A case study on the contradictions between the expectations and the actual results of water resources planning: lower Seyhan irrigation project of Adana- Turkey

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A CASE STUDY ON THE CONTRADICTIONS BETWEEN THE EXPECTATIