover some of the investments made. Table 1 provides the cost of irrigation development by water basin. The fee to be paid is calculated taking into consideration the development costs for an

amortization period of 30 years but no interest is charged nor corrected by inflation. Therefore the amount charged is small and in the order of 2000 to 7000 SP/ ha. The payments to be made are regulated by several legislative decrees and executive decisions have been issued in order to recover the cost of the irrigation projects.

Table 3.3: Cost of irrigation development in selected river basins

Tigris and Al Khabour basin (Al Hasakeh)	142 500 SP/Ha
Euphrates basin (Maskeneh Gharb)	185 268 SP/Ha
Euphrates basin (Beer Hashem)	64 200 SP/ha
Yarmouk basin	62 885 SP/ha
Coastal basin	56 775 SP/ha

Operation and maintenance cost of the irrigation and drainage networks are charged through a flat fee of SP 3500/ha for permanent irrigation and SP 600/ha for winter irrigation. These fees have been determined under the decision no. 5 of 21/11/1999 issued by the Prime Minister (see Annex 1). Table 4 provides the details of the actual cost of the main irrigation networks by basins and category of expenditures. It is interesting to note that the national average coincides practically with the amount charged as a flat rate. The table also illustrates that the actual cost of operation and maintenance for pump irrigation, is considerably higher (5 594 SP/ha) than for gravity irrigation (1 708 SP/ha.) as could be expected. It has been reported that the percentage of payment of the established O&M fees during year 1999 – 2000 was close to 90% which is very high for world standards.

Table 3.4: Recurrent Cost (Operation and Maintenance) 1993

Basin	Costs Type of irrigation	Irrigated area (ha)	Salaries, wages and compensations SP	Fuel, maintenance and spare parts	depreciation of machines below ten years SP	maintenance of the irrigation networks SP	electricity costs	Pumping stations costs	Total	Average cost of maintenance and operation	Remarks
Coast	Gravity	4 565	3 600	2 140	865	1 100	-	-	8 475	1 856.5	
	Pumping	19 249	15 979	9 225	3 647	4 638	30 690	700	71 367	3 707.5	
	Total	23 814	-	-	-	-	-	-	79 842	3 353	
Orontos	Gravity	81 481	40 090	15 840	2 829	67 850	-	-	122 609	1 505	
	Pumping	1 900	597	1 750	500	96.6	3 500	1 967.6	8 412	4 427	
	Total	83 381	-	-	-	-	-	-	131 021	1 570	
Yarmouk	Gravity	7 755.5	2 468	1 596	1 219	13 815	-	-	19 098	2 463	
	Pumping	13 503	10 770	3 409	2 789	17 468	39 750	304	64 490	4 774	
	Total	21 263.5	-	-	-	-	-	-	83 588	2 931	
Euphrates	Gravity	10 518	3 866	3 300	2 490	1 300	-	-	26 022	2 474	
	Pumping	67 297	55 934	45 436	18 011	39 784	239 622	5 635	426 100	6 332	
	Total	77 815	-	-	-	-	-	-	452 122	5 810	
Khabour	Gravity	8 000	1 609	276	2 520	12 392	-	-	16 797	2 100	
Barada & Awag	Gravity										
	Pumping										
	Total										
Al Badia	Gravity										
	Pumping										
	Total										
Total	Gravity	112 319.5	51 633	23 152	10 923	92 457	-	-	193 001	1 708	
	Pumping	101 954	83 280	59 814	24 947	61 986.6	269 372	18 606.6	570 369	5 594	
	Total	214 273.8	134 913	82 966	53 870	15 443.6	269 332	18 606.6	363.370	3 562.6	

3.2. Development, management and performance of groundwater irrigation system

Total irrigated area by wells is 715509 ha of which 314050ha (44%) are in Al Hassakeh (Khabour basin). The total number of wells is 201259 (including 13589 irrigation wells) out of which 53078 were not licensed in 1999. About ¾ of the wells use fuel as primary energy and only the remaining ¼ use electricity

Wells depth and discharge rates are quite variable. Due to the lack of reliable statistics on this issue, the Hydrological Studies Company has been contracted to collect the required data in Aleppo and Tigris and Al Khabour basins. The total number of wells used for agricultural purposes is 201 259 wells that irrigate an area of 715 509 hectares distributed as indicated in Table 3.5.

Table 3.5: Number of wells and related irrigated area

Basin	No. of wells	Irrigated area (ha)
Euphrates	34 898	190 694
Coastal	30 000	12 996
Tigris & AL Khabour	35 000	314 050
Al Yarmouk	5 000	10 637
Orontos $ Al Badia	46 225	129 377
Barad & Awag	50 136	57 755

It assumed that most of these wells have been licensed under decision no. 17 of 1/8/2000 issued by the Prime Minister related to the adoption of the modern irrigation.

Table no. 2.3 indicates that all of the water basins, except for the coastal and the Euphrates basins, have faced the problem of water deficit. Deficits ranged between 94 million cubic meters in Al Yarmouk basin and 3 106 million cubic meters in Al Khabour basin due to the expansion of the irrigated area and the severe drought. Table 2.3 indicates that the coastal and the Euphrates basins are in surplus. However, this surplus may increase if Syria acquires a fair share of the Euphrates and Tigris rivers. The critical water situation of many basins (Al Khabour, Orontos, Al Badia, etc..) is largely due to a disproportionate and often uncontrolled development of wells.

3.3. Irrigation practices at farm level

Surface irrigation is the prevailing irrigation system in Syria covering 95% of the irrigated area. Basin irrigation is the predominant technique used in surface irrigation and most of the irrigated wheat and barley are irrigated by this method. Irrigation field efficiency is reportedly low often below 60%. Furthermore the construction of ridges for the basins implies a loss of productive land which could be assessed between 5 and 10% reducing further the productivity of the land. Cotton and vegetables are irrigated by furrows but because the land is rarely leveled the efficiency of such technique is also low.

Table 2.2 indicates that the average consumption of the irrigated hectare is 12434 cubic meters per year and that the average consumption of the irrigated hectare in the Euphrates

basin is 16750 cubic meters per year. This is a significantly huge quantity that necessitates a serious reconsideration of the irrigation methods and shifting to modern irrigation systems.

Several actions have been taken by the government in order to insure water conservation. These actions are implemented by decision no. 258 of 22/1/2000 issued by the Minister of Irrigation and decision no. 3 of 3/5/2000 issued by the Prime Minister related to the rehabilitation of old irrigation systems and conversion to modern irrigation. In addition to decision no. 11 of 5/7/2000 issued by the Prime Minister related to conversion to modern irrigation in four years time (see Policy matrix in chapter 4). The main objective of these decisions is to reduce the consumption of the irrigated hectare from 12 434 to 7 000 cubic meters per year. At present some 127 000 ha are irrigated by sprinkler and drip irrigation (see table 4.1)

Improving the farmers' awareness of the advantages of modern irrigation, supporting them with the required soft loans and promoting the establishment of joint irrigation networks will decrease water depletion and sources deterioration.

3.4. Management of irrigation systems and Water User Associations

The ministry of Irrigation is responsible for the planning, design and management of dams and public irrigation systems covering some 400000 ha (see table 3.2). The Directorate of Operation and Maintenance is responsible for their management. The Directorate receives the necessary funds from the Central Treasury for proper operation and maintenance of the systems. Fields interviews did not reveal shortages of funds. At the Governorate level the corresponding units of the Ministry of Irrigation were well equipped with staff and machinery for the necessary operation and maintenance work. Field interviews indicated that farmers were generally satisfied with the services received.

There are also many smalls, and some medium, irrigation systems that take water from the rivers or springs and are managed by cooperatives. In such irrigation systems land holdings tend to be very small and the cooperative is responsible for providing a large number of services to their associates. One of such services is the maintenance of the irrigation system and the distribution of the water. Other services include provision of inputs and sale of produce. Water distribution is normally organized by groups of farmers that receive water from the same canal. The water in the main canal and pumping station is managed by a hired person or sometimes by some of the leaders of the cooperative. Water to the lateral canals is generally distributed on an established rotation.

In groundwater areas most of the wells are private and water is used in the farm of the owner of the well and sometimes it includes those plots of relatives that may be located near by. Farmers that have excess water capacity in their wells sell some of the extra capacity to neighbors. Prices quoted were in the range of 6 SP/m^3.

The development of Water User Associations in public irrigation schemes is practically non existing and the need for them does not seem obvious. To assess such a need a systematic survey should be undertaken among farmers that will permit to know their level of satisfaction with the services received. In any case, it seems desirable that farmers participate

more actively in the management affairs of their irrigation systems. With this purpose Irrigation Committees could be established so that government officials and farmers representatives decide on the main policy issues that regard the managing of the irrigation systems. An Irrigation Committee is made of a variable number of members that include farmers' representatives and government officials. The number of members depends on the size of the irrigation system and normally the farmers have one representative for each secondary canal. The number of government officials is normally equal to those of the farmers and the Committee is presided by a high-level government officer. In a later stage, the representation of government officers can be reduced.

Up to the present, there are only very few positive experiences on the development of water users group. The experience of the Al-Barika farm in the North of Deir Attiah village (governorate of Deir-Ezzor) where an Irrigation Cooperative was established in 1988 with only 12 members but now has more than 550 is a well known case and considered generally as a success. On the other hand, there are some recent experiences of joint use of groundwater resources that have not been up to the expectations. This is the case of several pilot projects selected in the Alepo Governorate (Abi-Kalkal, Tal Atiah, Tal Aished,) where the common use of pivot irritation systems were tried out by a group of a farmers. While the system was technically satisfactory the social issues were not properly addressed before establishing the water user group and several management problems have arisen. Nevertheless cooperative offer good possibilities for establishing water users groups within the cooperative and make the best possible use of the available resources. This possibility should be further explored in the future.

4. ANALYSIS OF THE POLICY FRAMEWORK FOR IRRIGATION WATER

The Government of Syria has enacted in the last years a considerable amount of legal regulations and decrees that relate to irrigation water. This active legislation development evidences the importance that water resources have for the Syrian economy. From 1999 to 2001 the legal framework that affects irrigation water has been thoroughly modified and strict measures have been taken into action.

4.1. Policy matrix for irrigation water in Syria

In the policy matrix below we summarize the policies related to irrigation water in which we have included policy objectives, policy strategies, policy measures, government departments involved and legal document enacted.

The legal regulations developed recently in Syria respond to specific policy objectives that are namely: (1) Conservation of water resources, (2) Food security and food production targets, (3) Settlement of nomad population. Each policy objective is translated into several policy strategies that are implemented by different policy measures. Each policy measure is being applied by different government offices and is included in a specific legal regulation.

POLICY MATRIX FOR IRRIGATION WATER IN SYRIA (i)

POLICY OBJECTIVES	POLICY STRATEGIES	MEASURES	GOVERNMENT DEPARTMENTS	LEGAL DOCUMENT
CONSERVATION OF WATER RESOURCES (i)	Sustainable use of groundwater aquifers	Well drilling is banned in the cretassic layer Only public Ministries are allowed to drill wells in the cretassic layer for domestic water use	SAC	Decision nº 6 (17/2/2001)
		Forbidding cultivation of summer crops in the steppe areas to preserve unrenewable groundwater reserves	MAAR MI	Decision nº 30 (21/10/2000)
		Obligation to license all unlicensed wells by July 1 2001 ➔ In titled lands owned by individuals or groups properly documented ➔ In untitled lands proving ownership by certificate of MAAR ➔ In State lands when the farmer is a tenant proven by MAAR ➔ In private lands when the farmer is a tenant or sharecropper	SAC MAAR MI	Decision nº 22 (30/4/2001)
		Well drilling licensing is banned Licenses renewal for drilling new wells to replace dried-out wells is banned Well deepening licenses are subject to the conditions determined by the irrigation department of the Governorate concerned Pumping system installation is not permitted unless renewable water is available	MI	Circular nº 13 (31-8-1999) Circular nº 31 (3-6-2000)
		Installation of flow meters in wells Grant irrigation license to farmers investing in the installation of flow meters	MI MAAR	Decision nº 31 (21/10/2000)
	Cost recovery in public irrigation schemes of surface waters	Establish an irrigation fee of 3500 SP/ha for permanent irrigation and 600 SP/ha for winter irrigation (recovery of O&M costs) Establish a land reclamation fee from 2000 – 7000 SP/ha (recovery of capital costs)	SAC	Decision nº 5 (21/12/1999)

POLICY MATRIX FOR IRRIGATION WATER IN SYRIA (ii) (cont)

POLICY OBJECTIVES	POLICY STRATEGIES	MEASURES	GOVERNMENT DEPARTMENTS	LEGAL DOCUMENT
CONSERVATION OF WATER RESOURCES (ii) **(cont)**	Irrigation rehabilitation and modernization	Submit studies for adoption of pressurized pipe irrigation systems	MI	Decision nº 3 (3-5-2000)
		Rehabilitation of public irrigation schemes within a specific schedule Supply to farmers with the required equipment and inputs Agricultural Credit Bank will finance modern irrigation networks and the installation of supplementary centrifugal pumping sets on licensed wells regardless of other loans obtained by the farmers	MI ACB	Decision nº 22 (30/4/2001)
		Rehabilitation of the Al Manajeer irrigation projects in the Tigris and Al Khabour basins	MI	Decision nº 37 (21-10-2000)
		Already implemented projects should be rehabilitated to adapt to modern irrigation techniques	MI	Decision nº 258 (22-1-2000)
	Adoption of modern irrigation technologies at farm level (i)	Submit studies for adopting modern irrigation techniques for strategic crops according on water basins capacity Allocate annual budgets and provide necessary loans Quality control of equipment	MI MEFT MAAR MIN MSIT	Decision nº 3 (3-5-2000) Decision nº 21 (18-4-2001)
		Conversion from traditional irrigation methods to modern irrigation techniques in 4 years A committee is formed with all Mnistries involved Start conversion in public sector systems	SAC MAAR MEFT SPC, MI MHU	Decision nº 11 (5-7-2000)

POLICY MATRIX FOR IRRIGATION WATER IN SYRIA (iii) (cont)

POLICY OBJECTIVES	POLICY STRATEGIES	MEASURES	GOVERNMENT DEPARTMENTS	LEGAL DOCUMENT
CONSERVATION OF WATER RESOURCES (iii) **(cont)**	Adoption of modern irrigation technologies at farm level (ii) (cont)	Financing of adoption of modern irrigation by the Agriculture Cooperative Bank ➔ The Government will provide 40 000 million SP ➔ 7 years repayment period for individual projects ➔ 10 years repayment period for cooperative projects ➔ 5,5% interest rate for private farmers ➔ 4% interest rate for cooperatives ➔ 100000-85000 SP/ha for drip irrigation of field crops ➔ 45000-33000 SP/ha for drip irrigation in fruit trees ➔ 25000-20000 SP/ha for sprinkler irrigation ➔ Collateral of 85% of the loan is required Give priority for financing the projects located in the water-deficit basins (Orantes, Al-Khabour, Barada and Al-Waj) Licenses will be granted to unlicensed wells provided that modern irrigation equipment (sprinkler, drip) is installed	MAAR MI MIN MEN ACOB CFB GUP	Decision nº 17 (1-8-2000) Decision nº 29 (21-10-2000) Decision nº 25 (7-5-2001)
FOOD SECURITY **MEET FOOD PRODUCTION TARGETS**	Coordinate Agricultural Plan and strategic crops with irrigation water availability	Establishment of crop rotations and cropping patterns according to the renewable water resources, dams and reservoirs allocated for irrigation	MAAR MI	Decision nº 3 (3-5-2000)
	Development of new irrigation areas	Allow farmers in Al- Raqqa Governorate (Assilah and Al Kassair) to cultivate 1400 ha with summer crops and 2800 ha with winter crops in season 2000/2001 giving priority to barley and forage in winter crops	MAAR MI	Decision nº 30 (21-10-2000)
		All irrigation and land reclamation projects should consider the adoption of modern irrigation techniques	MAAR MI	Decision nº 258 (22-1-2000)
SETTLEMENT OF NOMAD POPULATON	Development of new irrigation areas	To ensure settlement of population in Jarwan, Arwaished and Abu Khashab it is permitted to cultivate pastoral shrubs and fodder barley not exceeding use of 1500 million m3/year for all uses, summer crops are forbidden to preserve unrenewable ground water investment in new irrigated lands by wells in the steppe trying to preserve water resources and ensure settlement of population	MAAR	Decision nº 30 (21-10-2000)

Legend: Policy matrix for irrigation water

ACB	Agricultural Credit Bank
ACOB	Agriculture Cooperative Bank
CFB	Country Farmers Bureau
GUP	General Union of Peasants
MAAR	Ministry of Agriculture and Agrarian Reform
MEFT	Ministry of the Economy and Foreign Trade
MEN	Ministry of Environment
MHU	Ministry of Housing and Utilities
MI	Ministry of Irrigation
MIN	Ministry of Industry
MSIT	Ministry of Supply and Internal Trade
SAC	Supreme Agricultural Council
SPC	State Planning Commission

Within the policy objective of conserving water resources in Syria two of the major policy strategies are the development of new irrigation areas and the modernization of irrigation techniques at farm level. Some relevant figures of these tow polices are summarized below.

4.2. Development of new irrigation areas

The development of new irrigation in the public sector has been important increasing from 219273 ha in 1993 ha to 396518 in 2000 at a rate of 25000 ha/year. Most of the new systems are made of line canals from the headwork to the farm gate. Unfortunately the use of pressurized networks is still rather infrequent.

4.3. Adoption of modern irrigation technologies at farm level

GOS (Government of Syria) decided that all irrigated areas will be equipped with modern irrigation techniques in 4 years. This means that 1149349 ha will have to adopt them in 4 years which gives a rate of adoption of 287337 ha/year. This modernization policy should reduce water use from 12434 m3/ha to 8000 m3/ha.

The present adoption of these technologies for the last two years is summarized in Table 4.1.

Table 4.1: Area under sprinkler and localized irrigation

Year	Localized (ha)	Sprinkler (ha)	Total (ha)	Increment by year (ha)
1998	4339.3	65052.9	69392.2	
1999	8553	80480	89033	19640.8
2000	16087.7	110631.3	126719	37686

Some efforts are being made by the Extension Department of the Ministry of Agriculture to promote the adoption of these technologies by broadcasting TV and radio programs that emphasize the advantages of such technologies.

5. ADOPTION OF MODERN IRRIGATION TECHNOLOGIES

5.1. Introduction

The assessment of the effects of the adoption of modern irrigation technologies requires a disaggregated farm level analysis that will complete the analysis at aggregated and basins' levels that was presented in chapter 2. For this purpose different policy scenarios have been simulated that correspond to the adoption of different irrigation techniques under various types of water sources and types of farms that respond to the structural and agronomic characteristics of the irrigation agriculture in several regions in Syria.

5.2. Analysis at farm level. Field survey and information processing

A typology of farms has been built to represent the Syrian irrigated agriculture in different regional environments. Representative farms were selected based upon the statistical data available, according to farm size, production potential, factor allocation, cropping pattern and type of water source. Different alternatives for adopting modern irrigation techniques were considered to permit to evaluate the effects that the investments in new irrigation equipment will have on the financial results of different farm types and water sources.

Table 5.1 shows the distribution of irrigated holdings by size (area classes) for groundwater and surface water sources. As the area classes definition was rather confusing and is still under revision at the Bureau of Statistics, we have defined, based on the official figures and on our own estimations, three levels of aggregated strata with a high level of representation that have been used to define the representative farms. These aggregated strata are shown on table 5.1.

Table 5.2 shows the aggregated strata that were selected to define the representative farms with an adequate level of representativity. These strata include roughly 80 of the irrigated area and 70% of the irrigated holdings.

Table 5.1 Distribution of irrigated holdings by farm size strata (all water sources)

IRRIGATED HOLDINGS ACCORDING TO WATER SOURCE (area in donum)							
	GROUNDWATER		SURFACE WATER		TOTAL		
AREA CLASSES	Nº of holdings	Area	Nº of holdings	Area	total nº of holdings	total area	average size
1	3314	4201	1627	2024	4941	6225	1,26
2	12136	33502	8672	25332	20808	58834	2,83
5	17112	87008	14364	84601	31476	171609	5,45
10	25066	232443	21983	239687	47049	472130	10,03
20	31919	549067	29004	625166	60923	1174233	19,27
>10 - <20	**56985**	**781510**	**50987**	**864853**	**107972**	**1646363**	15,25
40	18312	482620	11259	358872	29571	841492	28,46
60	20889	821105	9458	421022	30347	1242127	40,93
100	15357	930076	4156	241575	19513	1171651	60,04
150	9209	750730	2514	179478	11723	930208	79,35
>40- <80	**45455**	**2501911**	**16128**	**842075**	**61583**	**3343986**	54,30
200	9972	1051323	2053	197005	12025	1248328	103,81
300	7651	1135294	1349	168723	9000	1304017	144,89
500	3397	774186	567	103813	3964	877999	221,49
>100 - <250	**21020**	**2960803**	**3969**	**469541**	**24989**	**3430344**	137,27
1000	1156	467426	142	53504	1298	520930	401,33
3000	130	207073	19	11726	149	218799	1468,45
	175620	7526054	107167	2712528	282787	10238582	36,21

Source: Own elaboration based on data of the Bureau of Statistics (1994 census)

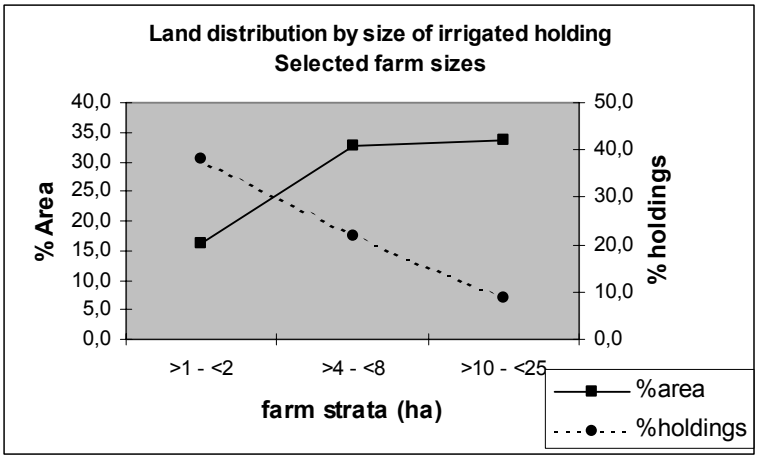
Table 5.2 Selection of representative farms by area and number of holdings

farm size (ha)	average farm size (ha)	%area	%holdings	representative farms (ha)
>1 - <2	1,52	16,08	38,18	1,5
>4 - <8	5,43	32,66	21,78	5
>10 - <25	13,73	33,50	8,84	14
total		82,24	68,80	

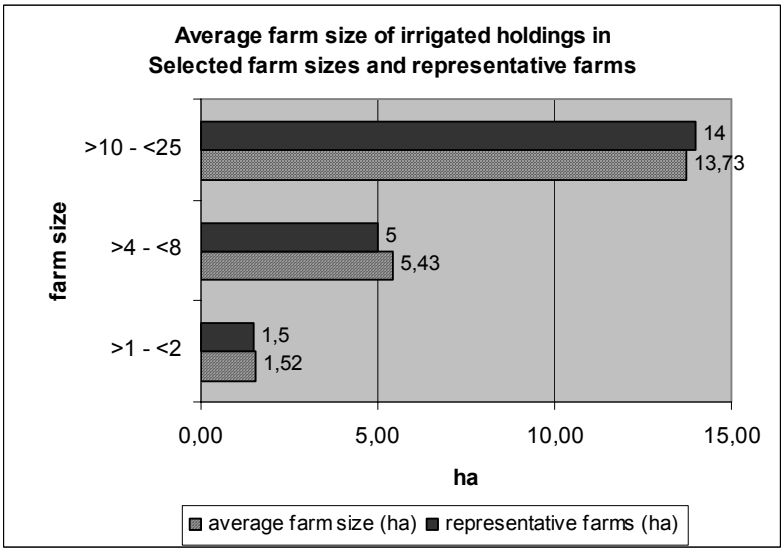
Graph 5.1 depicts the relationship between the percentage occupation of irrigated lands and the number of irrigated holdings in the selected farm sizes (area classes or strata). Land sizes are not extremely dispersed in Syria as shown in graph 5.1. For this reason as small irrigated farms are numerous, accounting for 30% of all farms, they occupy a rather large share of the total irrigated surface in the country (15%). As the farm size increases the percentage of occupied land increases and the number of holdings diminishes. The average irrigated farm in Syria is 3,6 ha and it represents very closely the most balanced farm size class. In fact, farms of around 3 ha in size occupy approximately one forth of all irrigated lands in Syria and the same percentage holds for the number of holdings.

Graph 5.2 shows the average size of the farms in the selected size strata and the size of the representative farms. We can see that small holdings ranging from 1 to 2 ha, where the average irrigated farm size is 1,52 ha, account for 16% of total irrigated area in Syria and represent 38% of all irrigated holdings. Medium size farms ranging from 4 to 8 ha, with an average farm size is 5,4 ha, represent 33% of all irrigated surface and 22% of all holdings in the country. Large farms of 10-25 ha account for 33 % of total irrigated area and for 8% of all irrigated holdings.

Graph 5.1- Percentage of area and number of holdings in the selected farm sizes



Graph 5.2. Average farm size of the selection of farm sizes and the representative farms



A field survey was conducted in set of 48 irrigated farms in the Hama Governorate which permitted to accede to direct farm-based information that was used for the definition of the technical parameters, cropping pattern, farm size, water use and irrigation techniques in the farm models. Field survey data provided also the data base for obtaining the irrigation cost parameters in all the irrigation techniques alternatives in the farm models.

5.3. Results of the analysis undertaken

5.3.1. Farm models: Farm typology, water source and irrigation technologies (basic features)

The farm typology defined in the previous section (Table 5.2 and Graph 5.2) is intended to represent the irrigation agriculture in Syria and features the characteristics of distinctive agricultural regions in the country. It consists on three selected representative farms according to the data available of size and number of irrigated holdings as defined in table 5.2. These farms are a large extensive farm of 14ha, a medium size semi-intensive farm of 5 ha and a small intensive farm of 1,5 ha, which together represent 77 % of all irrigated holdings and 64% of the irrigated surface. The general characteristics of the farms are the following:

Table 5.3: General characteristics of the representative farms

Farm type	Size (ha)	Cropping pattern		Region
Large farm	14	Wheat Cotton	70% 30%	Al-Hassake
Medium size farm	5	Wheat Cotton Potato Sugar Beet	50% 20% 15% 15%	Hama
Small farm	1.5	Tomato Potato Oranges	50% 25% 25%	Lattakia

Water sources in the different types of farms include surface water from rivers and underground water from wells of 200 m, 100 m and 50m. depth. Irrigation costs were calculated for all the different alternatives using field data information.

Irrigation techniques include traditional surface irrigation and modern sprinkler and drip irrigation. The combination of farm types, water sources and irrigation techniques has resulted in an ample number of farm models (crop budgets and farm budgets) which has permitted to compare the effects of the adoption of modern technologies for irrigation across farm structures and water sources.

The farm models simulated are sown in table 5.4

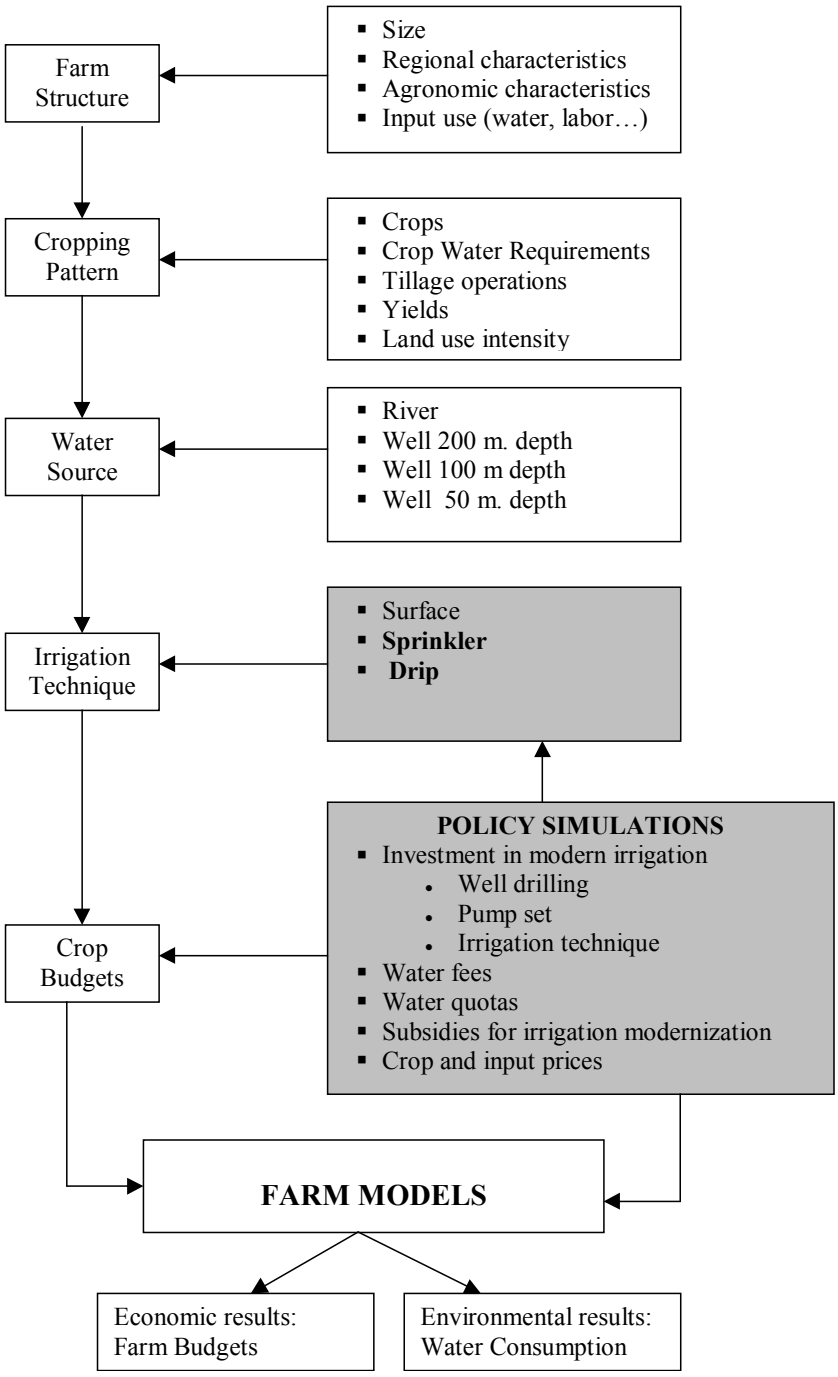
Table 5.4 Simulated Farm Models

FARM MODEL	DESCRIPTION
LARGEFARM-R-S	Large Farm, river water, surface irrigation, no investment in modern irrigation
LARGEFARM-R-MS	Large Farm, river water, modern irrigation: Sprinklers
LARGEFARM-R-MD	Large Farm, river water, modern irrigation: Drip
LARGEFARM-R-W100-S	Large Farm, water from well 100m , surface irrigation, no investment in modern irrigation
LARGEFARM-W100-MS	Large Farm, water from well 100m , investment in modern irrigation: sprinklers
LARGEFARM-W100-MD	Large Farm, water from well 100m , investment in modern irrigation: drip
LARGEFARM-R-W200-S	Large Farm, water from well 200m, surface irrigation, no investment in modern irrigation
LARGEFARM-W200-MS	Large Farm, water from well 200m, investment in modern irrigation: sprinklers
LARGEFARM-W200-MD	Large Farm, water from well 200m, investment in modern irrigation: drip
MEDIUMFARM-R-S	Medium Farm, river water, surface irrigation, no investment in modern irrigation
MEDIUMFARM-R-MS	Medium Farm, river water, modern irrigation: Sprinklers
MEDIUMFARM-R-MD	Medium Farm, river water, modern irrigation: Drip
MEDIUMFARM-R-W100-S	Medium Farm, water from well 100m, surface irrigation, no investment in modern irrigation
MEDIUMFARM-W100-MS	Medium Farm, water from well 100m, investment in modern irrigation: sprinklers
MEDIUMFARM-W100-MD	Medium Farm, water from well 100m , investment in modern irrigation: drip
SMALLFARM-R-S	Small Farm, river water, surface irrigation, no investment in modern irrigation
SMALLFARM-R-MS	Small Farm, river water, modern irrigation: Sprinklers
SMALLFARM-R-MD	Small Farm, river water, modern irrigation: Drip
SMALLFARM-R-W50-S	Small Farm, water from well 50 m , surface irrigation, no investment in modern irrigation
SMALLFARM-W50-MS	Small Farm, water from well 50 m , investment in modern irrigation: sprinklers
SMALLFARM-W50-MD	Small Farm, water from well 50 m, investment in modern irrigation: drip

Annex 4 includes a selection of farm models and crops and the final farm budgets and crop budgets are shown for the mentioned selection. Annex 6 explains the way the database has been organized to use it for training purposes and to further simulated other types of scenarios.

The methodology used in this analysis is summarized in the following scheme:

Methodological Scheme for farm level analysis



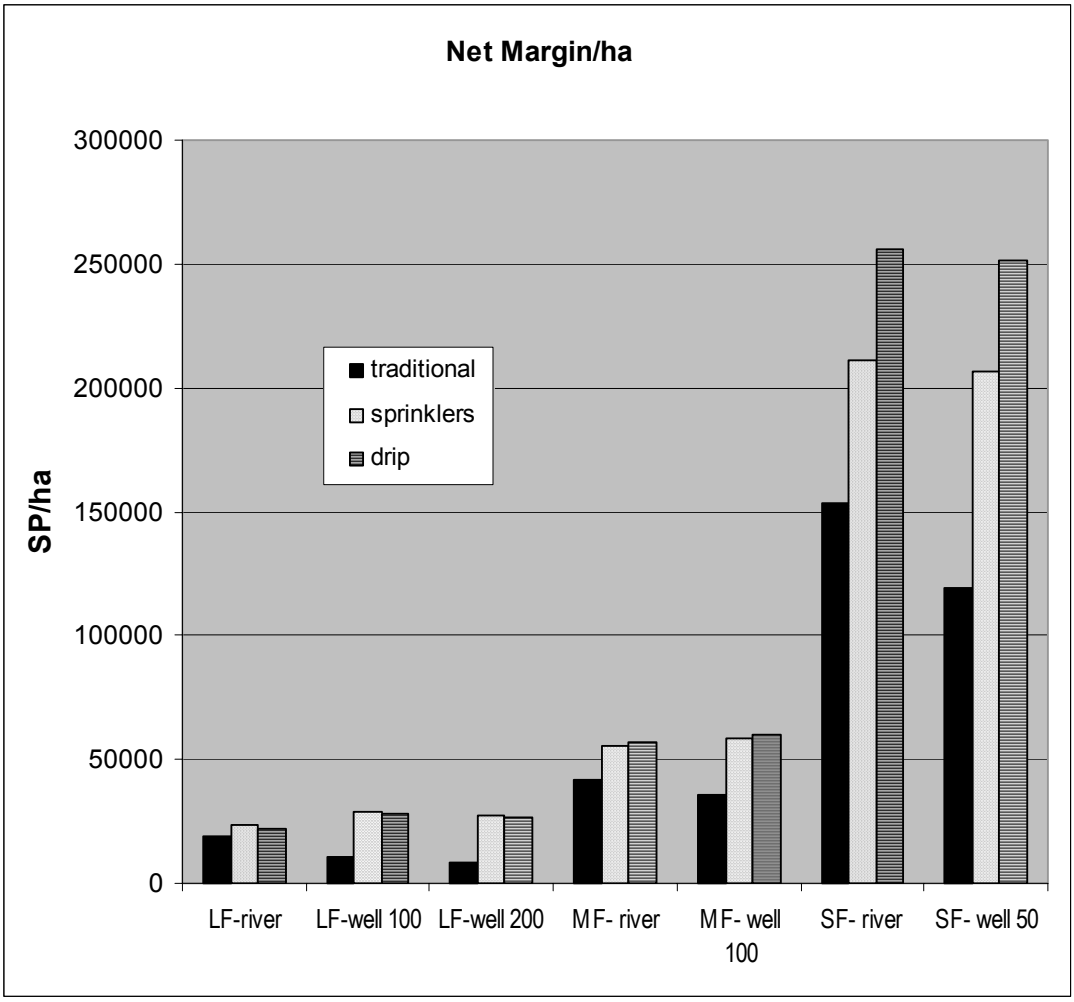
5.3.2. Effects of the adoption of different irrigation technologies by type of farm and water source (surface and ground water)

Comparative effects by farm types

The effects of the adoption of modern irrigation on farm profit is shown on Graph 5.3 (for net margin/ha) and in more detail on table 5.5 (for net and gross margin/ha) . As results show, the adoption of modern irrigation can be substantially different in the large, medium and small farms evidencing that structural parameters and cropping patterns are determinant and hence regional characteristics. Small intensive farms growing fruits and vegetables seem to be best suited for adopting modern irrigation techniques, especially drip irrigation. So, these farms have the largest profit by ha, three times higher than medium size farms and eight times higher than extensive large farms when traditional surface irrigation is used. When drip irrigation is adopted these differences increase and farm profit is five times higher in the small farms than in the medium size farms and ten times higher than in the large extensive farms. Large extensive farms irrigated by wells show, in general, a substantial increase in farm profit when adopting modern irrigation methods. However, as this result is due to initial low farm profits, it remains questionable whether these farms will be able to finance fully the adoption of these techniques unless a change in the cropping pattern is foreseen.

Across all farm types, the kind of water source (surface or underground water) determines also the profitability of adopting modern irrigation methods. In general river water from the government irrigation networks has a lower cost than underground water abstracted from wells. River water is charged by a nation-wide O&M flat fee of 3500 SP/ha and a basin-specific land reclamation fee that ranges from 2000 SP/ha to 6000 SP/ha. O&M costs for extracting water from wells are volumetric costs that range from 0,8 SP/m3 to 2,37 SP/m3 depending on the well depth and the type of energy used for pumping. Hence, the adoption of water-saving modern irrigation technologies results in larger increases in farm profits when water is extracted from wells as volumetric water costs are substantially reduced. It can be concluded from the comparative analysis that for assessing the effects of the adoption of modern irrigation technologies it has to be taken into account the interaction of the structural characteristics of the farm, the cropping pattern (determined by the agronomic conditions and the agricultural policies) and the irrigation technologies.

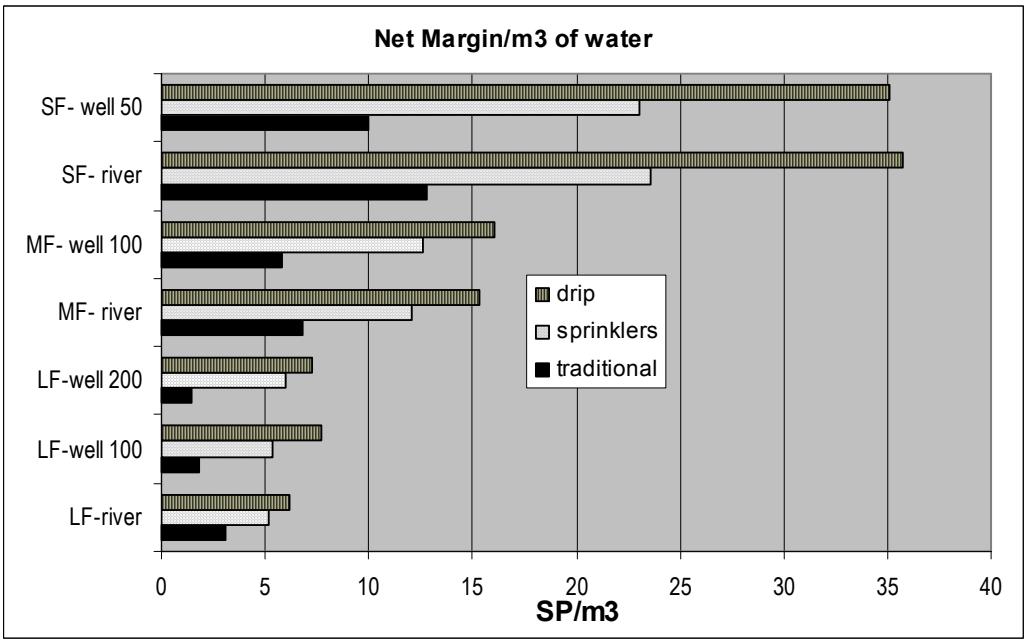
Graph 5.3 Financial effects of modern irrigation technologies by farm type



LF: large farm; MF: Medium farm; SF: small farm
(the complete definition of the farm models is shown in table 5.4 in the previous section)

Graph 5.4 shows the results on financial returns of water (net margin/m3 of water) and table 5.6 shows more detailed financial results (gross margin/m3 and net margin/m3). We can see that for all farm types, the adoption of modern irrigation techniques increases substantially both gross margin per m3 of water and net margin per m3 of water. However, differences between these two techniques are evidenced, and in the case of sprinklers increases range from 55 to 125% as in the case of drip irrigation these figures double ranging from 116 to 218%.

Graph 5.4 Financial returns of water by type of farm, irrigation technique and water source



Adoption of modern irrigation techniques in the large farm (table 5.5)

In the large farm irrigated by river water, farm profits increase moderately when modern irrigation techniques are adopted. From a net margin per ha of 18683 Sp/ha in surface irrigation to 23395 SP/ha in the case of sprinkler irrigation and 22387 SP/ha in drip irrigation. If water is extracted from wells of 100 m. depth, modern irrigation results in higher farm profit increases, passing from 10752 SP/ha in surface irrigation to 29127 SP/ha in sprinklers and 28212 SP/ha in drip irrigation due to the decrease in irrigation costs inbuilt in the modern water saving techniques as water costs depend on the volumes of extracted water. This tendency is reinforced as water becomes more expensive in deep wells of 200 m. depth. These results show that in this type of extensive farm sprinkler irrigation is more suitable than drip irrigation although sprinklers cannot be used along the whole growth period of cotton.

Adoption of modern irrigation in the medium size farm (table 5.5)

Medium size semi-intensive farms irrigated by river water increase farm profits by 33% when sprinkler irrigation is adopted (from 41911 SP/ha to 55797 SP/ha) and by 36% when drip irrigation is adopted (to 56949 SP/ha). These results evidence that drip irrigation is more suited for a more intensive cropping pattern (that includes potato). In medium size farms irrigated by wells, the adoption of sprinkler or drip irrigation results in a double increase in farm profits (64% and 67% respectively) than in the case of river water (from 35627 SP/ha to 58477 SP/ha for sprinklers and 59628 SP/ha for drip). The advantages of drip irrigation are reinforced as volumetric water savings are greater in this type of technology.

Adoption of modern irrigation in the small farm (table 5.5)

In the case of the small intensive farm, that grows mainly fruits and vegetables, the comparative efficiency of adopting drip irrigation is further evidenced both for surface river water and for underground water. Farm profits increase by 38% if sprinkler irrigation is adopted and 67% if drip irrigation is selected (from 153087 SP/ha to respectively 210985 SP/ha and 255962 SP/ha) in the case of surface water. If irrigation water is extracted from shallow 50 m wells (in accordance with the regional characteristics of the selected small farm), farm profits increase by a double amount, 67% in the case of adoption of sprinkler irrigation and 111 % in drip irrigation (from 119164 SP/ha to respectively 206304 SP/ha and 251478 SP/ha).

Comparative effects by types of crop

Table 5.7 shows the effects of the adoption of modern irrigation technologies in the different crops (crop budgets) that have been considered in the various farm models. The results show that for the same crop (e.g. wheat) grown under different types of farms and thus different tillage operations, the crop benefits (net margin/ha) are larger as farm intensification takes place. In the case of wheat and cotton that are grown in large and medium size farms, the adoption of modern irrigation increases substantially crop benefits. In wheat, sprinkler irrigation (which is the more adapted technology) doubles crop benefits (from 23080 SP/ha to 48710 SP/ha) and in cotton, drip irrigation (more suited than sprinklers) also closely doubles crop benefits (58627 SP/ha to 109810 SP/ha). Higher benefits are found in the intensive orange groves of the small farms where adopting drip irrigation more than doubles net margin/ha than in the case of traditional techniques (from 155529 SP/ha to 312270 SP/ha).

These result trends are further reinforced by the results of the financial returns of water shown in Table 5.8 where we can observe that net margin/m3 of water doubles when modern irrigation techniques are adopted in most of the crops. Even more so in the case of highly intensive crops, such as oranges, where returns of water amount to 14,3 SP/m3 in the case of surface irrigation and rise to 50 SP/m3 when drip irrigation is installed.

Table 5.5: Financial effects of irrigation techniques by type of farm and water source

TYPE OF FARM	WATER SOURCE	GROSS MARGIN (SP/HA)			% Increase Sprinklers	% Increase Drip	NET MARGIN (SP/HA)			% Increase Sprinklers	% Increase Drip
		Traditional Irrigation technique	Modern Irrigation technique				Traditional Irrigation technique	Modern Irrigation technique			
		Surface	Sprinklers	Drip			Surface	Sprinklers	Drip		
Large	River	37861	44126	48989	17	29	18683	23395	22387	25	20
	Well 100 m	27815	47047	52010	69	87	10752	29127	28219	171	162
	Well 200 m	27033	46493	51557	72	91	8671	27274	26467	215	205
Medium	River	68676	84426	91359	23	33	41911	55797	56949	33	36
	Well 100 m	58647	87813	94747	50	62	35627	58477	59628	64	67
Small	River	241034	299217	349261	24	45	153087	210985	255962	38	67
	Well 50 m	218094	302219	352460	39	62	119164	206304	251478	73	111

Table 5.6 – Financial returns of water by type of farm, water source and irrigation technique

TYPE OF FARM	WATER SOURCE	GROSS MARGIN /m3 OF WATER (SP/m3)			% Increase: Sprinklers	% Increase: Drip	NET MARGIN /m3 OF WATER (SP/m3)			% Increase: Sprinklers	% Increase: Drip
		Traditional Irrigation technique	Modern Irrigation technique				Traditional Irrigation technique	Modern Irrigation technique			
		Surface	Sprinklers	Drip			Surface	Sprinklers	Drip		
Large	River	6,23	9,67	13,43	55	116	3,07	5,13	6,14	67	100
	Well 100 m	4,57	10,31	14,25	126	212	1,77	5,34	7,73	202	337
	Well 200 m	4,45	10,19	14,13	129	218	1,43	5,98	7,25	318	407
Medium	River	11,12	18,23	24,66	64	122	6,79	12,05	15,37	77	126
	Well 100 m	9,5	18,96	25,57	100	169	5,77	12,63	16,09	119	179
Small	River	20,18	33,4	48,73	66	141	12,82	23,55	35,71	84	179
	Well 50 m	18,26	33,74	49,18	85	169	9,98	23,03	35,09	131	252

Table 5.7 Effects of irrigation technologies on crop budgets by type of farm and water source

			FINANCIAL RESULTS BY AREA					
CROP	FARM TYPE	WATER SOURCE	GROSS MARGIN /ha (SP/ha)			NET MARGIN /ha (SP/ha)		
			Traditional Irrigation technique	Modern Irrigation technique		Traditional Irrigation technique	Modern Irrigation technique	
			Surface	Sprinklers	Drip	Surface	Sprinklers	Drip
WHEAT	Large	River	26277	30270	33956	13663	19673	23595
		Well 100 m	20897	33439	37191	8283	22841	26830
		Well 200 m	20415	33107	36926	7801	22510	26565
	Medium	River	39650	55560	61098	29300	45210	50748
		Well 100 m	33430	59060	64598	23080	48710	54248
COTTON	Large	River	64892	75433	84426	46231	57549	66704
		Well 100 m	44309	78034	87207	25649	60150	69485
		Well 200 m	43002	77135	86488	24341	59251	68766
	Medium	River	107475	122280	132369	70665	95492	106301
		Well 100 m	87215	125780	135869	58627	98992	109801
SUGAR BEET	Medium	River	90125	110405	118349	43375	63155	72299
		Well 100 m	80665	113905	121849	33915	66655	75799
POTATO	Medium	River	73913	106768	116903	39813	74268	85363
		Well 100 m	65533	110268	120403	31433	77768	88863
	Small	River	117325	153363	186055	64709	104293	137931
		Well 50 m	101295	156120	188961	48679	107050	140837
TOMATO	Small	River	195078	238407	275857	125525	174764	213160
		Well 50 m	178373	241139	278743	108820	177496	216045
ORANGES	Small	River	258075	329399	385534	175565	252405	309486
		Well 50 m	238039	332004	388319	155529	255010	312270

Table 5.8 Financial returns of water on crop budgets by type of farm and water source

			FINANCIAL RESULTS BY VOLUME					
CROP	FARM TYPE	WATER SOURCE	GROSS MARGIN /m3 OF WATER (SP/m3)			NET MARGIN /m3 OF WATER (SP/m3)		
			Traditional Irrigation technique	Modern Irrigation technique		Traditional Irrigation technique	Modern Irrigation technique	
			Surface	Sprinklers	Drip	Surface	Sprinklers	Drip
WHEAT	Large	River	6,54	10,04	14,09	3,4	6,53	9,79
		Well 100 m	5,2	11,1	15,43	2,06	7,58	11,13
		Well 200 m	5,08	10,99	15,32	1,94	7,47	11,02
	Medium	River	8,81	16,46	22,63	6,51	13,4	18,8
		Well 100 m	7,43	17,5	23,93	5,13	14,43	20,09
COTTON	Large	River	5,95	9,23	12,91	4,24	7,04	10,2
		Well 100 m	4,07	9,55	13,34	2,35	7,36	10,63
		Well 200 m	3,95	9,44	13,23	2,23	7,25	10,52
	Medium	River	9,77	14,82	20,06	6,42	11,57	16,11
		Well 100 m	7,93	15,25	20,59	5,33	12	16,64
SUGAR BEET	Medium	River	15,02	24,53	32,87	7,23	14,03	20,08
		Well 100 m	13,44	25,31	33,85	5,65	14,81	21,06
POTATO	Medium	River	13,44	25,88	35,43	7,24	18	25,87
		Well 100 m	11,92	26,73	36,49	5,72	18,85	26,93
	Small	River	13,04	22,72	34,45	7,19	15,45	25,54
		Well 50 m	11,26	23,13	34,99	5,41	15,86	26,08
TOMATO	Small	River	20,95	34,14	49,38	13,48	25,03	38,16
		Well 50 m	19,2	34,5	49,9	11,7	25,4	38,7
ORANGES	Small	River	23,79	40,49	59,24	16,19	31,03	47,56
		Well 50 m	21,9	40,81	59,67	14,3	31,35	47,99

Table 5.9 Irrigation costs by type of farm, water source and irrigation technique

TYPE OF FARM			IRRIGATION COSTS				
FARM TYPE	WATER SOURCE	IRRIGATION TECHNIQUE	Average IWR	Total irrigation cost	Irrigation investment costs/ha	O&M/ha	%O&M/GM
Large	River	surface	6082	115500	4750	3500	9
		sprinklers	4561	288512	7529	13079	30
		drip	3649	349188	13779	11163	23
	Well 100 m	surface	6082	225064	2635	13441	48
		sprinklers	4561	207172	4718	10080	21
		drip	3649	266700	10986	8064	16
	Well 200 m	surface	6082	253456	3934	14170	52
		sprinklers	4561	232386	6017	10582	23
		drip	3649	290262	12267	8466	16
Medium	River	surface	6125	28000	2100	3500	5
		sprinklers	4631	98185	6133	13504	16
		drip	3705	119430	12383	11503	13
	Well 100 m	surface	6175	90480	4758	13338	23
		sprinklers	4631	84225	6841	10004	11
		drip	3705	105470	13091	8003	8
Small	River	surface	11945	5500	2000	3500	1
		sprinklers	8959	31723	8983	22740	8
		drip	7167	34300	15233	19067	5
	Well 50 m	surface	11945	38903	12983	25920	12
		sprinklers	8959	36016	16666	19350	6
		drip	7167	38396	22916	15480	4

6. CONCLUSIONS AND GENERAL OBSERVATIONS

6.1. On water resources

The present water balance for the SAR is negative with a deficit of –3104 Mm3. Growing population at fast rate will put additional demand on the existing resources which are not enough to satisfy existing demand. The development of new water resources seems very limited considering that Syria has developed already 164 dams. Therefore much of the present and future water policy will have to rely on the demand management. Restoring a positive water balance in the future appears as an important policy objective that will require some drastic measures in some of the existing basins where the deficit has reached alarming proportions.

6.1.1. A water policy addressed to modernize the existing irrigation areas will lead to a positive national water balance by the year 2012. However this policy will require the importation of some crops to maintain food security.

6.1.2. When modernization policies are combined with the expansion of irrigated areas in the order of 420000 ha for the period of 15 year period water balances tend to revert to the initial values (Scenario 1) or produce only a moderate reduction of the deficit (Scenario 3).

6.1.3. The fact that some basins have quite large deficits while others have positive balances indicates the need for a differentiated policy whereby modernization will concentrate in those with high deficits while development of new areas will only be permitted in those having positive balances. Scenario 4 presents one of such policies which allows to get relatively close to a positive balance. The expansion of the irrigated area will be limited to some 165000 ha. A possible agreement with Turkey regarding the flow available at the border could provide the basis for additional expansions of the irrigated area in the Euphrates basin.

6.2. On the adoption of modern technologies

6.2.1. The rate of adoption by farmers during 1999 was 37686 ha/year with an increment of 92% over the previous year. In spite of this remarkable increment the present rate is much lower than the expected rate of 287337 ha/year. World-wide experience indicates that such target may be difficult to achieve considering that rates of 80000 ha/year are considered already high.

6.2.2. Field surveys indicate that farmers of remote areas are not well informed of the advantages and financial terms for purchasing irrigation equipment. They have also expressed that limited access to credit and uncertainty about future financial results influence their resistance to adoption.

6.2.3. Adoption of the technique does not necessarily imply that water savings will take place unless equipment is properly used. Even if the equipment is used properly farmers may wish to plant more area or crops that are more water consuming. Training is an indispensable component of the adoption program in order to achieve expected results.

6.2.4. Existing experiences indicate that the training of farmers in the use of this techniques requires between 2-4 days of trainer/ha. When this extrapolated to the area to be modernized the training needs are very large.

6.2.5. Farmers request for financial assistance from the Cooperative Bank are normally routed through the technical staff of the Water Management Section of the Ministry of Agriculture at Governorate level and this calls for sufficient staff properly qualified to undertake this function.

6.2.6. Adoption of theses modern technologies are mostly in the irrigated areas by wells due to the certainty of having the water when necessary and this trend is likely to continue if it is not modified by external factors (differentiated subsidies e.g.)

6.2.7. Adoption of modern irrigation systems in public surface irrigation systems will present technological problems as most of the irrigation networks work in a rotation system that makes water available to the farm on turns of variable duration. Such modality is not compatible with the use of sprinkler and drip irrigation systems that require a frequent water supply (daily or every 2-3 days). Therefore the existing irrigation networks will have to be adapted to this technical requisite.

7. RECOMMENDATIONS

7.1. Water balances

1. A differentiated water basin policy would offer the best opportunity to reduce the imbalances among basins. In principle such policy should consist of an intensive plan of modernization in the most critical basins with lower pace of implementation on those where the deficit is of smaller magnitude. The intensification plan of modernization in the Al Khabour and Orantes basins could aim to modernize the total irrigated area by wells in a period of 8 years with an approximate rate of 55000 ha per year (39000 ha/year in Al Khabour and 16000 ha/year in Orontes). In the water basins where the balance is positive, development of new irrigation can take place limited to the area that can be developed by the existing positive water balance. The first approximation of the Scenario 4 shows that development of new areas could be in the range of 11000-13000 ha/year but elaboration of more detailed scenarios will be required to define these targets more precisely.

2. The implementation of the above recommendation in the Al Khabour and Orontes basins will no be sufficient to re-establish a positive balance in the time span considered and therefore additional measures will be required to achieve a sustainable balance.

7.2. Modernization of groundwater irrigated areas

3. The analysis made at farm level shows that the adoption of the modern irrigation techniques is financially attractive in most cases. However this may not be sufficient to ensure their rapid adoption in the critical basins where water balances are highly negative. Therefore the GOS should adopt some measures that will contribute to accelerate the rate of adoption in these basins. Experience word wide indicates that subsidies of different kind are practiced in many countries for the adoption of these techniques. The level of subsidy practiced reaches up to 50% of the total investment costs in some cases. Some countries practiced different ways of achieving this subsidy. Justification of this 'water conservation subsidy' will be the replenishing of the aquifers (Environmental justification). Furthermore, this subsidy will put groundwater farmers in a similar situation to the farmers using surface waters since they have enjoyed traditionally a certain level of subsidies in the provision of water to their farms. The establishment of the level of subsidy would require some in depth analysis with detailed field information.

4. Adoption of modern irrigation technologies in farms irrigated by well in the Al-Khabour and Orontes basin will not be sufficient to restore a positive balance in the basin and more restrictive measures will be required. Such measures may either be:

   - Limiting the amount of water/ha that can be used in every well considering the aquifer's recharge rate and penalizing those that exceed it with a penalty fee. However, the implementation of this measure requires the installation of flow meters.

- Establish the equivalence between the maximum permitted water quantity per ha and the area that can be planted of different crops according to different technologies. This is refered to as a *water/crop quota system* and it will permit the farmers to chose their cropping pattern within an established quota of water and have it approved by the government authorities. In order not to distort the national objectives of strategic crops' production, the government can establish support prices for strategic crops to achieve those objectives. This water/crop quota system could be implemented gradually over a 5 years period. An example of the water/crop quota system is illustrated below:

Example of a water/crop quota system for a water allocation of 4000 m3/ha (first year)

Irrigation Technique	Wheat	Cotton	Sugar beet	Sunflower seeds	Barley
Traditional irrigation	0,9ha	0,25 ha	0,6	0,9 ha	0,90 ha
Sprinkler irrigation	1,20 ha	0,35 ha	1,0	1,20 ha	1,20 ha
Drip irrig ation	1,20 ha	0,45 ha	1,1	1,30 ha	1,20 ha

Example of a water/crop quota system for a water allocation of 2700 m3/ha (fifth year)

Irrigation Technique	Wheat	Cotton	Sugar beet	Sunflower seeds	Barley
Traditional irrigation	0,60ha	0,15 ha	0,5	0,6 ha	0,60 ha
Sprinkler irrigation	0,90 ha	0,25 ha	0,70	0,74 ha	0,84 ha
Drip irrigation	0,90 ha	0,40 ha	0,77	0,90 ha	0,84ha

- Closing wells that do not fulfill criteria (efficiency, unauthorized, double source of water, unsuitable water quality, etc.)
- Choosing the right combination of measures will require more detailed information about the hydrological characteristics of the basins and the present use of the water (inventory of the existing wells) but considering that installation of flow meters may take some time to implement the most feasible alternative in the short run would be to control the permitted quantity of water as indicated before.

5. None of these measures will be easily accepted by farmers as they will perceive them as a reduction of their income. Enforcement of some of them may cause social unrest and result in limited implementation. Any such measure should be accompanied by some financial incentives to decrease the resistance for their adoption. (Recommendation 3) Furthermore, discussions with farmers groups should take place before arriving to their implementation.

6. Modernization of farms where wheat and cotton are traditionally grown present the technical problem that sprinkler irrigation is suitable for wheat but not adequate for all phases of crop development of cotton. The inverse applies for drip irrigation. The water/crop quota system provides a good basis for solving this serious technical limitation as farmers can choose the most suitable cropping pattern to their irrigation techniques.

7. Operating cost of electrified wells are about the half of those using different types of fuel. Considering that irrigation cost represent an important percentage (sometimes up to 50 %) of the gross margin it would be important to pursue an electrification policy of the wells in order to increase the financial margin of the respective farms and make them more competitive. This policy will be limited by the cost of transporting the electricity to remote places which would offset the benefits from the reduced operating costs.

8. Monitoring and control of the adoption of modern irrigation techniques will be advisable for the assessment of the impact at farm, regional and national level. Considering that the adoption of these techniques has different financial effects on different types of farms (size, cropping pattern, productive potential and water source) adequate statistical information and data bases at farm level should be developed.

7.3. Modernization of surface irrigated areas

9. Adoption of modern irrigation techniques will be limited by the existing characteristics of the networks. They will have to be modernized essentially by replacing the existing canals by pipes and installation of pumping stations that will put the system under pressure. To carry out such transformation it will advisable to start by the older systems that have lower efficiency.

10. It is estimated that some 265000 has of public irrigation systems were developed in the last 10 years and have acceptable levels of efficiency where it would not be advisable to implement the modernization of the irrigation networks until later in the future. In these systems precision land leveling will be the most suitable modernization technique.

11. Measuring of water delivery contributes effectively to reduce water use. It is recommended that in the areas where modernization will not take place in the early years, that measuring devices (Parshall, cut-throat and others) be installed and water delivered according to acceptable water consumption standards.

12. Although it is difficult to change the distribution water system in existing irrigation networks from a rotation to continuous supply it is possible in some cases and there are models that permit to simulate such transformation. It is recommended that such transformation be studied in one selected irrigation system and if results are positive a real implementation can be carried out so that farmers may have a continuos access to water and be able to adopt modern irrigation techniques.

13. In the remaining area (131518 ha) of the public systems (old systems) modernization of the networks should take place and subsequent adoption of modern irrigation techniques. It is possible that some of these networks present some local difficulties and not all of them be suitable for modernization. Therefore a conservative target could be in the order of 100 000 ha for the 15 years period.

14. For the private irrigated lands from rivers and springs (164061 ha) transformation to modern irrigation method should be technically possible and financially attractive. As these systems are not generally located in areas of critical shortage of water their

modernization could take place at a moderate rate in the period of 15 years, i.e. 10937 ha/year.

7.4. Irrigation expansion

15. As most of the aquifers in Syria are overexploited expansion of irrigated area should take place essentially in basins where the water balance is positive, i.e Euphrates and Tigris and Coastal basins. The area to be developed is in the order of 170 000 ha for the period of 15 years according to the Scenario 4. This amount could be increased if favorable agreements are reached with Turkey regarding the flows to be released in the Euphrates and Tigris rivers.

7.5. Training and extension

16. An intensive training program should accompany the implementation of the modernization targets. The training program should be addressed to the following recipients:
    - Farmers
    - Extension agents
    - Professionals from the public and private sector to increase the design and implementation capacity.

17. The number of people to be trained in each category and the related costs will require the preparation of a detailed proposal and the following are only gross estimation for an initial period of 5 years.
    - 50000 farmers
    - 500 extension agents
    - 30-40 professionals from the public and private sector

7.6. Water user associations

18. Field visits to public irrigation systems indicated that payment of O&M fees are very high (90-95%) and that services received are considered as satisfactory in general terms. Therefore the establishment of WUAs does not appear as an urgent need but a greater participation in the decision making processes will be recommended. Such mechanism could consist in the establishment of Irrigation Committees in every irrigation system integrated by a mix of farmers representatives and government officials to decide in all operational and investment matters.

19. Experiences form other countries indicate that the establishment of water user associations among the owners of wells could provide an important inter-phase between the government and the farmers particularly when severe measures are needed to reduce water abstraction. Therefore it would be advisable to establish water user associations (WUA) by grouping wells located in the vicinity and discuss with them the implementation of the restrictive measures discussed in recommendation No. 3 . This

could be tried out in some specific areas and expand if the results are considered positive by concerned parties.

20. In many cooperatives the provision of water is treated like one more input and the general manager allocates the resource according to established rules. It could be a positive experience if all water affairs are handled by a special committee of farmers. This could be an initial step in moving towards a more independent management of the irrigation water in the cooperative.

8. PROJECT PROFILE (TRAINING PROJECT)

Project Title: National Training Center on Modern Irrigation Techniques

Justification

The water resources situation in Syria is very critical. Supply is already below demand and future perspectives are not very encouraging as the rate of population growth is high and possibilities for expanding supply are limited and expensive. Therefore reduction in the demand is essential for maintaining equilibrium between supply and demand. Irrigation is by far the largest consumer accounting for more than 80% of the total water use. Unfortunately irrigation water use has a record of poor efficiency and values below 40% are often found in public and private irrigation schemes. The major cause of inefficient water use is poor water management at farm level. Traditional methods (basin irrigation), lack of land leveling and over watering are the main causes for low efficiency at farm level.

The Government of Syria has acknowledged these problems and adopted a national policy aimed at encouraging the adoption of modern irrigation technologies at farm level. For this purpose several facilities have been provided consisting mainly on the tax free imports of irrigation equipment and the provision of credit facilities for the purchasing of the equipment. As nearly 60% of the irrigated area uses ground water resources, the adoption of these techniques offer considerable advantages, such as a considerable reduction in the volume of water pumped and in the related costs, greater productivity and hence greater returns for the farmers. These benefits can also be realized in surface irrigation schemes but modernization of networks will be necessary in most instances. The adoption of these techniques is proceeding at a good rate and during the year 2000 more than 25 000 ha were added to the existing 100 000 ha of such modern irrigation techniques in the country.

However, a suitable training program does not accompany the adoption of such techniques and inefficient use of the equipment is being reported in many places. Most of the equipment dealers do not provide any training or, if they do it is very superficial and short. The extension service is more oriented towards agronomic practices and extension agents lack the sufficient knowledge of such technologies. In general, the number of professionals that are technically prepared for designing drip and sprinkler systems are also in short supply in the country.

Objectives

i) To establish a Training Center within the Directorate of Water Management of the Ministry o Agriculture that will be responsible for undertaking a training program on the installation, use and proper maintenance of modern irrigation systems. The target group will be made of engineering and agriculture graduates from the public and private sector. Those coming from the public sector will be mostly extension agents.

ii) To undertake a training program for farmers that have purchased modern irrigation equipment. Farmers from neighboring fields will be invited to participate in the program.

Outputs

i) Trained personnel in the design, installation, use and maintenance of modern irrigation systems at the rate of 20 professionals, 100 extension agents and 5000 farmers per year.
ii) Modules of training courses developed for each group. The training of professionals should allow them to design and install modern irrigation techniques. The focus of the training for the extension agents will be on the proper use and maintenance of equipment. The extension agents will be the trainers of farmers and they will be responsible for carrying out demonstration practices where farmers from neighboring fields will participate.
iii) Physical facilities for the Training Unit that will include proper training and office space but also demonstration fields where field practices will be carried out.

Training Strategy

The training strategy will be based in the establishment of a core group of professionals in the Training Center that will be responsible for training of the trainers. This core group will be formed by two types of staff: one of high level and responsible for the training of professionals and the other of medium level addressed to the training of the extension agents.

The course for engineers will last three weeks and professionals participating on it should have good basic formation on hydraulic sciences and irrigation. The purpose of the training is to provide the private and public sector with a number of qualified engineers that will be able to design and install modern irrigation techniques. The participants in the course should cover part of the registration fees. The selection process of participants should be rigorous.

The course for extension agents will last 6 weeks. Their training requires longer time because most of them have only an agronomic background and principles of hydraulics must be introduced to them.

The extension agents will do the training of farmers by organizing training sessions with farmers that have already purchased the irrigation equipment. The training sessions will be carried out in thee phases. A first phase of 3 days duration where farmers are introduced to the principles of proper use of the equipment. The second phase that will also last 3 days and will be mostly addressed to proper maintenance of equipment. The final phase will be of 2 days duration and will consist in the evaluation of the irrigation uniformity of the equipment. Farmers from surrounding areas will be invited to participate in the field days. Desirably 50 farmers should participate in every demonstration.

Inputs

The following inputs will be required

International staff and consultants

- One Chief Technical adviser 60 m/m
- One irrigation specialist in modern irrigation methods 12 m/m
- International consultants (20 m/m)

National staff and consultants

- National project Director
- Three Irrigation engineers specialized on modern irrigation methods
- Five trainers on modern irrigation methods
- Administrator for the training center
- Administrative staff
- Other employees

Building and land facilities

- Building and offices
- Training classes
- Hostel facilities
- Demonstration farm

Furniture and irrigation equipment for Training Center and hostel

- Furniture for offices and training classes
- Irrigation equipment for 5 ha

Teaching aids and computer facilities

- Teaching aids
- 25 computers and server

Transportation facilities

- 4 cars
- 5 4-wheels drive cars
- 3 buses (2 medium, one large)

Duration

The duration of the project will be 5 years

Total Budget

The total budget is (National and International components included): US$ **3644300**

Detailed Budget

Project Items	International (US $)	National (SP)
International Staff		
One Chief Technical adviser (60 m/m)	750000	
One irrigation specialist in modern irrigation methods (12 m/m)	144000	
International consultants (20 m/m)	300000	
National Staff		
National project Director (60 m/m)		3000000
Three Irrigation engineers specialized on modern irrigation methods (3*60 m/m)		6300000
Five trainers on modern irrigation methods (5*60m/m)		7500000
Administrator for the training center (60 m/m)		2400000
Administrative staff (5*60 m/m)		3000000
Other employees (15* 60 m/m)		6750000
Building and offices for the trainers		
Training classes	200000	5000000
Hostel facilities	100000	7000000
Demonstration farm		2500000
Furniture and irrigation equipment for Training Center and hostel		
Furniture for offices and training classes		2500000
Irrigation equipment for 5 ha	20000	
Project Items	**International (US $)**	**National (SP)**
Teaching aids and computer facilities		
Teaching aids	10000	
25 computers and server	80000	
Transportation facilities		
4 cars	80000	
5 4- wheels drive cars	150000	
Buses (2 medium size, one large)	200000	
Operating expenses		
Operating expenses	300000	3000000
Unforeseen expenses (10%)	233400	4895000

Total	**2567400**	**53845000**

1 US $ = 50 SP

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10. ANNEXES

ANNEX 1

RECENT LEGAL REGULATIONS CONCERNING IRRIGATION POLICIES

DECISION N^{O}. 3

Ministry of Irrigation
The Prime Minister
Based on the provisions of Low No. /14/ for the year 1975 and on the conclusion of the Higher Agricultural Council Session No. /2/ dated 26.4.2000.
Decides the following:

Article 1.- The two ministries of Agriculture And Agrarian Reform and of Irrigation are assigned to do the following:
A: Make a plan for the irrigated areas, agricultural rotation and cropping patterns according to the available renewable ground resources and dams reservoirs allocated for irrigation.
B: Take all procedures necessary to make conversion to use of develop irrigation techniques which fit the agriculture crops and the various water resources, and according to the water rations.

Article 2.- Ministry of irrigation is assigned to do the following:
A: Sort out the situation of the unlicensed wells at all water basins in the light of the available and renewable water resources.
B: Prepare the studies necessary to set up irrigation projects on ground water depending on the principle of cooperative investment o wells to reduce their number and their investment costs.
C: Forbid absolutely wells boring at the closed and assign the technical and executing bodies to suppress all cases which break the low and take necessary procedures to implement this matter.
D: Make necessary studies to rehabilitate old irrigation projects according a programmed plan taking into consideration the adoption of pipes schemes and use of modern irrigation techniques, and allocate the annual budgets for this according to the priorities.
E: Sort out the water deficiency matter at the irrigation projects of the upper Orants and Al Khabour.

Article 3.- The two Ministries of: Economy and Foreign Trade and of Agriculture & Agrarian Reform are assigned to decide the needs for modern irrigation techniques and provide necessary loons trying to raise the ceiling of these loons to finance the full requirements of using these techniques.

Article 4.- Ministries of Agriculture & Agrarian Reform, of Industry, and Supply & internal Trade are assigned to make mechanisms and procedures necessary to control the quality and specifications of irrigation equipment industry.

Article 5.- This decision to be circulated and informed for being implemented.

Done in Damascus on 3.5.2000.
Prime Minister
Head of Higher Agriculture Council
Dr. M. Mastafa Mero

DECISION N^{O}. 5

The Prime Minister,
Based on the provisions of Legislative Decree no. 8 of 12/2/1996
And the decisions made in its sessions dated 4/5/1999
Decides the following:

Article 1.- The annual irrigation fee determined under Legislative Decree no. 8 of 12/2/1996 is to be increased to SP 3500/hectare for permanent irrigation and SP 600/hactare for winter irrigation.

Article 2.- Decision no. 1 of 15/2/1996 is to be cancelled.

Article 3.-This decision is to be circulated to the authorities concerned for implementation.

Damascus 21/12/1999
Prime Minister
Mahmoud Al Zubi

DECISION N^{O}. 6

The Prime Minister/Head of the Supreme Agricultural Council;
Based on the provisions of Law no. 14 of 1975 and the decisions made on the Council's cession no. 2 of 17/2/2001;
Decides the following:

Article 1.- The establishment of wells in the cretassic layer is banned unless drink and domestic use purposes. Such wells can be only drilled by the public ministries and tourist agencies upon a request made by the authorized minister.

Article 2.- This decision is to be published in the official gazette and circulated to the authorities concerned for implementation.

Prime Minister
Head of the Supreme Agricultural Council
Dr. Mohamed Mustafa Miro

DECISION N^{O}. 10

The Prime Minister
Based on the provisions of Low No ./14/ for the year 1975 and on the conclusion of the Higher Agricultural Council Session No. /2/ dated 26.4.2000.
Decides the following:

Article 1.- The two ministries of Agriculture And Agrarian Reform and of Irrigation are assigned to do the following :

A: Make a plan for the irrigated areas agricultural rotation and cropping Patterns according to the available renewable ground resources and dams reservoirs allocated for irrigation.
B: Take all procedures necessary to make conversion to use of develop irrigation techniques which fit the agriculture crops and the various water resources, and according to the water rations.

Article 2.- Ministry of irrigation is assigned to do the following:

A: Sort out the situation of the unlicensed wells at all water basins in the light of the available and renewable water resources.
B: Prepare the studies necessary to set up irrigation projects on ground water depending on the principle of cooperative investment o wells to reduce their number and their investment costs.
C: Forbid absolutely wells boring at the closed and assign the technical and executing bodies to suppress all cases which break the low and take necessary procedures to implement this matter.
D: Make necessary studies to rehabilitate old irrigation projects according a programmed plan taking into consideration the adoption of pipes schemes and use of modern irrigation techniques, and allocate the annual budgets for this according to the priorities .
E: Sort out the water deficiency matter at the irrigation projects of the upper Orants and Al Khabour.

Article 3.- The two Ministries of: Economy and Foreign Trade and of Agriculture & Agrarian Reform are assigned to decide the needs for modern irrigation techniques and provide necessary loons trying to raise the ceiling of these loons to finance the full requirements of using these techniques.

Article 4.- Ministries: of Agriculture & Agrarian Reform, of Industry, and Supply & internal Trade are assigned to make mechanisms and procedures necessary to control the quality and specifications of irrigation equipment industry.

Article 5.- This decision to be circulated and informed for being implemented

Done in Damascus on 3.5.2000.
Prime Minister
Head of Higher Agriculture Council
Dr. M. Mastafa . Mero.

DECISION N^{O}. 11

Prime Minister – Head of higher Agriculture council ,Based on the provisions of low No. /14/ for the year 1975 and on the conclusions of the Higher Agriculture council session No . /4/ dated 24.6.2000.
Decides the following:

Article 1.- Agree on conversion from traditional irrigation methods to modern irrigation techniques during four years.

Article 2.- A committee is formed the ministries:

- Economy And Foreign Trade
- Agriculture And Agrarian Reform
- State Planning Commission
- Electricity
- Industry
- Housing And Utilities

Their responsibility is: Submit a study which includes a program of water investment according to a future strategy which defines the policies of providing water needs for people, and for irrigated agriculture especially strategic crops, and prepare the inputs for implementation programs in the light of the water basins capacity.

Article 3.- Ministry of Agriculture & Agrarian Reform, And Ministry of Irrigation are assigned to start the conversion process of traditional irrigated areas at public sector forms to developed irrigation techniques (sprinkle, drip)

Article 4.- This decision to be circulated and informed to be implemented .

Done in Damascus on 5.7.2000.
Prime Minister
Head of Higher Agriculture Council
Dr-M. Mostafa Mero.

DECISION N^{O} .17

Prime Minister / Head of Higher Agriculture Council , Based on the provision of low No./14/ for the year 1975, And on the conclusions of the Higher Agriculture Council session.
Decides the following:

Article 1.- The cooperative Agriculture Bank is responsible to finance all projects of the conversation to modern irrigation techniques (sprinkle-drip) according to the financing rates mentioned in the requirements table prepared by Ministry of Agriculture And Agrarian Reform and the cooperative Agriculture Bank, giving priority for financing the projects which are located at the basing of: Orants – Al khabour – Barada and Al A'waj – Al Yarmok. Ministry of irrigation is assigned to give license for the unlicensed wells on the condition that modern irrigation techniques will be licensed are not located within the area of drinking wells, springs, and governmental irrigation schemes if the water of these schemes is enough to irrigate the areas located in this place)

Article 2.- Period of loan repayment is fixed at /10/ years for the projects of cooperative irrigation (three wells or more) and /7/ years for individual irrigation projects .

Article 3.- Ministry of Agriculture And Agrarian Reform and Ministry of Irrigation are assigned projects free of charge .

Article 4.- from permanent work groups include representative from:

- Ministry of Agriculture And Agrarian Reform
- Ministry of irrigation
- Ministry of Industry
- Ministry of Environment
- Country Farmers Bureau
- General Union of peasants
- Cooperative Agriculture Bank

Their responsibility is to prepare necessary studies and instructions to achieve what is decided above and follow up implementation.

Article 5.- Ministry of Industry is assigned to make a study on the possibility to produce modern irrigation equipment by public and joint sector.

Article 6.- Encourage private sector to set up integrated industrial establishments to process modern irrigation equipment (sprinkle - drip)

Article 7.- This decision to be circulated and informed for implementation

Done in Damascus on 1.8.2000.
Prime Minister
Head of Higher Agriculture Council
Dr- M. Mostafa Mero .

DECISION N^{O}. 21

The Prime Minister
Head of the Supreme Agricultural Council (SAC)
Based on the provisions of Law no. 14 of 1975
And the decision made in the SAC cession no. 3 of 10/4/2001
Decides the following:

Article 1.- A task force composed of:

- the Deputy Minister of Agriculture;
- the Deputy Minister of Irrigation; and
- the Deputy Minister of Industry

is established in order to survey the situation of irrigation equipment and water meter local production and make the required proposals to ensure their availability in the local markets at the reasonable prices and acceptable qualities. This assignment is to be implemented within two weeks from the date of this decision.

Article 2.- The Ministries of Industry, Supply and Domestic Trade are entrusted with the following:

- Address the issues related to the unlicensed irrigation equipment plants, particularly those using recycled materials or don't comply by the Syrian specification;
- Improve the irrigation equipment testing laboratories in the industrial research centers;
- Licenses are to be granted only to offices supervised by a specialized engineer.

Article 3.- This decision is to be published in the Gazette and circulated to the authorities concerned for implementation.

Damascus April 18, 2001
Prime Minister
Head of SAC
Dr. MHD. Mustafa Miro

DECISION N^{O}. 22

The Prime Minister, Head of the Supreme Agricultural Council
Based on the provisions of Law no. 14 of 1975
And the decision made by the Supreme Agricultural Council session no. 3 of 10/4/2001
Decides the following:

Article 1.- The Ministry of Irrigation is entrusted with licensing the unlicensed wells according to the following:

- in the titled lands (owned by an individual owner): based on the property document and a blueprint of the land where the well is located;
- in the titled land (owned by a group of people): based on a document proving ownership of a share in the land and a blueprint of the land, a document issued by MAAR proving that the well is located in the part owned by the license applicant.
- In the untitled lands: based on a certificate issued by the authorized body and certified by the Department of Agriculture proving the ownership of land where the well is located and a blueprint identifying the location of the well and the cultivated area.
- In the State land: based on a document issued by the Department of Agriculture proving that the applicant has rented the land and a blueprint identifying the location of the well and the size of the rented land.
- In the private land cultivated by sharecroppers or tenants: based on a document issued by the Department of Social Affairs and Labor indicating the relation ship between the sharecropper/tenant and the owner.

Article 2.- The Ministry of Irrigation is entrusted with licensing the wells exploited in Al Badia for winter crops and fruit trees exclusively. This is considered as an exception from the SAC decision no. 27 of 1995 and according to the renewable water sources.

Article 3.- The Ministry of Irrigation is entrusted with licensing the exploited wells within the area included in government infrastructure scheme after the approval of the Municipality concerned.

Article 4.- The licensing application deadline is to be extended up to July 1, 2001. The applications should be attached to the documents included in article (1) of this decision. Due attention should be given to the results of the unlicensed wells survey carried out by the Ministries of Irrigation and Agriculture based on the SAC decision no. 17 of 2000.

Article 5.- The Ministry of Irrigation is entrusted with the rehabilitation of the public irrigation networks within a specific schedule and supplying the farmers with the required equipment and inputs.

Article 6.- The ACB is entrusted to finance the modern irrigation networks and the supplementary lateral centrifugal pumping set to be installed on licensed wells regardless of other loans taken by the farmers.

Article 7.-This decision is to be published in the Gazette and circulated to the authorities concerned for implementation.

Damascus April 30, 2001
Prime Minister
Head of SAC
Dr. MHD. Mustafa Miro

DECISION N^{O}. 25

The Prime Minister
Head of the Supreme Agricultural Council (SAC)
Based on the provisions of Law no. 14 of 1975
And the decision made in the SAC cession no. 3 of 29/4/2001
Decides the following

Article 1.- The Agricultural Cooperative Bank is entrusted with financing the cenversion to modern irrigation based on the decisions made in this respect. The value of these loans is to be transferred to the interest free current accounts of the executing companies opened at the ACB. The transfer is to be made in installments according to the implementation stages.

Article 2.- This decision is to be published in the Gazette and circulated to the authorities concerned for implementation.

Damascus May 7, 2001
Prime Minister
Head of SAC
Dr. MHD. Mustafa Miro

DECISION N^{O}. 29

The Prime Minister - Head of Higher Agriculture Council Based on the provision of low No. /14/ for the year 1975,on the decision No./24/dated 8.8.2000. issued by the prime Ministry concerning the formation of a committee to study the regulations and decisions of the cooperative agriculture Bank ,And on the conclusion of the Higher Agriculture council session No./7/ dated 9.10.2000.
Decides the following:

Article No.1- The Cooperative Agriculture Bank is assigned to modify its system according to the following:

a. Concerning the subject of solidarity and unity:

- The principle of solidarity is to be applied on the loans given for the farmers cooperatives only.
- Mid and long term loans given for cooperative members should be covered by in kind guarantees only to be submitted by the beneficiary member according to the regulations of the cooperative Agr. Bank and to the interest rates applied for private sector.
- Short tern loans are given upon the Agriculture planning according to the plan and after submitting the ownership documents for the member to keep these documents in the permanent file of each cooperative exist at the branches of the Agr. Bank. The farmers cooperative and association should inform the Agr. Bank about each change or replacement of ownership documents.
- Seasonal loans are given for different cultivation according to the agriculture planning decided by the Maslaha of Agriculture (section) cooperative distributes areas and cropping patterns for investors who actually own holdings according to the ownership document related to each member and he can prove this ownership by one of the following documents: (ownership paper – beneficiary document – Authorization for using the land-rent contract – cultivation contract – document issued by Ministry of social and Labor or State properties directorate – court decision which proves the ownership by the loan applier)
- Use of the agriculture products value by each cooperative member after the deduction of this personal debt vale according to the debt statement raised by the cooperative and approved by the farmer organization on its own responsibility either to give cash money or make a cheque for the favor of the cooperative account to be cashed for beneficiaries .
- Accuracy is very necessary for the correctness of the loans distribution statements by cooperative according to article /51/ of the bank operations regulations , compare them with the debt statement mentioned in last paragraph , and define the debt of each member of the cooperative when giving against agriculture products value .
- Member who don't repay their due amounts for the bank for mid and long –term loans, will be subject to legal actions taken by the bank and farmer organization and procedures in this regard will be taken according to the provision of cooperative regulation and the low of the Agriculture bank.
- The cooperative council helps the borrower members who got short – team debts according to the regulation of the cooperative and article /11/ of the bank operations regulation especially paragraph /2-b/ concerning the commitment of the cooperative council to repay the due debt within two years from the date to be due and on this basis amounts will be paid without affecting the members who don't have any debt .

- Current accounts of the cooperative will be used at the end of each year to repay its due debts.
- Concerning personal guarantee submitted by private sector individuals to get short – term loans, these guarantees are accepted for loans which don't exceed nine hundred thousand Syrian pounds only, while bigger loans should be covered by in-kind guarantees only (article /71/ - bank operations regulation)

In the field of improving banking services at cooperative and private sector:

- Give more authority or mandate for branch credit committees defined in article /12/ of the guidelines of the bank operation regulations to increase mid- term loans to five hundred thousand Syrian pound instead of three hundred thousand Syrian pounds.
- Make sure to apply the provision of article /3/ of the cooperative Agri. Bank low. Which was issued by the legislative decree No./141/ for the year 1970 on loans and financing and the finance of the public and cooperative sectors by in kind finance only.

Concerning the procedures of implementation of low No./2/ for the year 2000 on the repayment of cooperative Agriculture Bank debts by installments:

Assign a committee consists of ministers of (Economy & Foreign Trade-Agriculture-Justice), chief of the General Union of peasants and the General Manager of the cooperative Agri-Bank) The committees job is to check the implementation instructions of the low No./2/ for the year 2000 on debt repayment on installments especially regarding the following paragraphs.

A: Not covering the farmers who delivered production inputs and the materials covered by loans procedures under this low trying to encourage them to repay the value of these materials and exempt them from the interests due on these materials from date of delivery till 31.12.2000 to be again starting from 1.1.2001 according to article 37 of the bank operations regulation .

B: Those who break the provisions of articles /58-59/ of the bank law , will be covered by installments law if they repay a rate not less than 25% of the penalty value excluding the penalty amount decided by through a judgement if there is any .

C: Insist on the exemption of farmers , who deliver their production for one of the public marketing organizations , for the penalties and delay interests starting from date of delivery of the crops, and the committee submits the necessary suggestion within three days from that date .

Concerning the finance of modern irrigation techniques:

Accepted and enough in kind guarantees should be submitted at the Agriculture Bank to cover these loans.

Concerning stop of finance of some purposes which are listed under requirements table:

Finance of water sets replacement takes place as the following:

- Replacement of water set should happen after ten years from the first finance except in case of force measure to be evaluated by specialized authorities.
- Finance of water set replacement is given one time only for those who haven't benefit form this finance before.

- Replacement finance is limited and given for farmers who will covert the traditional irrigation to modern one.
- Total amount of replacement loan is fixed and doesn't exceed 250 thousand Syrian pounds.
- Loans of water sets repair are given annually and don't exceed 20 thousand Syrian pounds for one set and a ceiling of 40 thousand Syrian pound for one farmers or cooperative member no matter how many sets he has:

Finance of green houses of bananas, vegetables and flowers, will continue as it is now and leave the decision about it for the concerned authorities according to the decision of Minister of Agriculture.
Fruit trees ands are financed by short term loans necessary for the services of these trees the finance is in kind and doesn't exceed 50 % of the cash payment defined in requirement table.

Continue to finance the following purposes:

- Loans of warehouses construction for the cooperative sector- poultry loans.
- Loans of cows purchase and breeding – loans of sheep purchase and feed.

Stop to finance the following purpose:

Mid and short – term loans for bees hives- fisheries Loans- Tractors implements – Cattle feed- Used harvesters – Agriculture Sprayers.

Concerning the loans of the green belt: contact should be made with the concerning authorities to know the need extern to continue financing this purpose because of climate. Considering the continuation of the finance is decided by the concerned authorities only.

Article 2.- All instructions which contradict with what is mentioned above are canceled .

Article 3.- Increase the capital of the cooperative Agri. Bank to Ten billion Syrian pounds according to the suggestions by the conference of managers of the cooperative Agriculture Bank branches .

Article 4.- Insist on the central Bank of Syria to be rapid in completing the papers and documents which belong to the cooperative Agri- Bank.

Article 5.- A committee is assigned consists of ministers of (Economy and Foreign Trade – Agriculture – and Justice) chief of the General union of peasants and the General manager of the cooperative Agri. Bank. The committee job is to check the implementation instructions of low No./2/ for the year 2000 on debt installment and submit the necessary suggestion within three days.

Article 6.- Provide the necessary input such as drip and sprinkle irrigation schemes either through local processing or through import to be given for farmers in kind to ensure execution and keep their prices as the prices of the local market.

Article 7.- Provide necessary credits for the Agriculture Bank from the control Bank of Syria to allocate the amounts of Syria to allocated the amounts of loan at 100 % rate .

Article 8.- This decision to be published and informed for execution .

Done in Damascus on 21.10.2000.
Prime Minister
Head of Higher Agriculture Council
Dr. M. Mastafa. Mero

DECISION N^{O}.30

The prime Minister – Head of Higher Agriculture Council, Based on the provisions of low No./14/ for the year 1975,And according to the conclusions of the Higher Agriculture Council session No./7/ dated 9/10/2000 decides the following:

Article 1.- Allow farmers of the two sites Assilah and Al Kassair (All Raqq Governorate) to cultivate 1400 ha. With summer crops and 2800 ha. Area with winter crops for the agriculture season 2000/2001 giving priority for barely and forage in winter cultivation.

Article 2.- In order to ensure the settlement of the population at Jarwan, Arwaished and Abu Khashab sites, a decision was issued to allow them to cultivate pastoral shrubs ad fodder barley on an area not exceeding 150 million m^3 / year for all uses while summer crops are totally forbidden in these areas to preserve the unrenewable ground water .

Article 3.- Ministry of Irrigation is assigned to prepare a project which included proposals for the investment of irrigated lands on wells in the the steppe trying to conserve water preserve and ensure settlement of population in that area . Ministry of Agriculture will be responsible to define population area and invested wells there.

Article 4.- This decision to be published and informed for execution .

Done in Damascus on 21.10.2000.
Prime Minister
Head of the Higher
Agriculture Council
Dr- M. Mostafa Mero

DECISION N^{O} . 31

The prime Minister – Head of Higher Agriculture Council ,Based on the provisions of low No./14/ for the year 1975,And according to the conclusions of the Higher Agriculture Council session No./7/ dated 9/10/2000 decides the following:

Article 1.- The General Directorate for the irrigation of Tigris and Al Khabour basin is assigned to give are irrigation license for the investors who will install meters on water sources for the mentioned crops . summer cultivation will be decided during March 2001 in light of water availability .

Article 2.- Form committees which include representatives from the Agricultural Bank, directorate of agriculture, directorate of Irrigation, and Peasants Union in Al Hassaka Governorate, These committees are responsible for making inspections, define the affected areas on the schemes and the river as a result of lack of irrigation water during the previous season. Also make a list of the affected persons and rate of damage to be approved by the governor and submitted to the management of the Agriculture Bank to take necessary procedure.

Article 3.- Approval on having mortgage sign on the rent contracts made with farmers for irrigated lands (State Lands – Laying hold) as guarantee for the term loans.

Article 4.- continue to give licenses after the installation of the meters on the wells, and follow the instructions in this regard .

Article 5.- Agree to join the irrigation Bureau in Araqqa Governorate to the General Organization of Euphrates dam and provide qualified enough staff and transport means to make its work easier.

Article 6.- This decision to be published and informed for execution .

Done in Damascus on 21.10.2000.
Prime Minister
Head of Higher Agriculture Council
Dr. M. Mastafa Mero

DECISION NO . 37

The prime Minister – Head of Higher Agriculture Council ,Based on the provisions of low No./14/ for the year 1975,And according to the conclusions of the Higher Agriculture Council session No./7/ dated 9/10/2000 decides the following:

Article 1.- General Directorate of irrigation Tigris and Al Khabour Basin is assigned to study the possibility of rehabilitation of Al Manajeer irrigation projects , to be included in its plan .

Article 2.**-** this decision is to be published and informed to be executed .

Done in Damascus on 21.10.2000
Prime Minister
Head of Higher Agriculture Council
Dr. M. Mastafa Mero

DECISION N^{O}. 258

The Minister of Irrigation,
Based on the provisions of Law no. 16 of 1982;
Due the importance of modern irrigation for water use efficiency and irrigated area increase;
Further to the instructions related to the implementation of irrigation and land reclamation projects and supporting farmers in the process of converting to modern irrigation decides the following:

Article 1.- All the Ministry's departments concerned with the design of irrigation projects, preparation of the technical specification and the implementation of land reclamation and irrigation networks projects should comply with the following instructions:

- the design of all irrigation and land reclamation projects should take into account the adoption of modern irrigation.
- the authorities concerned with investigating the projects' documents should give priority to those designed as per paragraph (a) above.
- all the already implemented projects should be rehabilitated so as to adapt to modern irrigation.
- the above instructions should be implemented by the ministry's concerned departments.

Article 2.- This decision is to be circulated to the authorities concerned for implementation.

Damascus 22/1/2000
Minister of irrigation
Eng. Abdul Rahman Madani

CIRCULAR N°13

Further to our circular no. 34/b/1356/15 of 25/4/1987, circular no. 32/B/3529/15 of 19/8/1990 and resolutions and instructions related to wells regulation in force;
Based on the decision made by the Ministers' Council in its session dated 24/8/1999 concerning the water conservation;

- Wells drilling licensing is banned.
- Licenses renewal for establishing new wells instead of the ones that dried up is also banned.
- Wells deepening licenses are to be given based on the conditions determined by the irrigation department in the Governorate concerned.

Damascus 31/8/1999
Prime Minister
Mahmoud Al Zubi

CIRCULAR N^{O}. 31

To:
The central technical departments;
The general departments;
The public establishments concerned;

Due to the current drought and the need to rationalize water use and based on the decision no. 3 issued by the Prime Minister/ head of the Supreme Agricultural Council.

All the authorities concerned are instructed not to give any well drilling license or pumping system installation unless the renewable water is available.

Dated 3/6/2000
Minister of Irrigation
Eng. Taha AL Atrash

ANNEX 2

IRRIGATION COSTS

The following tables describe the different irrigation costs that have been used in the calculation of the farm budgets. They include amortization cost for all kind of investments: drilling of wells, pumpsets of different power and discharges, and modern irrigation techniques. Operation and maintenance costs for the most common combinations of equipment have been also calculated. Labour requirements for the most common irrigation techniques were also estimated. All cost were based on information collected locally either by the trainees or consultants.

Table 2.1. Cost of developing a well

Well of 50 m depth	Unit	Cost per Unit	Number of units	Total cost
Placing and mounting of drilling equipment	u	25000,0	1	25000,0
Drilling in soil of medium hardness	lm	250,0	75	18750,0
Provision and instalation of sleeves	lm	2200,0	10	22000,0
Provision and installation of pipe of 8 mm and diametre <168mm	lm	2000,0	50	100000,0
Geophysical measurements	lm	400,0	50	20000,0
Testing of well (primary cleaning)	u	10000,0	1	10000,0
Testing of well (72 h)	u	80000,0	1	80000,0
Chemical analysis of water samples	u	3000,0	1	3000,0
Total				275750,0

Well of 100 m depth	Unit	Cost per Unit	Number of units	Total cost
Placing and mounting of drilling equipment	u	25000,0	1	25000,0
Drilling in soil of medium hardness	lm	250,0	125	31250,0
Provision and instalation of sleeves	lm	2200,0	20	44000,0
Provision and installation of Pipp of 8 mm and diametre <273mm	lm	1250,0	100	125000,0
Geophysical measurements	lm	400,0	100	40000,0
Testing of well (primary cleaning)	u	10000,0	1	10000,0
Testing of well (72 h)	u	80000,0	1	80000,0
Chemical analysis of water samples	u	3000,0	1	3000,0
Total				355250,0

Well of 200 m depth	Unit	Cost per Unit	Number of units	Total cost
Placing and mounting of drilling equipment	u	25000,0	1	25000,0
Drilling in soil of medium hardness	lm	250,0	225	56250,0
Provision and instalation of sleeves	lm	2200,0	20	44000,0
Provision and installation of Pipp of 8 mm and diametre <273mm	lm	1250,0	200	250000,0
Geophysical measurements	lm	400,0	200	80000,0
Testing of well (primary cleaning)	u	10000,0	1	10000,0
Testing of well (72 h)	u	80000,0	1	80000,0
Chemical analysis of water samples	u	3000,0	1	3000,0
Total				545250,0

Well of 400 m depth	Unit	Cost per Unit	Number of units	Total cost
Placing and mounting of drilling equipment	u	25000,0	1	25000,0
Drilling in soil of medium hardness	lm	250,0	425	106250,0
Provision and instalation of sleeves	lm	2200,0	20	44000,0
Provision and installation of pipe of 8 mm and diametre <273mm	lm	1250,0	400	500000,0
Geophysical measurements	lm	400,0	400	160000,0
Testing of well (primary cleaning)	u	10000,0	1	10000,0
Testing of well (72 h)	u	80000,0	1	80000,0
Chemical analysis of water samples	u	3000,0	1	3000,0
Total				925250,0

Table 2.2. Pumpset investment costs

Equipment	Unit	Unit Cost	Number of units	Total cost
Pumpset				
Alternative 1: Pumpset (fuel, 100 hp, 80 m3/h)				
Well base + Pumpset base	SP/u	35000	1	35000
Pump (5 inches diameter, 80 m3/h)	SP/u	458000	1	458000
Engine (Scania, 100 hp)	SP/u	210000	1	210000
Fuel tank (6000 liters)	SP/u	12000	1	12000
Total pump set				**715000**
Alternative 2: Pumpset (fuel, 70 hp, 60 m3/h)				
Well base + Pumpset base	SP/u	35000	1	35000
Pump (5 inches diameter, 80 m3/h)	SP/u	250000	1	250000
Engine (Scania, 100 hp)	SP/u	150000	1	150000
Fuel tank (6000 liters)	SP/u	12000	1	12000
Total pump set				**447000**
Alternative 3: Pumpset (fuel, 40 hp, 40 m3/h)				
Well base + Pumpset base	SP/u	20000	1	20000
Pumpset (40 hp, inches diameter, 40 m3/h)	SP/u	180000	1	180000
Fuel tank (3000 liters)	SP/u	7000	1	7000
Total pump set				**207000**
Alternative 4: Pumpset (fuel, 20 hp, 20 m3/h)				
Well base + Pumpset base	SP/u	10000	1	10000
Pumpset (20 hp, 2 inches diameter, 20 m3/h)	SP/u	140000	1	140000
Fuel tank (1000 liters)	SP/u	3000	1	3000
Total pump set				**153000**
Alternative 5: Pumpset (electricity, 75kw, 80m3/h)				
Well base + Pumpset base	SP/u	35000	1	35000
Pump set (electric motor 75 kw, 5 inches diameter, 80 m3/h)	SP/u	700000	1	700000
Total pump set				**735000**

Notes:
(1) Asumes 150 days at 14 hours/ day=2100

Table 2.3. Cost of the farm irrigation techniques

Farm Irrigation method		
Drip irrigation (field crops)	SP/u	100000
Drip irrigation (fruit trees)	SP/u	45000
Sprinlkler irrigation (manually moved)	SP/u	25000
Sprinlkler irrigation (automatically moved, pivot)	SP/u	25000
Precision land levelling	SP/u	25000

Table 2.4. Summary of investment cost in irrigation equipment

Equipment	**Unit**	**Total cost**	**Expected life (years)**	**Annual Depreciation**	**Interest on capital**
Wells					
Well of 50 m depth	u	363750	30	**12125**	485
Well of 100 m depth	u	421250	30	**14042**	**562**
Well of 200 m depth	u	611250	30	**20375**	815
Well of 400 m depth	u	991250	30	33042	1322
					0
Pumpsets					0
Alternative 1: Pumpset (fuel, 100 hp, 80 m3/h)	u	715000	20	**34700**	1388
Alternative 2: Pumpset (fuel, 70 hp, 60 m3/h)	u	457000	20	**22850**	914
Alternative 3: Pumpset (fuel, 40 hp, 40 m3/h)	u	207000	20	**9750**	390
Alternative 4: Pumpset (fuel, 20 hp, 20 m3/h)	u	153000	20	**7350**	294
Alternative 5: Pumpset (electricity, 75kw, 80m3/h)	u	735000	20	28700	1148
					0
Farm Irrigation method					0
Drip irrigation (field crops)	ha	100000	10	8333	333
Drip irrigation (fruit trees)	ha	45000	10	3750	150
Sprinlkler irrigation (manually moved)	ha	25000	10	2083	83
Sprinlkler irrigation (automatically moved, pivot)	ha	25000	10	2083	83
Precision land levelling	ha	25000	5	5000	200

Table 2.5. Operation and maintenance costs of irrigation equipment

Equipment	Unit	Unit Cost	Number of units	Cost per hour	Number of hours	Cost per year	Cost per m3
Well							
Repairs and maintenance	SP/u	5000	1	2,38	2100	5000	
Total well				2,38	2100	5000	**0,0298**
Pumpset							
Alternative 1: Pumpset (fuel, 100 hp, 80 m3/h)							
Kerosene (1)	SP/liter	6,5	22,22	144,43	2100	303303	
Oil (2)	SP/liter	50	0,24	12,00	2100	25200	
Pump attendant	SP/hour	18,75	1	18,75	2100	39375	
Repairs and maintenance of pump set	SP/year	17500	1	8,33	2100	17500	
Total pump set				183,51	2100	385378	**2,2939**
Total Alternative 1 (well+ pump set)				**185,89**	**2100**	**390378**	**2,3237**
Alternative 2: Pumpset (fuel, 70 hp, 60m3/h)							
Kerosene (1)	SP/liter	6,5	14	91,00	2100	191100	
Oil (2)	SP/liter	50	0,24	12,00	2100	25200	
Pump attendant	SP/hour	18,75	1	18,75	2100	39375	
Repairs and maintenance of pump set	SP/year	17500	1	8,33	2100	17500	
Total pump set				130,08	2100	273175	**2,1681**
Total Alternative 2 (well+ pump set)				**132,46**	**2100**	**278175**	**2,2077**
Alternative 3: Pumpset (fuel, 40 hp, 40 m3/h)							
Kerosene	SP/liter	6,5	8,5	55,25	2100	116025	
Oil (2)	SP/liter	50	0,06	3,00	2100	6300	
Pump attendant	SP/hour	18,75	1	18,75	2100	39375	
Repairs and maintenance of pump set	SP/year	15000	1	7,14	2100	15000	
Total pump set				84,14	2100	176700	**2,1036**
Total Alternative 3 (well+ pump set)				**86,52**	**2100**	**181700**	**2,1631**

Alternative 4: Pumpset (fuel, 20 hp, 20 m3/h)							
Kerosene	SP/liter	6,5	3	19,50	2100	40950	
Oil (2)	SP/liter	50	0,01	0,50	2100	1050	
Pump attendant	SP/hour	18,75	1	18,75	2100	39375	
Repairs and maintenance of pump set	SP/year	5000	1	2,38	2100	5000	
Total pump set				41,13	2100	86375	**2,0565**
Total Alternative 4 (well+ pump set)				**43,51**	**2100**	**91375**	**2,1756**
Alternative 5: Pumpset (electricity, 75kw, 80m3/h)							
Electricity	SP/kw	0,80	75	60,00	2100	126000	
Repairs and maintenance of pump set	SP/year	6000	1	2,86	2100	6000	
Total pump set				62,86		132000	**0,7857**
Total Alternative 5 (well+ pump set)				**65,24**	**2100**	**137000**	**0,8155**
Farm Irrigation method							
Maintenance of Drip irrigation (field crops)	SP/year	8333	0,25	0,99	2100	2083	**0,0124**
Maintenance of Drip irrigation (fruit trees)	SP/ha	3750	0,25	0,45	2100	938	**0,0056**
Maintenance of Sprinlkler irrigation (manually moved)	SP/ha	2083	0,25	0,25	2100	521	**0,0031**
Maintenance of Sprinlkler irrigation (automatically moved, pivot)	SP/ha	2083	0,25	0,25	2100	521	**0,0031**
Maintenance of Precision land levelling	SP/ha	5000	0,10	0,24	2100	500	**0,0030**

(1) A barrel of 200 liters is sufficient for 9 hours operation, hence (200*6,5)/9 =144,4

(2) Oil engine is replaced every 100 hours operation and carter has a capacity of 24 liters: 24/100 = 0,24 l/hour

(3) Annual cost of repairs and maintenance of irrigation methods are estimated as 25% of the annual depreciation rate except for land levelling where a 10 % is considered

Table 2.6. Labor cost of farm Irrigation method (per ha)

Farm Irrigation method	Number of Irrigations	Number of hours of labourer per irrigation	Total number of hours	Cost of labour per hour	Total Labour Cost/ha
Drip irrigation (field crops)	120	0,3	36	40	1440
Drip irrigation (fruit trees)	120	0,2	24	40	960
Sprinlkler irrigation (manually moved)	10	6	60	40	2400
Sprinlkler irrigation (automatically moved, pivot)	120	0,3	36	40	1440
Precision land levelling (1)	10	8	80	40	3200

(1) Number of irrigations are depending of crops and the time needed for each irrigation depends on method (forrow, basins, border, etc.)

ANNEX 3
SELECTION OF REPRESENTATIVE FARMS

Table 3.1 – Irrigated Holdings by area classes (groundwater)

HOLDINGS IRRIGATED BY GROUNDWATER (area in donum)													
	HOLDINGS IRRIGATED FROM WELLS ONLY						HOLDINGS IRRIGATED BY MORE THAN ONE METHOD		HOLDINGS IRRIGATED BY OTHER METHODS		TOTAL NUMBER OF	TOTAL	AVERAGE SIZE OF
	DIESEL ENGINES		ELECTRIC MOTORS		WINDMILLS								
AREA CLASSES	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	HOLDINGS	AREA	HOLDING
1	948	1182	842	1115	10	14	223	287	1291	1603	3314	4201	1,27
2	4530	13619	2811	7986	87	270	962	2908	3746	8719	12136	33502	2,76
5	7517	44487	3259	15971	90	439	1845	11130	4401	14981	17112	87008	5,08
10	11581	128808	3695	30147	127	1182	3361	38434	6302	33872	25066	232443	9,27
20	15302	316205	3610	48945	97	1202	5346	116985	7564	65730	31919	549067	17,20
40	8961	284975	1623	32537	49	1207	3038	104437	4641	59464	18312	482620	26,36
60	11220	519993	1639	52097	59	1422	3101	151735	4870	95858	20889	821105	39,31
100	9207	665821	1018	49766	47	2479	1657	114785	3428	97225	15357	930076	60,56
150	5859	559026	536	32604	22	878	1017	87624	1775	70598	9209	750730	81,52
200	6485	768430	614	56340	28	2757	1078	121872	1767	101924	9972	1051323	105,43
300	5197	844689	513	64411	22	2369	736	120737	1183	103088	7651	1135294	148,39
500	2293	550139	208	44653	6	1026	335	96434	555	81934	3397	774186	227,90
1000	788	314482	47	19925	3	1775	132	71352	186	59892	1156	467426	404,35
3000	74	149265	6	8281	0	0	25	32317	25	17210	130	207073	1592,87
	89962	5161121	20421	464778	647	17020	22856	1071037	41734	812098	175620	7526054	42,85

Source: Central Prime Minister's Office, Bureau of Statistics-1994 Agricultural Census

Table 3.2 - Irrigated Holdings by area classes (surface water)

HOLDINGS IRRIGATED BY SURFACE WATER (area in donum)															
	HOLDINGS IRRIGATED FROM RIVERS ONLY						HOLDINGS IRRIGATED FROM DAMS ONLY						TOTAL NUMBER OF	TOTAL	AVERAGE SIZE OF
	DIESEL ENGINES		ELECTRIC MOTORS		WITHOUT ENGINES		DIESEL ENGINES		ELECTRIC MOTORS		WITHOUT ENGINES				
AREA CLASSE	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	HOLDINGS	AREA	HOLDING
1	759	902	67	88	544	662	46	67	71	104	140	201	1627	2024	1,24
2	4477	13238	264	756	2534	6578	199	708	279	875	919	3177	8672	25332	2,92
5	7402	45733	387	2239	3533	17236	732	5010	401	2335	1909	12048	14364	84601	5,89
10	11511	134244	555	5852	5178	45817	1064	13200	620	6561	3055	34013	21983	239687	10,90
20	13512	301811	701	14318	5686	98841	4477	119814	609	12017	4019	78365	29004	625166	21,55
40	5706	192740	388	12088	2524	71439	804	27456	280	8764	1557	46385	11259	358872	31,87
60	4595	210837	267	12505	2084	90187	375	15440	248	13014	1889	79039	9458	421022	44,51
100	2204	122612	179	9876	784	47534	124	8503	108	7920	757	45130	4156	241575	58,13
150	1376	89855	131	7242	358	27580	34	3005	95	10444	520	41352	2514	179478	71,39
200	1104	95232	146	10859	294	30654	50	7246	49	7006	410	46008	2053	197005	95,96
300	792	94414	100	10512	229	25622	26	3927	27	5410	175	28838	1349	168723	125,07
500	353	58528	38	7922	107	19290	10	3402	8	3013	51	11658	567	103813	183,09
1000	89	32441	1	540	29	10714	6	6526	4	844	13	2439	142	53504	376,79
3000	14	9202	0	0	2	1605	0	0	0	0	3	919	19	11726	617,16
	53894	1401789	3224	94797	23886	493759	7947	214304	2799	78307	15417	429572	107167	2712528	25,31

Source: Central Prime Minister's Office, Bureau of Statistics-1994 Agricultural Census

Table 3.3 – Irrigated Holdings by area classes (all water sources)

IRRIGATED HOLDINGS ACCORDING TO WATER SOURCE (area in donum)							
	GROUNDWATER		SURFACE WATER		TOTAL		
AREA CLASSES	Nº of holdings	Area	Nº of holdings	Area	total nº of holdings	total area	average size
1	3314	4201	1627	2024	4941	6225	1,26
2	12136	33502	8672	25332	20808	58834	2,83
5	17112	87008	14364	84601	31476	171609	5,45
10	25066	232443	21983	239687	47049	472130	10,03
20	31919	549067	29004	625166	60923	1174233	19,27
40	18312	482620	11259	358872	29571	841492	28,46
60	20889	821105	9458	421022	30347	1242127	40,93
100	15357	930076	4156	241575	19513	1171651	60,04
150	9209	750730	2514	179478	11723	930208	79,35
200	9972	1051323	2053	197005	12025	1248328	103,81
300	7651	1135294	1349	168723	9000	1304017	144,89
500	3397	774186	567	103813	3964	877999	221,49
1000	1156	467426	142	53504	1298	520930	401,33
3000	130	207073	19	11726	149	218799	1468,45
	175620	7526054	107167	2712528	282787	10238582	36,21

Source: Central Prime Minister's Office, Bureau of Statistics-1994 Agricultural Census

Table 3.4 - Irrigated Holdings by area classes (all water sources): Selection of farm strata

IRRIGATED HOLDINGS ACCORDING TO WATER SOURCE (area in donum)							
	GROUNDWATER		SURFACE WATER		TOTAL		
AREA CLASSES	Nº of holdings	Area	Nº of holdings	Area	total nº of holdings	total area	average size
1	3314	4201	1627	2024	4941	6225	1,26
2	12136	33502	8672	25332	20808	58834	2,83
5	17112	87008	14364	84601	31476	171609	5,45
10	25066	232443	21983	239687	47049	472130	10,03
20	31919	549067	29004	625166	60923	1174233	19,27
>10 - <20	56985	781510	50987	864853	107972	1646363	15,25
40	18312	482620	11259	358872	29571	841492	28,46
60	20889	821105	9458	421022	30347	1242127	40,93
100	15357	930076	4156	241575	19513	1171651	60,04
150	9209	750730	2514	179478	11723	930208	79,35
>40- <80	45455	2501911	16128	842075	61583	3343986	54,30
200	9972	1051323	2053	197005	12025	1248328	103,81
300	7651	1135294	1349	168723	9000	1304017	144,89
500	3397	774186	567	103813	3964	877999	221,49
>100 - <250	21020	2960803	3969	469541	24989	3430344	137,27
1000	1156	467426	142	53504	1298	520930	401,33
3000	130	207073	19	11726	149	218799	1468,45
	175620	7526054	107167	2712528	282787	10238582	36,21

Source: Central Prime Minister's Office, Bureau of Statistics-1994 Agricultural Census

Table 3.5 - Irrigated Holdings by Governorate (groundwater)

HOLDINGS IRRIGATED BY GROUNDWATER (area in donum)													
	HOLDINGS IRRIGATED FROM WELLS ONLY						HOLDINGS IRRIGATED BY MORE THAN ONE METHOD		HOLDINGS IRRIGATED BY OTHER METHODS		TOTAL NUMBER OF	TOTAL	AVERAGE SIZE OF
	DIESEL ENGINES		ELECTRIC MOTORS		WINDMILLS								
GOVERNORATE	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	HOLDINGS	AREA	HOLDING
Damascus	1360	22638	767	11115	18	340	599	6904	274	8053	3018	49050	16,25
Dam. Rural	12827	243245	3264	46819	80	941	1847	16093	4054	91384	22072	398482	18,05
Homs	7327	204705	3547	51513	58	1040	1527	22669	3897	126069	16356	405996	24,82
Hama	13922	448008	1618	38254	34	890	1778	17830	3974	148352	21326	653334	30,64
Tartous	8685	123712	2429	15944	53	434	5831	18710	1434	26918	18432	185718	10,08
Lattakia	3178	45349	4395	36715	163	1394	4504	30075	1908	40578	14148	154111	10,89
Idleb	4572	234898	1484	49640	15	820	1055	20135	312	26318	7438	331811	44,61
Aleppo	15631	826225	1081	41515	140	6144	6251	296156	2494	213137	25597	1383177	54,04
Al-Rakka	4319	838295	78	7769	2	750	1098	88418	570	56220	6067	991452	163,42
Deir-Ezzor	2087	272788	41	1297			283	8249	1870	126300	4281	408634	95,45
Al-Hasakek	14328	1854932	1241	156655	18	2694	1739	133488	1366	182710	18692	2330479	124,68
Al-Swida	49	1504	35	868	3	333	1471	8324	5	258	1563	11287	7,22
Dara	1349	40592	399	7358	62	1223	13626	144083	652	24029	16088	217285	13,51
Quneitra	328	4230	42	317	1	15	125	963	46	711	542	6236	11,51
TOTAL	89962	5161121	20421	464778	647	17018	41734	812098	22856	1071036	175620	7526051	42,85

Source: Central Prime Minister's Office, Bureau of Statistics-1994 Agricultural Census

Table 3.6 - Irrigated Holdings by Governorate (surface water)

HOLDINGS IRRIGATED BY SURFACE WATER (area in donum)															
	HOLDINGS IRRIGATED FROM RIVERS ONLY						HOLDINGS IRRIGATED FROM DAMS ONLY						TOTAL NUMBER OF	TOTAL	AVERAGE SIZE OF
	DIESEL ENGINES		ELECTRIC MOTORS		WITHOUT ENGINES		DIESEL ENGINES		ELECTRIC MOTORS		WITHOUT ENGINES				
GOVERNORATE	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	Nº of holdings	Area	HOLDINGS	AREA	HOLDING
Damascus	230	3918	73	1039	442	3524	23	393	18	140	67	980	853	9994	11,72
Dam. Rural	578	7888	133	1428	4524	46144	33	450	22	391	57	726	5347	57027	10,67
Homs	531	11195	63	995	3218	48942	108	1693	39	522	2920	44040	6879	107387	15,61
Hama	5288	117150	141	1975	2286	14103	6244	163848	78	2802	3119	64005	17156	363883	21,21
Tartous	856	7385	73	366	2935	13619	63	499	17	142	210	3187	4154	25198	6,07
Lattakia	1625	23041	530	6613	1294	16246	863	12541	1847	25679	4160	61141	10319	145261	14,08
Idleb	1773	31584	53	744	561	9225	201	3788	16	242	69	1216	2673	46799	17,51
Aleppo	3250	164964	55	4381	1023	47116	128	9706	538	35457	658	54160	5652	315784	55,87
Al-Rakka	3413	129845	122	4969	5068	212984	42	2280	142	7453	1268	80014	10055	437545	43,52
Deir-Ezzor	32811	737793	749	19746	14	385	17	724	12	254			33603	758902	22,58
Al-Hasakek	3234	162370	1216	52358	1078	51183	92	15710	45	4802	1359	83978	7024	370401	52,73
Al-Swida	4	320			22	229					4	157	30	706	23,53
Dara	76	958	15	177	1080	26829	115	2401	24	407	1467	34741	2777	65513	23,59
Quneitra	225	3378	1	5	341	3231	18	272	1	16	59	1227	645	8129	12,60
TOTAL	53894	1401789	3224	94796	23886	493760	7947	214305	2799	78306	15417	429572	107167	2712528	25,31

Source: Central Prime Minister's Office, Bureau of Statistics-1994 Agricultural Census

Table 3.7 - Irrigated Holdings by Governorate (all water sources)

IRRIGATED HOLDINGS ACCORDING TO WATER SOURCE (area in donum)							
	GROUNDWATER		SURFACE WATER		TOTAL		
AREA CLASSES	Nº of holdings	Area	Nº of holdings	Area	total nº of holdings	total area	average size
Damascus	853	49050	3018	9994	3871	59044	15,25
Dam. Rural	5347	398482	22072	57027	27419	455509	16,61
Homs	6879	405996	16356	107387	23235	513383	22,10
Hama	17156	653334	21326	363883	38482	1017217	26,43
Tartous	4154	185718	18432	25198	22586	210916	9,34
Lattakia	10319	154111	14148	145261	24467	299372	12,24
Idleb	2673	331811	7438	46799	10111	378610	37,45
Aleppo	5652	1383177	25597	315784	31249	1698961	54,37
Al-Rakka	10055	991452	6067	437545	16122	1428997	88,64
Deir-Ezzor	33603	408634	4281	758902	37884	1167536	30,82
Al-Hasakek	7024	2330479	18692	370401	25716	2700880	105,03
Al-Swida	30	11287	1563	706	1593	11993	7,53
Dara	2777	217285	16088	65513	18865	282798	14,99
Quneitra	645	6236	542	8129	1187	14365	12,10
TOTAL	107167	7526051	175620	2712528	282787	10238579	36,21

Source: Central Prime Minister's Office, Bureau of Statistics-1994 Agricultural Census

ANNEX 4

FARM AND CROP BUDGETS

The complete set of farm model simulations is shown in the table below. A selection of farm models is market (*) and the farm budgets are shown in this annex.

COPLETE SET OF SIMULATED FARM MODELS:

FARM MODEL	DESCRIPTION
LARGEFARM-R-S (*)	Large Farm, river water, surface irrigation, no investment in modern irrigation
LARGEFARM-R-MS	Large Farm, river water, modern irrigation: Sprinklers
LARGEFARM-R-MD	Large Farm, river water, modern irrigation: Drip
LARGEFARM-R-W100-S	Large Farm, water from well 100m , surface irrigation, no investment in modern irrigation
LARGEFARM-W100-MS (*)	Large Farm, water from well 100m , investment in modern irrigation: sprinklers
LARGEFARM-W100-MD	Large Farm, water from well 100m , investment in modern irrigation: drip
LARGEFARM-R-W200-S	Large Farm, water from well 200m, surface irrigation, no investment in modern irrigation
LARGEFARM-W200-MS	Large Farm, water from well 200m, investment in modern irrigation: sprinklers
LARGEFARM-W200-MD	Large Farm, water from well 200m, investment in modern irrigation: drip
MEDIUMFARM-R-S (*)	Medium Farm, river water, surface irrigation, no investment in modern irrigation
MEDIUMFARM-R-MS	Medium Farm, river water, modern irrigation: Sprinklers
MEDIUMFARM-R-MD	Medium Farm, river water, modern irrigation: Drip
MEDIUMFARM-R-W100-S	Medium Farm, water from well 100m, surface irrigation, no investment in modern irrigation
MEDIUMFARM-W100-MS	Medium Farm, water from well 100m, investment in modern irrigation: sprinklers
MEDIUMFARM-W100-MD (*)	Medium Farm, water from well 100m , investment in modern irrigation: drip
SMALLFARM-R-S (*)	Small Farm, river water, surface irrigation, no investment in modern irrigation
SMALLFARM-R-MS	Small Farm, river water, modern irrigation: Sprinklers
SMALLFARM-R-MD	Small Farm, river water, modern irrigation: Drip
SMALLFARM-R-W50-S	Small Farm, water from well 50 m , surface irrigation, no investment in modern irrigation
SMALLFARM-W50-MS	Small Farm, water from well 50 m , investment in modern irrigation: sprinklers
SMALLFARM-W50-MD (*)	Small Farm, water from well 50 m, investment in modern irrigation: drip

(*) Selected farm models

CROP BUDGETS

From the farm models in the table above and in the database (see annex 6) 6 crops have been selected and the correspondent crop budgets are shown in this annex.

Selection of crops:

- WHEAT (LARGE FARM, RIVER, SURFACE)
- COTTON (LARGE FARM, RIVER, SURFACE)
- SUGAR BEET (MEDIUM FARM, WELL-100, SURFACE)
- POTATO (MEDIUM FARM ,WELL-100, SURFACE)
- TOMATO (SMALL FARM, WELL-50, DRIP)
- ORANGES (SMALL FARM, WELL-50, DRIP)

1. LARGE FARM: River water, surface irrigation, no investment in new equipment

Total area of Farm: 14 ha
Crop distribution: 70 % Wheat ; 30 %Cotton
Zone: Al Hassake

Winter crops & Vegetables		Summer crops &Vegetables		Total planted	
Irr	R.F	Irr	R.F	Irr	R.F
9.8	0.0	4.2	0.0	14.0	0

	Wheat	Cotton	
Irrigation fee (O&M + rec. Invest.)		8250	SP/HA
water requirements in the farm		85144	total m3
water requirements /ha		6082	m3/ha
total irrigation cost		115500	SP/HA

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg			857500
By-Product (straw)	ton			0
Gross Revenue				**857500**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	46		34300
Sowing	hr	0		0
Chemical Fertilizer Application	hr	0		0
Organic fertilizer Application	hr	0		0
Levelling	hr	0		0
Herbicide Application	hr	8		4200
Insecticides Application	hr	0		0
Harvesting	hr	39		29361
Other	hr	0		0
carring on car	Bag	314		3136
Transport	Kg	14700		12642
Total Hired Machinery	%			83639
Total Owned Machinery	%			0
Total Machinery				**83639**
Labor (man-hours/ha):				
Tillages	hr	0		0
Sowing	hr	56		1855
Chemical Fertilizer Application	hr	56		1855
Organic fertilizer Application	hr	0		0
Levelling	hr	0		0
Herbicide Application	hr	0		0
Controlling	hr	0		0
Weeding	hr	382		21021
Harvesting	hr	1966		42064
Other	hr	0		0
Irrigation	hr	1323		43012

Family Labor	%			46665
Hired Labor	%			63142
Total Labor	hr	**3783**		**219614**
Material Inputs:				
Seed	kg	3360		48090
Chemical Fertilizer:	ha	0		
N	kg	4550		35035
P	kg	3360		27922
K	kg	0		0
Other Types	kg	0		0
Manure	tons	0		0
Containers (sacs)	No.	350		19215
Irrigation water	ha	14	3500	49000
Total Inputs				**179262**
Credit:				
Credit in cash	SP			16800
Credit in kind	SP	2030		18270
Credit for well drilling	SP			
Credit for pump set	SP			
Credit for irrigation technique	SP			
Total credit	SP			35070
Interest Rate	%			4%
Credit Cost	SP			**1403**
Total Variable Costs				**327446**
Gross Margin				**530054**
Gross Margin/ha				**37861**
Fixed Costs:				
Family Labor	%			46665
Land Rent	ha			155326
Well drilling	SP			
Pump set	SP			
Land reclamation irrigation fee	ha	14.0	4750	66500
Total Fixed Costs				**268490**
Net Margin (Profit)				**261564**
Net Margin (Profit)/ha				**18683**
Gross Margin/unit Labor				**140**
Gross Margin/cu m of Water				**6.23**
Net Margin/cu m of Water				**3.07**
Irrigation Investment Annual Cost/ha	SP/ha			4750
Irrigation O&M costs/ha	SP/ha			3500
O&M costs/Gross Margin	%			9

2. LARGE FARM: Well (100m), investment in modern irrigation: Sprinklers

Total area of Farm: 14 ha
Crop distribution: 70 % Wheat ; 30 % Cotton
Zone: Al Hassake

Winter crops & Vegetables		Summer crops &Vegetables		Total planted	
Irr	R.F	Irr	R.F	Irr	R.F
9.8	0.0	4.2	0.0	14.0	0
Wheat		Cotton			

Irrigation Fee (O&M costs)	2.21	SP/m3
water requirements in the farm	63858	total m3
water requirements /ha	4561	m3/ha
total irrigation cost	141126	SP

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg			1071875
By-Product (straw)	ton			0
Gross Revenue				**1071875**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	46		34300
Sowing	hr	0		0
Chemical Fertilizer Application	hr	0		0
Organic fertilizer Application	hr	0		0
Levelling	hr	0		0
Herbicide Application	hr	8		4200
Insecticides Application	hr	0		0
Harvesting	hr	39		29361
Other	hr	0		0
carring on car	Bag	392		3920
Transport	Kg	14700		12642
Total Hired Machinery	%			84423
Total Owned Machinery	%			0
Total Machinery				**84423**
Labor (man-hours/ha):				
Tillages	hr	0		0
Sowing	hr	56		1855
Chemical Fertilizer Application	hr	56		1855
Organic fertilizer Application	hr	0		0
Levelling	hr	0		0
Herbicide Application	hr	0		0
Controlling	hr	0		0
Weeding	hr	382		21021
Harvesting	hr	1966		42064
Other	hr	0		0

Irrigation	hr			16071
Family Labor	%			29504
Hired Labor	%			53362
Total Labor	hr	**2947**		**165731**
Material Inputs:				
Seed	kg	3360		48090
Chemical Fertilizer:	ha	0		
N	kg	4550		35035
P	kg	3360		27922
K	kg	0		0
Other Types	kg	0		0
Manure	tons	0		0
Containers (sacs)	No.	350		19215
Irrigation water	cu m	63858		141126
Total Inputs				**271387**
Credit:				
Credit in cash	SP			16800
Credit in kind	SP	2030		18270
Credit for well drilling	SP	1	14042	14042
Credit for pump set	SP	1	22850	22850
Credit for new irrigation technique	SP	14	2083	29162
Total credit	SP			101124
Interest Rate	%			4%
Credit Cost	SP			**4045**
Total Variable Costs				**413217**
Gross Margin				**658658**
Gross Margin/ha				**47047**
Fixed Costs:				
Family Labor	%			29504
Land Rent	ha			155326
Well drilling	SP	1	14042	14042
Pump set	SP	1	22850	22850
Land reclamation irrigation fee	ha	14.0	0	0
Irrigation technique				
Sprinklers	SP/HA	14.0	2083	29162
Drip	SP/HA			
levelling	SP/HA			
Total Fixed Costs				**250884**
Net Margin (Profit)				**407774**
Net Margin (Profit)/ha				**29127**
Gross Margin/unit Labor				**224**
Gross Margin/cu m of Water				**10.31**
Net Margin/cu m of Water				**6.39**
Irrigation Investment Annual Cost/ha	SP/ha			4718
Irrigation O&M costs/ha	SP/ha			10080
O&M costs/Gross Margin	%			21

3. MEDIUM FARM: River water, surface irrigation, no investment in new equipment

Total area of Farm: 5 ha
Crop distribution: 50 % Wheat ; 20 % Cotton; 15% Potato; 15% Sugar beet
Zone: Hama

Wheat	Cotton	Potato	Sugar beet	Total planted	
Irr	irr	Irr	irr	Irr	R.F
2,5	1,0	0,75	0,75	5,0	0

Irrigation fee (O&M + rec. Invest. costs)	5600	SP/HA
water requirements in the farm	30875	m3
water requirements /ha	6175	m3/ha
total irrigation costs	28000	SP

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg			518297
By-Product (straw)	ton			0
Gross Revenue				**518297**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	94		11438
Sowing	hr	53		3000
Chemical Fertilizer Application	hr	45		2250
Organic fertilizer Application	hr	0		0
Levelling	hr	2		938
Herbicide Application	hr	8		375
Insecticides Application	hr	33		1625
Harvesting	hr	33		6500
Other	hr	0		0
carring on car	Bag	213		7000
Transport	Kg	103		14000
Total Hired Machinery	%			47125
Total Owned Machinery	%			0
Total Machinery				**47125**
Labor (man-hours/ha):				
Tillages	hr	0		0
Sowing	hr	38		1500
Chemical Fertilizer Application	hr	15		750
Organic fertilizer Application	hr	15		750
Levelling	hr	0		0
Herbicide Application	hr	120		6000
Controlling	hr	8		375

Weeding	hr	100		3750
Harvesting	hr	84		21885
Other	hr	33		1875
Irrigation	hr	665		25975
Family Labor	%			62860
Hired Labor	%			0
Total Labor	hr	**1076**		**125720**
Material Inputs:				
Seed	kg	3588		54113
Chemical Fertilizer:	ha	0		0
N	kg	2575		19275
P	kg	1288		11538
K	kg	375		4219
Other Types	kg	0		0
Manure	tons	38		15000
Containers (sacs)	No.	530		6150
Irrigation water	ha	5	3500	17500
Total Inputs				**127794**
Credit:				
Credit in cash	SP	0		0
Credit in kind	SP	0		0
Credit for well drilling	SP			
Credit for pump set	SP			
Credit for irrigation technique	SP			
Total credit	SP			0
Interest Rate	%			4%
Credit Cost	SP			**0**
Total Variable Costs				**174919**
Gross Margin				**343378**
Gross Margin/ha				**68676**
Fixed Costs:				
Family Labor	%			45360
Land Rent	ha			77963
Well drilling	SP			
Pump set	SP			
Land reclamation irrigation fee	ha	5,0	2100	10500
Total Fixed Costs				**133823**
Net Margin (Profit)				**209556**
Net Margin (Profit)/ha				**41911**
Gross Margin/unit Labor				**319**
Gross Margin/cu m of Water				**11,12**

Net Margin/cu m of Water				**6,79**
Irrigation Investment Annual Cost/ha	SP/ha			2100
Irrigation O&M costs/ha	SP/ha			3500
O&M costs/Gross Margin	%			5

4. MEDIUM FARM: Well (100m), investment in modern irrigation: Drip

Total area of Farm: 5 ha
Crop distribution: 50 % Wheat ; 20 % Cotton; 15% Sugar Beet; 15% Potato
Zone: Hama

Wheat	Cotton	Sugar beet	Potato	Total planted	
Irr	irr	Irr	irr	Irr	R.F
2,5	1,0	0,75	0,75	5,0	0

Irrigation Fee (O&M costs) 2,16 SP/m3
water requirements in the farm 18525 m3
water requirements /ha 3705 m3/ha
total irrigation O&M cost 40014 SP

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg			673786
By-Product (straw)	ton			0
Gross Revenue				**673786**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	94		11438
Sowing	hr	53		3000
Chemical Fertilizer Application	hr	45		2250
Organic fertilizer Application	hr	0		0
Levelling	hr	2		938
Herbicide Application	hr	8		375
Insecticides Application	hr	33		1625
Harvesting	hr	33		6500
Other	hr	0		0
carring on car	Bag	213		7000
Transport	Kg	103		14000
Total Hired Machinery	%			47125
Total Owned Machinery	%			0
Total Machinery				**47125**
Labor (man-hours/ha):				
Tillages	hr	0		0
Sowing	hr	38		1500
Chemical Fertilizer Application	hr	15		750
Organic fertilizer Application	hr	15		750
Levelling	hr	0		0
Herbicide Application	hr	120		6000

Controlling	hr	8		375
Weeding	hr	100		3750
Harvesting	hr	84		13664
Other	hr	33		1875
Irrigation	hr	120		4560
Family Labor	%			33224
Hired Labor	%			0
Total Labor	hr	**531**		**66447**
Material Inputs:				
Seed	kg	3588		54113
Chemical Fertilizer:	ha	0		0
N	kg	2575		19275
P	kg	1288		11538
K	kg	375		4219
Other Types	kg	0		0
Manure	tons	38		15000
Containers (sacs)	No.	530		6150
Irrigation water	cu m	18525		40014
Total Inputs				**150308**
Credit:				
Credit in cash	SP	0		0
Credit in kind	SP	0		0
Credit for well drilling	SP	1	14042	14042
Credit for pump set	SP	1	9750	9750
Credit for irrigation technique	SP	5	8333	41665
Total credit	SP			65457
Interest Rate	%			4%
Credit Cost	SP			**2618**
Total Variable Costs				**200051**
Gross Margin				**473735**
Gross Margin/ha				**94747**
Fixed Costs:				
Family Labor	%			32174
Land Rent	ha			77963
Well drilling	SP	1	14042	14042
Pump set	SP	1	9750	9750
Land reclamation irrigation fee	ha	5,0	0	0
Irrigation technique				
Sprinklers	SP/HA			
Drip	SP/HA	5,0	8333	**41665**
levelling	SP/HA			
Total Fixed Costs				**175593**
Net Margin (Profit)				**298142**

Net Margin (Profit)/ha				**59628**
Gross Margin/unit Labor				**892**
Gross Margin/cu m of Water				**25,57**
Net Margin/cu m of Water				**16,09**
Irrigation Investment Annual Cost/ha	SP/ha			13091
Irrigation O&M costs/ha	SP/ha			8003
O&M costs/Gross Margin	%			8

5. SMALL FARM: River water, surface irrigation, no investment in new equipment

Total area of Farm: 1,5 ha
Crop distribution: 50 % Tomato ; 25 % Potato; 25% Oranges
Zone: Lattakia

Tomato	overlapping potato	total tomato	potato	oranges	total area planted	farm size	land intensification index
0,75	0,375	1,125	0,375	0,375	1,875	1,500	1,25

Irrigation fee (O&M + rec.invest.costs)	5500	SP/HA
water requirements in the farm	17917	total m3
water requirements /ha	11945	m3/ha
total irrigation costs	8250	SP

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg			466215
By-Product (straw)	ton			0
Gross Revenue				**466215**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	24		10740
Sowing	hr	5		563
Chemical Fertilizer Application	hr	0		0
Organic fertilizer Application	hr	0		0
Levelling	hr	3		1725
Herbicide Application	hr	4		938
Insecticides Application	hr	0		0
Controlling	hr	25		6413
Harvesting	hr	5		563
Other	hr	0		0
carring on car	Bag	0		0
Transport	Kg	2417		21231
Total Hired Machinery	%			42171
Total Owned Machinery	%			0
Total Machinery				**42171**
Labor (man-hours/ha):				
Tillages	hr	8		235
Sowing	hr	54		1702
Chemical Fertilizer Application	hr	56		1737

Organic fertilizer Application	hr	38		1174
Levelling	hr	36		1127
Herbicide Application	hr	19		587
Controlling	hr	81		2835
Weeding	hr	283		8389
Harvesting	hr	1571		51954
Other	hr	194		7575
Irrigation	hr	368		14480
Family Labor	%			91795
Hired Labor	%			0
Total Labor	hr	**2706**		**183590**
Material Inputs:				
Seed	kg	1125		16101
Chemical Fertilizer:	ha	0		3433
N	kg	150		2685
P	kg	56		1035
K	kg	56		1389
Other Types	kg	9377		13650
Manure	tons	18		5513
Containers (sacs)	No.	663		13438
Irrigation water	ha	1,500	3500	5250
Total Inputs				**62494**
Credit:				
Credit in cash	SP	0		0
Credit in kind	SP	0		0
Credit for well drilling	SP			
Credit for pump set	SP			
Credit for irrigation technique	SP			
Total credit	SP			0
Interest Rate	%			4%
Credit Cost	SP			**0**
Total Variable Costs				**104665**
Gross Margin				**361550**
Gross Margin/ha				**241034**
Fixed Costs:				
Family Labor	%			91795
Land Rent	ha			37125
Well drilling	SP			
Pump set	SP			
Land reclamation irrigation fee	ha	1,500	2000	3000
Total Fixed Costs				**131920**
Net Margin (Profit)				**229631**

Net Margin (Profit)/ha				**153087**
Gross Margin/unit Labor				**134**
Gross Margin/cu m of Water				**20,18**
Net Margin/cu m of Water				**12,82**
Irrigation Investment Annual Cost/ha	SP/ha			2000
Irrigation O&M costs/ha	SP/ha			3500
O&M costs/Gross Margin	%			1

6. SMALL FARM: Well (50m), investment in modern irrigation: Drip

Total area of Farm: 1,5 ha
Crop distribution: 50 % Tomato ; 25 % Potato; 25% Oranges
Zone: Lattakia

Tomato	overlapping potato	total tomato	potato	oranges	total area planted	farm size	land intensification index
0,75	0,375	1,125	0,375	0,375	1,875	1,500	1,25

Irrigation fee (O&M costs)	2,16	SP/m3
water requirements in the farm	10750	m3
water requirements /ha	7167	m3/ha
total irrigation O&M costs	23221	SP

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg			652701
By-Product (straw)	ton			0
Gross Revenue				**652701**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	24		10740
Sowing	hr	5		563
Chemical Fertilizer Application	hr	0		0
Organic fertilizer Application	hr	0		0
Levelling	hr	3		1725
Herbicide Application	hr	4		938
Insecticides Application	hr	0		0
Controlling	hr	25		6413
Harvesting	hr	5		563
Other	hr	0		0
carring on car	Bag	0		0
Transport	Kg	2417		21231
Total Hired Machinery	%			42171
Total Owned Machinery	%			0
Total Machinery				**42171**
Labor (man-hours/ha):				
Tillages	hr	8		235
Sowing	hr	54		1702
Chemical Fertilizer Application	hr	56		1737
Organic fertilizer Application	hr	38		1174
Levelling	hr	36		1127
Herbicide Application	hr	19		587

Controlling	hr	81		2835
Weeding	hr	283		8389
Harvesting	hr	1571		51954
Other	hr	194		7575
Irrigation	hr	68		2660
Family Labor	%			79975
Hired Labor	%			0
Total Labor	hr	**2406**		**159950**
Material Inputs:				
Seed	kg	1125		16101
Chemical Fertilizer:	ha	0		3433
N	kg	150		2685
P	kg	56		1035
K	kg	56		1389
Other Types	kg	9377		13650
Manure	tons	18		5513
Containers (sacs)	No.	663		13438
Irrigation water	cu m	10750		23221
Total Inputs				**80465**
Credit:				
Credit in cash	SP	0		0
Credit in kind	SP	0		0
Credit for well drilling	SP	1	12125	12125
Credit for pump set	SP	1	9750	9750
Credit for irrigation technique	SP	1,500	8333	12500
Total credit	SP			34375
Interest Rate	%			4%
Credit Cost	SP			**1375**
Total Variable Costs				**124010**
Gross Margin				**528691**
Gross Margin/ha				**352460**
Fixed Costs:				
Family Labor	%			79975
Land Rent	ha			37125
Well drilling	SP	1	12125	12125
Pump set	SP	1	9750	9750
Land reclamation irrigation fee	ha	1,500	0	0
Irrigation technique				
Sprinklers	SP/HA			
Drip	SP/HA	1,500	8333	12500
levelling	SP/HA			
Total Fixed Costs				**151474**
Net Margin (Profit)				**377216**
Net Margin (Profit)/ha				**251478**

Gross Margin/unit Labor				**220**
Gross Margin/cu m of Water				**49,18**
Net Margin/cu m of Water				**35,09**
Irrigation Investment Annual Cost/ha	SP/ha			22916
Irrigation O&M costs/ha	SP/ha			15480
O&M costs/Gross Margin	%			4

1. WHEAT (LARGE FARM, RIVER, SURFACE)

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg	4000	11	44000
By-Product (straw)	ton			0
Gross Revenue				**44000**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	2,5	800	2000
Sowing	hr			0
Chemical Fertilizer Application	hr			0
Organic fertilizer Application	hr			0
Levelling	hr			0
Herbicide Application	hr			0
Insecticides Application	hr			0
Harvesting	hr	4	749	2996
Other	hr			0
carring on car(seal to Privet)	Bag	32	10	320
Transport(farm gate seal no Transportion cost)				
Total Hired Machinery	%	**100**		**5316**
Total Owned Machinery	%	**0**		**0**
Total Machinery				**5316**
Labor (man-hours/ha):				
Tillages	hr			
Sowing	hr	4	31,25	125
Chemical Fertilizer Application	hr	4	31,25	125
Organic fertilizer Application	hr			0
Levelling	hr			0
Herbicide Application	hr			0
Controlling	hr			0
Weeding	hr			0
Harvesting	hr			
Other	hr			
Irrigation	hr	60	39,4	2364
Family Labor	%	100		2614
Hired Labor	%	0		0
Total Labor	hr	**68**		**2614**
Material Inputs:				
Seed	kg	300	15,5	4650
Chemical Fertilizer:	ha			
N	kg	250	7,7	1925
P	kg	150	8,31	1247
K	kg			
Other Types	kg			
Manure	tons			
Containers (sacs)	No.	25	42	1050
Irrigation water	ha	1	3500	3500
Total Inputs				**12372**

Credit:				
Credit in cash/ha	SP			
Credit in kind/ha	SP	100	9	900
Credit well drilling	SP			
Credit pump set	SP			
Credit irrigation technique	SP			
Total credit/ha	SP			900
Interest Rate	%			4%
Credit Cost/ha	SP			**36**
Total Variable Costs				**17724**
Gross Margins				**26277**
Fixed Costs:				
Family Labor	%	100		2614
Land Rent	ha	1	10000	10000
Well drilling	SP			
Pump set	SP			
Total Fixed Costs				**12614**
Net Margin (Profit)				**13663**
Gross Margin/unit Labor				**386**
Gross Margin/cu m of Water				**6,54**
Net Margin/cu m of Water				**3,40**

2. COTTON (LARGE FARM, RIVER SURFACE)

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg	3500	29	101500
By-Product (straw)	ton			0
Gross Revenue				**101500**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	5	700	3500
Sowing	hr			0
Chemical Fertilizer Application	hr			0
Organic fertilizer Application	hr			0
Levelling	hr			0
Herbicide Application	hr	2	500	1000
Insecticides Application	hr			0
Harvesting	hr			
Other	hr			
carring on car(seal to Privet)	Bag			
Transport	kg	3500	0,86	3010
Total Hired Machinery	%	**100**		**7510**
Total Owned Machinery	%	**0**		**0**
Total Machinery				**7510**
Labor (man-hours/ha):				
Tillages	hr			
Sowing	hr	4	37,5	150
Chemical Fertilizer Application	hr	4	37,5	150
Organic fertilizer Application	hr			
Levelling	hr			
Herbicide Application	hr			
Controlling	hr			
Weeding	hr	91	55	5005
Harvesting	hr	468	21,4	10015
Other	hr			
Irrigation	hr	175	27	4725
Family Labor	%	25		5011
Hired Labor	%	75		15034
Total Labor	hr	**742**		**20045**
				Material Inputs:
Seed	kg	100	6	600
Chemical Fertilizer:	ha			
N	kg	500	7,7	3850
P	kg	450	8,31	3740
K	kg			
Other Types	kg			
Manure	tons			
Containers (sacs)	No.	25	85	2125
Irrigation water	ha	1	3500	3500
Total Inputs				**13815**
Credit:				
Credit in cash/ha	SP			4000
Credit in kind/ha	SP	250	9	2250

Total credit/ha	SP			6250
Interest Rate	%			4%
Credit Cost/ha	SP			**250**
Total Variable Costs				**36608**
Gross Margin				**64892**
Fixed Costs:				
Family Labor	%	25		5011
Land Rent	ha	1	13649	13649
Total Fixed Costs				**18660**
Net Margin (Profit)				**46231**
Gross Margin/unit Labor				**87**
Gross Margin/cu m of Water				**5,95**
Gross Margin/cu m of Water				**4,24**

3. SUGAR BEET (MEDIUM FARM, WELL-100, SURFACE)

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	Kg	60000	2	120000
By-Product (straw)	ton	10	500	5000
Gross Revenue				**125000**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	15	200	3000,0
Sowing	hr	0	0	0,0
Chemical Fertilizer Application	hr		0	0,0
Organic fertilizer Application	hr			0,0
Levelling	hr	2,5	500	1250,0
Herbicide Application	hr	0	0	0,0
Insecticides Application	hr			0,0
Harvesting	hr	0	0	0,0
Other	hr	0	0	0,0
carring on car(seal to Privet)				
Transport	Ton	70	200	14000,0
Total Hired Machinery	%	**100**		**18250**
Total Owned Machinery	%	**0**		**0**
Total Machinery				**18250**
Labor (man-hours/ha):				
Tillages	hr	0	0	0
Sowing	hr	50	40	2000
Chemical Fertilizer Application	hr	10	50	500
Organic fertilizer Application	hr	10	50	500
Levelling	hr	0	0	0
Herbicide Application	hr	150	50	7500
Controlling	hr	10	50	500
Weeding	hr	0	0	0
Harvesting	hr	100	100	10000
Other	hr	30	50	1500
Irrigation	hr	50	50	2500
Family Labor	%	100		25000
Hired Labor	%	0		0
Total Labor	hr	**410**		**25000**
Material Inputs:				
Seed	kg	10	265	2650
Chemical Fertilizer:	D			0
N	kg	600	8	4800
P	kg	300	8,5	2550
K	kg	250	12,5	3125
Other Types	kg			
Manure	tons			
Containers (sacs)	No.			0
Irrigation water	ha	1	3500,00	3500
Total Inputs				**16625**
Credit:				
Credit in cash/ha	SP			
Credit in kind/ha	SP			0
Total credit/ha	SP			0

Interest Rate	%			4%
Credit Cost/ha	SP			**0**
Total Variable Costs				**34875**
Gross Margin				**90125**
Fixed Costs:				
Family Labor	%	100		25000
Land Rent		1	21750	21750
Total Fixed Costs				**46750**
Net Margin (Profit)				**43375**
Gross Margin/unit Labor				**220**
Gross Margin/cu m of Water				**15,02**
Net Margin/cu m of Water				**7,23**

4. POTATO (MEDIUM FARM, WELL-100, SURFACE)

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg	20250	8,25	167063
By-Product (straw)	ton			0
Gross Revenue				**167063**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	10	225	2250
Sowing	hr	10	100	1000
Chemical Fertilizer Application	hr			0
Organic fertilizer Application	hr			0
Levelling	hr			0
Herbicide Application	hr		10	50 500
Insecticides Application	hr		10	50 500
Harvesting	hr	10	200	2000
Other	hr			0
carring on car(seal to Privet)	bag		50	40 2000
Transport	Ton	1	2000	2000
Total Hired Machinery	%	**100**		**10250**
Total Owned Machinery	%	**0**		**0**
Total Machinery				**10250**
Labor (man-hours/ha):				
Tillages	hr			
Sowing	hr	0	0	0
Chemical Fertilizer Application	hr		10	50 500
Organic fertilizer Application	hr		10	50 500
Levelling	hr	0	0	0
Herbicide Application	hr		10	50 500
Controlling	hr	0	0	0
Weeding	hr	0	0	0
Harvesting	hr	10	700	7000
Other	hr	0	0	0
Irrigation	hr	10	400	4000
Family Labor	%	100		12500
Hired Labor	%	0		0
Total Labor	hr	**50**		**12500**
Material Inputs:				
Seed	No.	3500	13	45500
Chemical Fertilizer:	ha			
N	kg	500	7,8	3900
P	kg	250	10	2500
K	kg	250	10	2500
Other Types	kg			
Manure	tons	50	400	20000
Containers (sacs)	No.	500	10	5000
Irrigation water	ha	1	3500,00	3500
Total Inputs				**82900**
Credit:				
Credit in cash/ha	SP			

Credit in kind/ha	SP			0
Total credit/ha	SP			0
Interest Rate	%			4%
Credit Cost/ha	SP			**0**
Total Variable Costs				**93150**
Gross Margin				**73913**
Fixed Costs:				
Family Labor	%	100		12500
Land Rent	ha	1	21600	21600
Total Fixed Costs				**34100**
Net Margin (Profit)				**39813**
Gross Margin/unit Labor				**1478**
Gross Margin/cu m of Water				**13,44**
Net Margin/cu m of Water				**7,24**

5. TOMATO (SMALL FARM, WELL-50, DRIP)

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg	34160	9,45	322812
By-Product (straw)	ton			0
Gross Revenue				**322812**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	11	560	6160
Sowing	hr			
Chemical Fertilizer Application	hr			
Organic fertilizer Application	hr			
Levelling	hr	2	575	1150
Herbicide Application	hr			
Insecticides Application	hr			
Controlling	hr	2	350	700
Harvesting	hr			
Other	hr			
carring on car(seal to Privet)	Bag			
Transport	Ton	40	347	13880
Total Hired Machinery	%	**100**		**21890**
Total Owned Machinery	%	**0**		**0**
Total Machinery				**21890**
Labor (man-hours/ha):				
Tillages	hr			
Sowing	hr	35	31,3	1096
Chemical Fertilizer Application	hr	24	31,3	751
Organic fertilizer Application	hr	20	31,3	626
Levelling	hr	24	31,3	751
Herbicide Application	hr			0
Controlling	hr	40	35	1400
Weeding	hr	185	31,3	5791
Harvesting	hr	1050	31,3	32865
Other	hr			0
Irrigation	hr	36	39,4	1418
Family Labor	%	100		44698
Hired Labor	%	0		0
Total Labor	hr	**1414**		**44698**
Material Inputs:				
Seed	kg	0,32	4100	1312
Chemical Fertilizer:	ha			
N	kg			
P	kg			
K	kg			
Other Types	kg	1	3000	3000
Manure	tons	10	300	3000
Containers (sacs)	Ha	1	2800	2800
Irrigation water	cu m	5586,6	2,16	12067
Total Inputs				**22179**
Credit:				

Credit in cash/ha	SP			
Credit in kind/ha	SP	0	0	0
Total credit/ha	SP			0
Interest Rate	%			4%
Credit Cost/ha	SP			**0**
Total Variable Costs				**44069**
Gross Margin				**278743**
Fixed Costs:				
Family Labor	%	100		44698
Land Rent	ha	1	18000	18000
Total Fixed Costs				**62698**
Net Margin (Profit)				**216045**
Gross Margin/unit Labor				**197**
Gross Margin/cu m of Water				**49,9**
Net Margin/cu m of Water				**38,7**

6. ORANGES (SMALL FARM, WELL-50, DRIP)

	UNIT	QUANTITY	PRICE (SP)	TOTAL Value (SP)
Main Product	kg	30800	16	492800
By-Product (straw)	ton			0
Gross Revenue				**492800**
Land Operations:				
Machinery (hours/ha):				
Tillages	hr	20	200	4000
Sowing	hr			0
Chemical Fertilizer Application	hr			0
Organic fertilizer Application	hr			0
Levelling	hr			0
Herbicide Application	hr	10	250	2500
Insecticides Application	hr			0
Controlling	hr	60	250	15000
Harvesting	hr			0
Other	hr			0
carring on car(seal to Privet)	Bag			0
Transport	kg	6300	1	6300
Total Hired Machinery	%	**100**		**27800**
Total Owned Machinery	%	**0**		**0**
Total Machinery				**27800**
Labor (man-hours/ha):				
Tillages	hr	20	31,3	626
Sowing	hr		0	0
Chemical Fertilizer Application	hr	60	31,3	1878
Organic fertilizer Application	hr	20	31,3	626
Levelling	hr			0
Herbicide Application	hr			0
Controlling	hr	60	35	2100
Weeding	hr	200	25	5000
Harvesting	hr	500	39,4	19700
Other	hr	500	39,4	19700
Irrigation	hr	36	39,4	1418
Family Labor	%	100		51048
Hired Labor	%	0		0
Total Labor	hr	**1396**		**51048**
				Material Inputs:
Seed	kg			0
Chemical Fertilizer:	ha			0
N	kg	400	17,9	7160
P	kg	150	18,4	2760
K	kg	150	24,7	3705
Other Types	kg	25000	1	25000
Manure	tons	10	300	3000
Containers (sacs)	No.	1050	20	21000
Irrigation water	cu m	6507,6	2,16	14056
Total Inputs				**76681**
				Credit:

Credit in cash/ha	SP			0
Credit in kind/ha	SP	0	0	0
Total credit/ha	SP			0
Interest Rate	%			4%
Credit Cost/ha	SP			**0**
Total Variable Costs				**104481**
Gross Margin				**388319**
Fixed Costs:				
Family Labor	%	100		51048
Land Rent	ha	1	25000	25000
Total Fixed Costs				**76048**
Net Margin (Profit)				**312270**
Gross Margin/unit Labor				**278**
Gross Margin/cu m of Water				**59,67**
Net Margin/cu m of Water				**47,99**

ANNEX 5

POLICY SIMULATION SCENARIOS

Scenario 1: Modernization of all irrigated area in four years and development of 414395 ha of new irrigation

Year 2000

Water balance

	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2000									
Rain fall (Actual /average)	%	59%	49%	30%	60%	80%	40%	100%-40%	-
Water resources (surface)	million m3	12	88	49	666	1246	315	6818	9194
Water resources (underground)	million m3	490	131	54	964	622	640	2494	5395
Water resources (total)	million m3	502	219	103	1630	1868	955	9312	14589
Utilization rate	%	0.90	0.85	0.60	0.85	0.65	0.95	0.98	-
Actually available	million m3	452	186	62	1386	1214	907	9126	13332
Domestic & Industrial waste water	million m3	257	50	8	214	0	36	130	695
Agricultural drainage	million m3	568	36	-	231	43	428	725	2031
Total available for use	million m3	1277	272	70	1831	1257	1371	9981	16058
Water use									
Irrigated area	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Irrigation requirements	m3/ha	16000	10500	11000	9100	6000	10600	16700	12429
Irrigation water use	million m3	**1207**	**360**	**43**	**2306**	**433**	**4283**	**7228**	**15860**
Population	million persons	4.0890	0.9430	0.1130	2.5280	1.8290	0.6690	4.1050	14.2760
Requirements per person	m3/per capita	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Domestic water use	million m3	298	69	8	185	134	49	300	1042
Industry water use	million m3	77	18	2	48	35	13	78	315
Evaporation	million m3	5	31	15	148	16	132	1643	1 990
Total uses	million m3	1588	478	68	2687	617	4477	9249	19162
Balance	million m3	**-311**	**-206**	**2**	**-856**	**640**	**-3105**	**732**	**-3104**

Year 2001

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2001		1								
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation	ha		0	1987	0	8794	1600	5423	10000	27804
Modernization	ha	319017	18857	8575	968	63357	18033	101019	108209	319017
Total area (new and modernized)	ha		18857	10562	968	72151	19633	106442	118209	346821
Irrigation requirements (modernized)	m3/ha		11200	7350	7700	6370	4200	7420	11690	8700.2191
Total water used	million m3		211	78	7	460	82	790	1382	3010
Total to be modernized	ha		56572	25724	2903	190070	54099	303056	324626	957051
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		905	270	32	1730	325	3212	5421	11895
Total water use irrigation	million m3		**1116**	**348**	**39**	**2189**	**407**	**4002**	**6803**	**14905**
Domestic	million m3		306	71	8	189	137	50	307	1068
Industry	million m3		83	19	2	51	37	14	83	335
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1510	468	65	2578	597	4198	8836	18252
Balance	million m3		**-233**	**-196**	**5**	**-747**	**660**	**-2827**	**1144**	**-2194**

Year 2014

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2014			14							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha		0	13620	0	81970	17260	61545	105000	279395
New irrigation in 2010 to 2014	ha		0	0	0	4000	0	60000	44000	108000
Total new irrigation	ha		0	13620	0	85970	17260	121545	149000	387395
Modernization	ha	1276068	75429	34299	3871	253427	72132	404075	432835	1276068
Total new and modernized	ha		75429	47919	3871	339397	89392	525620	581835	1663463
CWR modernized	m3		11200	7350	7700	6370	4200	7420	11690	8696
Total water use modernized	million m3		845	352	30	2162	375	3900	6802	14466
Total to be modernized	ha		0	0	0	0	0	0	0	0
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		0	0	0	0	0	0	0	0
Total water use irrigation	million m3		**845**	**352**	**30**	**2162**	**375**	**3900**	**6802**	**14466**
Domestic	million m3		403	93	11	249	180	66	404	1406
Industry	million m3		109	25	3	68	49	18	110	426
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1362	501	59	2626	620	4116	8958	18243
Balance	million m3		**-85**	**-229**	**11**	**-796**	**637**	**-2745**	**1022**	**-2184**

Year 2015

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2015			15							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha		0	13620	0	81970	17260	61545	105000	279395
New irrigation in 2010 to 2015	ha		0	0	0	5000	0	75000	55000	135000
Total new irrigation	ha		0	13620	0	86970	17260	136545	160000	414395
Modernization	ha	1276068	75429	34299	3871	253427	72132	404075	432835	1276068
Total new and modernized	ha		75429	47919	3871	340397	89392	540620	592835	1690463
CWR modernized	m3		11200	7350	7700	6370	4200	7420	11690	8703
Total water use modernized	million m3		845	352	30	2168	375	4011	6930	14712
Total to be modernized	ha		0	0	0	0	0	0	0	0
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		0	0	0	0	0	0	0	0
Total water use irrigation	million m3		**845**	**352**	**30**	**2168**	**375**	**4011**	**6930**	**14712**
Domestic	million m3		411	95	11	254	184	67	413	1436
Industry	million m3		112	26	3	69	50	18	112	434
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1373	504	59	2640	625	4229	9098	18528
Balance	million m3		**-96**	**-232**	**11**	**-809**	**632**	**-2858**	**883**	**-2469**

Scenario 2: Modernization of the whole irrigated area in 15 years

Year 2000

	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2000									
Rain fall (Actual /average)	%	59%	49%	30%	60%	80%	40%	100%-40%	-
Water resources (surface)	million m3	12	88	49	666	1246	315	6818	9194
Water resources (underground)	million m3	490	131	54	964	622	640	2494	5395
Water resources (total)	million m3	502	219	103	1630	1868	955	9312	14589
Utilization rate	%	0.90	0.85	0.60	0.85	0.65	0.95	0.98	-
Actually available	million m3	452	186	62	1386	1214	907	9126	13332
Domestic & Industrial waste water	million m3	257	50	8	214	0	36	130	695
Agricultural drainage	million m3	568	36	-	231	43	428	725	2031
Total available for use	million m3	1277	272	70	1831	1257	1371	9981	16058
Water use									
Irrigated area	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Irrigation requirements	m3/ha	16000	10500	11000	9100	6000	10600	16700	12429
Irrigation water use	million m3	**1207**	**360**	**43**	**2306**	**433**	**4283**	**7228**	**15860**
Population	million persons	4.0890	0.9430	0.1130	2.5280	1.8290	0.6690	4.1050	14.2760
Requirements per person	m3/per capita	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Domestic water use	million m3	298	69	8	185	134	49	300	1042
Industry water use	million m3	77	18	2	48	35	13	78	315
Evaporation	million m3	5	31	15	148	16	132	1643	1 990
Total uses	million m3	1588	478	68	2687	617	4477	9249	19162
Balance	million m3	**-311**	**-206**	**2**	**-856**	**640**	**-3105**	**732**	**-3104**

Year 2001

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2001			1							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the ba	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation	ha		0	0	0	0	0	0	0	0
Modernization	ha	80000	4729	2150	243	15888	4522	25333	27136	80000
Total area (new and modernized)	ha		4729	2150	243	15888	4522	25333	27136	80000
Irrigation requirements (modernized)	m3/ha		11200	7350	7700	6370	4200	7420	11690	8700.22
Total water used	million m3		53	16	2	101	19	188	317	696
Total to be modernized	ha		70700	32149	3628	237539	67610	378742	405699	1196068
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		1131	338	40	2162	406	4015	6775	14866
Total water use irrigation	million m3		**1184**	**353**	**42**	**2263**	**425**	**4203**	**7092**	**15562**
Domestic	million m3		306	71	8	189	137	50	307	1068
Industry	million m3		83	19	2	51	37	14	83	335
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1578	474	68	2651	615	4398	9126	18909
Balance	million m3		**-301**	**-202**	**2**	**-821**	**643**	**-3027**	**855**	**-2851**

Year 2014

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2014			14							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the ba	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha		0	0	0	0	0	0	0	0
New irrigation in 2010 to 2014	ha		0	0	0	0	0	0	0	0
Total new irrigation	ha		0	0	0	0	0	0	0	0
Modernization	ha	1120000	66204	30104	3398	222432	63310	354655	379898	1120000
Total new and modernized	ha		66204	30104	3398	222432	63310	354655	379898	1120000
CWR modernized	m3		11200	7350	7700	6370	4200	7420	11690	8700
Total water use modernized	million m3		741	221	26	1417	266	2632	4441	9744
Total to be modernized	ha		9225	4195	473	30995	8822	49420	52937	156068
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		148	44	5	282	53	524	884	1940
Total water use irrigation	million m3		**889**	**265**	**31**	**1699**	**319**	**3155**	**5325**	**11684**
Domestic	million m3		403	93	11	249	180	66	404	1406
Industry	million m3		109	25	3	68	49	18	110	426
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1406	414	61	2163	564	3371	7482	15461
Balance	million m3		**-129**	**-142**	**9**	**-333**	**693**	**-2000**	**2499**	**598**

Year 2015

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2015			15							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the ba	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha		0	0	0	0	0	0	0	0
New irrigation in 2010 to 2015	ha		0	0	0	0	0	0	0	0
Total new irrigation	ha		0	0	0	0	0	0	0	0
Modernization	ha	1200000	70933	32254	3640	238320	67832	379988	407033	1200000
Total new and modernized	ha		70933	32254	3640	238320	67832	379988	407033	1200000
CWR modernized	m3		11200	7350	7700	6370	4200	7420	11690	8700
Total water use modernized	million m3		794	237	28	1518	285	2820	4758	10440
Total to be modernized	ha		4496	2045	231	15107	4300	24087	25802	76068
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		72	21	3	137	26	255	431	945
Total water use irrigation	million m3		**866**	**259**	**31**	**1656**	**311**	**3075**	**5189**	**11386**
Domestic	million m3		411	95	11	254	184	67	413	1436
Industry	million m3		112	26	3	69	50	18	112	434
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1394	410	60	2127	561	3292	7357	15201
Balance	million m3		**-117**	**-138**	**10**	**-296**	**697**	**-1921**	**2624**	**857**

Scenario 3. Modernization of 80000 ha/year +27600 ha/year of new irrigation

Year 2000

	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2000									
Rain fall (Actual /average)	%	59%	49%	30%	60%	80%	40%	100%-40%	-
Water resources (surface)	million m3	12	88	49	666	1246	315	6818	9194
Water resources (underground)	million m3	490	131	54	964	622	640	2494	5395
Water resources (total)	million m3	502	219	103	1630	1868	955	9312	14589
Utilization rate	%	0.90	0.85	0.60	0.85	0.65	0.95	0.98	-
Actually available	million m3	452	186	62	1386	1214	907	9126	13332
Domestic & Industrial waste water	million m3	257	50	8	214	0	36	130	695
Agricultural drainage	million m3	568	36	-	231	43	428	725	2031
Total available for use	million m3	1277	272	70	1831	1257	1371	9981	16058
Water use									
Irrigated area	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Irrigation requirements	m3/ha	16000	10500	11000	9100	6000	10600	16700	12429
Irrigation water use	million m3	**1207**	**360**	**43**	**2306**	**433**	**4283**	**7228**	**15860**
Population	million persons	4.0890	0.9430	0.1130	2.5280	1.8290	0.6690	4.1050	14.2760
Requirements per person	m3/per capita	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Domestic water use	million m3	298	69	8	185	134	49	300	1042
Industry water use	million m3	77	18	2	48	35	13	78	315
Evaporation	million m3	5	31	15	148	16	132	1643	1 990
Total uses	million m3	1588	478	68	2687	617	4477	9249	19162
Balance	million m3	**-311**	**-206**	**2**	**-856**	**640**	**-3105**	**732**	**-3104**

Year 2001

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2001			1							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation	ha		0	1987	0	8794	1600	5423	10000	27804
Modernization	ha	80000	4729	2150	243	15888	4522	25333	27136	80000
Total area (new and modernized)	ha		4729	4137	243	24682	6122	30756	37136	107804
Irrigation requirements (modernized)	m3/ha		11200	7350	7700	6370	4200	7420	11690	8700.2191
Total water used	million m3		53	30	2	157	26	228	434	930
Total to be modernized	ha		70700	32149	3628	237539	67610	378742	405699	1196068
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		1131	338	40	2162	406	4015	6775	14866
Total water use irrigation	million m3		**1184**	**368**	**42**	**2319**	**431**	**4243**	**7209**	**15796**
Domestic	million m3		306	71	8	189	137	50	307	1068
Industry	million m3		83	19	2	51	37	14	83	335
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1578	489	68	2707	621	4438	9243	19144
Balance	million m3		**-301**	**-216**	**2**	**-877**	**636**	**-3067**	**738**	**-3085**

Year 2014

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2014			14							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha		0	13620	0	81970	17260	61545	105000	279395
New irrigation in year 2012	ha		0	0	0	4000	0	60000	44000	108000
Total new irrigation	ha		0	13620	0	85970	17260	121545	149000	387395
Modernization	ha	1120000	66204	30104	3398	222432	63310	354655	379898	1120000
Total new and modernized	ha		66204	43724	3398	308402	80570	476200	528898	1507395
CWR modernized	m3		11200	7350	7700	6370	4200	7420	11690	8696
Total water use modernized	million m3		741	321	26	1965	338	3533	6183	13108
Total to be modernized	ha		9225	4195	473	30995	8822	49420	52937	156068
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		148	44	5	282	53	524	884	1940
Total water use irrigation	million m3		**889**	**365**	**31**	**2247**	**391**	**4057**	**7067**	**15048**
Domestic	million m3		403	93	11	249	180	66	404	1406
Industry	million m3		109	25	3	68	49	18	110	426
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1406	514	61	2711	636	4273	9224	18825
Balance	million m3		**-129**	**-242**	**9**	**-880**	**621**	**-2902**	**757**	**-2766**

Year 2015

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2015			15							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha		0	13620	0	81970	17260	61545	105000	279395
New irrigation in year 2012	ha		0	0	0	5000	0	75000	55000	135000
Total new irrigation	ha		0	13620	0	86970	17260	136545	160000	414395
Modernization	ha	1200000	70933	32254	3640	238320	67832	379988	407033	1200000
Total new and modernized	ha		70933	45874	3640	325290	85092	516533	567033	1614395
CWR modernized	m3		11200	7350	7700	6370	4200	7420	11690	8703
Total water use modernized	million m3		794	337	28	2072	357	3833	6629	14050
Total to be modernized	ha		4496	2045	231	15107	4300	24087	25802	76068
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		72	21	3	137	26	255	431	945
Total water use irrigation	million m3		**866**	**359**	**31**	**2210**	**383**	**4088**	**7060**	**14996**
Domestic	million m3		411	95	11	254	184	67	413	1436
Industry	million m3		112	26	3	69	50	18	112	434
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1394	510	60	2681	633	4306	9227	18811
Balance	million m3		**-117**	**-238**	**10**	**-850**	**624**	**-2934**	**753**	**-2753**

Scenario 4. Differentiated policy: Modernization of all the irrigated area in the Al Khabour and Orontes basins in five years and 15 years in the remaining basins +120000 ha/year of new irrigation in Euphrates and 45000 in the Coast basins

Year 2000

	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2000									
Rain fall (Actual /average)	%	59%	49%	30%	60%	80%	40%	100%-40%	-
Water resources (surface)	million m3	12	88	49	666	1246	315	6818	9194
Water resources (underground)	million m3	490	131	54	964	622	640	2494	5395
Water resources (total)	million m3	502	219	103	1630	1868	955	9312	14589
Utilization rate	%	0.90	0.85	0.60	0.85	0.65	0.95	0.98	-
Actually available	million m3	452	186	62	1386	1214	907	9126	13332
Domestic & Industrial waste water	million m3	257	50	8	214	0	36	130	695
Agricultural drainage	million m3	568	36	-	231	43	428	725	2031
Total available for use	million m3	1277	272	70	1831	1257	1371	9981	16058
Water use									
Irrigated area	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Irrigation requirements	m3/ha	16000	10500	11000	9100	6000	10600	16700	12429
Irrigation water use	million m3	**1207**	**360**	**43**	**2306**	**433**	**4283**	**7228**	**15860**
Population	million persons	4.0890	0.9430	0.1130	2.5280	1.8290	0.6690	4.1050	14.2760
Requirements per person	m3/per capita	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Domestic water use	million m3	298	69	8	185	134	49	300	1042
Industry water use	million m3	77	18	2	48	35	13	78	315
Evaporation	million m3	5	31	15	148	16	132	1643	1 990
Total uses	million m3	1588	478	68	2687	617	4477	9249	19162
Balance	million m3	**-311**	**-206**	**2**	**-856**	**640**	**-3105**	**732**	**-3104**

Year 2001

	Unit		Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2001			1							
Irrigated area in 2000	ha		75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%		0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation	ha		0	0	0	0	3000	0	25000	28000
Modernization	ha	80000	5029	2287	258	50685	4809	80815	28856	172738
Total area (new and modernized)	ha		5029	2287	258	50685	7809	80815	53856	200738
Irrigation requirements (modernized)	m3/ha		11200	7350	7700	6370	4200	7420	11690	8700.2191
Total water used	million m3		56	17	2	323	33	600	630	1660
Total to be modernized	ha		70400	32012	3613	202742	67323	323260	403979	1103330
CWR for not modernized	m3		16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3		1126	336	40	1845	404	3427	6746	13924
Total water use irrigation	million m3		**1183**	**353**	**42**	**2168**	**437**	**4026**	**7376**	**15584**
Domestic	million m3		306	71	8	189	137	50	307	1068
Industry	million m3		83	19	2	51	37	14	83	335
Evaporation	million m3		5	31	15	148	16	132	1643	1 990
Total uses	million m3		1576	474	67	2556	627	4222	9409	18931
Balance	million m3		**-300**	**-201**	**2**	**-726**	**631**	**-2851**	**571**	**-2873**

Year 2014

	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2014		14							
Irrigated area in 2000	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%	0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha	0	0	0	0	30000	0	120000	150000
New irrigation in 2010 to 2014	ha	0	0	0	0	12000	0	0	12000
Total new irrigation	ha	0	0	0	0	42000	0	120000	162000
Modernization	ha	70400	32012	3613	253427	67323	404075	403979	1234830
Total new and modernized	ha	70400	32012	3613	253427	109323	404075	523979	1396830
CWR modernized	m3	11200	7350	7700	6370	4200	7420	11690	8769
Total water use modernized	million m3	788	235	28	1614	459	2998	6125	12249
Total to be modernized	ha	5029	2287	258	0	4809	0	28856	41238
CWR for not modernized	m3	16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3	80	24	3	0	29	0	482	618
Total water use irrigation	million m3	**869**	**259**	**31**	**1614**	**488**	**2998**	**6607**	**12867**
Domestic	million m3	403	93	11	249	180	66	404	1406
Industry	million m3	109	25	3	68	49	18	110	426
Evaporation	million m3	5	31	15	148	16	132	1643	1 990
Total uses	million m3	1386	408	60	2079	733	3214	8764	16644
Balance	million m3	**-109**	**-136**	**10**	**-248**	**524**	**-1843**	**1217**	**-585**

Year 2015

	Unit	Barada & Awag	Yarmouk	Al Badia	Orontos Al Asi)	(Coastal	Al Khabour	Euphrates and Tigris	Total
Year 2015		15							
Irrigated area in 2000	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Percentage of irrigated area in the bas	%	0.06	0.03	0.00	0.20	0.06	0.32	0.34	1
New irrigation up to year 2010	ha	0	0	0	0	30000	0	120000	150000
New irrigation in 2010 to 2015	ha	0	0	0	0	15000	0	0	15000
Total new irrigation	ha	0	0	0	0	45000	0	120000	165000
Modernization	ha	75429	34299	3871	253427	72132	404075	432835	1276068
Total new and modernized	ha	75429	34299	3871	253427	117132	404075	552835	1441068
CWR modernized	m3	11200	7350	7700	6370	4200	7420	11690	8809
Total water use modernized	million m3	845	252	30	1614	492	2998	6463	12694
Total to be modernized	ha	0	0	0	0	0	0	0	0
CWR for not modernized	m3	16000	10500	11000	9100	6000	10600	16700	
Total water used not modernized	m3	0	0	0	0	0	0	0	0
Total water use irrigation	million m3	**845**	**252**	**30**	**1614**	**492**	**2998**	**6463**	**12694**
Domestic	million m3	411	95	11	254	184	67	413	1436
Industry	million m3	112	26	3	69	50	18	112	434
Evaporation	million m3	5	31	15	148	16	132	1643	1 990
Total uses	million m3	1373	404	59	2086	742	3216	8631	16509
Balance	million m3	**-96**	**-132**	**11**	**-255**	**515**	**-1845**	**1350**	**-451**

ANNEX 6

DESCRIPTION AND ORGANIZATION OF THE DATA BASES

The Utilization of water resources for Agriculture in the SAR: Analysis of the current regime and policy

Data bases

Contents:

1- Farm models database

Description of the data base:

The data base is composed by a series of farm models in excel sheets. Each file contains a farm model as defined bellow.
Each farm model is defined by:

- The size of the farm with a defined cropping pattern (Large farm, medium farm and small farm)
- The type of water source (river, well 100 m., well 200 m.,well 50m)
- The irrigation technique (surface, sprinkler, drip)

In each file of a specific farm model, the characteristics of the farm are defined (e.g. Large Farm (14 ha) – River water – surface irrigation) and the cropping pattern is specified (14 ha total area of farm, of which 70% wheat: 9,8 ha; 30% cotton: 4,2 ha). The spread sheet is organized as follows:

- One sheet for each crop (e.g. wheat, cotton) which includes the crop budget for each particular crop (for one ha)
- One sheet for the total has of each crop (eg. Total wheat, total cotton), which gives the crop budget for the total number of has of a particular crop in a particular type of farm (e. g. 9,8 ha for total wheat, 4,2 ha for total cotton). The sheets of the 'total crop' are linked to the 'single crop' sheet so that if simulations are done in the single crops (e.g. a reduction of the irrigation water requirement when adopting modern irrigation, or an increase in yields) it is reflected automatically in the 'total crop' sheet according to the number of has of this crop.

- One final sheet for the farm budget linked to the 'total crop' sheets. All irrigation investment costs (e.g. well drilling, pump set, drip irrigation equipment) are included only in the farm budget sheet.

Index of farm models

FILE NAME	DESCRIPTION
LARGEFARM-R-S	Large Farm, river water, surface irrigation, no investment in modern irrigation
LARGEFARM-R-MS	Large Farm, river water, modern irrigation: Sprinklers
LARGEFARM-R-MD	Large Farm, river water, modern irrigation: Drip
LARGEFARM-R-W100-S	Large Farm, water from well 100m , surface irrigation, no investment in modern irrigation
LARGEFARM-W100-MS	Large Farm, water from well 100m , investment in modern irrigation: sprinklers
LARGEFARM-W100-MD	Large Farm, water from well 100m , investment in modern irrigation: drip
LARGEFARM-R-W200-S	Large Farm, water from well 200m, surface irrigation, no investment in modern irrigation
LARGEFARM-W200-MS	Large Farm, water from well 200m, investment in modern irrigation: sprinklers
LARGEFARM-W200-MD	Large Farm, water from well 200m, investment in modern irrigation: drip
MEDIUMFARM-R-S	Medium Farm, river water, surface irrigation, no investment in modern irrigation
MEDIUMFARM-R-MS	Medium Farm, river water, modern irrigation: Sprinklers
MEDIUMFARM-R-MD	Medium Farm, river water, modern irrigation: Drip
MEDIUMFARM-R-W100-S	Medium Farm, water from well 100m, surface irrigation, no investment in modern irrigation
MEDIUMFARM-W100-MS	Medium Farm, water from well 100m, investment in modern irrigation: sprinklers
MEDIUMFARM-W100-MD	Medium Farm, water from well 100m , investment in modern irrigation: drip
SMALLFARM-R-S	Small Farm, river water, surface irrigation, no investment in modern irrigation
SMALLFARM-R-MS	Small Farm, river water, modern irrigation: Sprinklers
SMALLFARM-R-MD	Small Farm, river water, modern irrigation: Drip
SMALLFARM-R-W50-S	Small Farm, water from well 50 m , surface irrigation, no investment in modern irrigation
SMALLFARM-W50-MS	Small Farm, water from well 50 m , investment in modern irrigation: sprinklers
SMALLFARM-W50-MD	Small Farm, water from well 50 m, investment in modern irrigation: drip

2. Water balances per basin database

Water balances are calculated according to four different scenarios
Every Scenario is in one sheet of the spreadsheet and defined at the top of the sheet. A summary table of the four scenarios is the following:

Scenario 1	Present policy	Irrigation modernization (319.017 ha/yr) (4 years) Irrigation expansion (4414.395 ha) (15 years)
Scenario 2	Modernization Policy	Modernization of existing irrigation schemes (15 years) No irrigation expansion
Scenario 3	Long-term combined policy	Irrigation modernization (80.000 ha/yr) (15 years) Irrigation expansion (15 years)
Scenario 4	Differentiated policy (modernization in critical basins and irrigation expansion in selected basins)	Modernization in critical basins (Al Kahbour and Orontes) in 5 years No irrigation expansion in critical basins (Al Kahbour and Orontes) Modernization of remaining basins in 15 years Irrigation expansion only in Euphrates basin (120.000 ha) and in Coastal basin (45.000 ha)

- The assumptions made for the development and modernization of irrigation areas are located at the bottom of each sheet for each scenario.
- The assumptions made for the domestic and industrial sectors can be found in the corresponding cells but they are based on 200 l/person /day (domestic) and 19,8 l/person/ day for the industrial sector.
- The rate of growth for the population adopted was 2,45% for the first five year and 2,16% for the remaining 10 years

3- Irrigation investment and O&M costs

The file contains:

- The estimated investment cost for the drilling of wells of different depth (50, 100, 200). Information was gathered from the field and from Syrian reports.
- The investment estimated cost pump sets of different categories
- The investment cost of modern irrigation techniques
- For each of the above categories the annual amortization cost was determined using lineal depreciation. The interest compound amortization was also determined but not used in the farm models.
- For each category of irrigation equipment the O&M cost were also determined
- The labor cost for each type of irrigation was also determined but this information is very rough as change with the type of crop and number of irritations.

4- LEGAL REGULATIONS CONCERNING THE IRRIGATION WATER SECTOR

The file contains a compilation of legal regulations that concern irrigation policies in Syria (these are included in Annex 1)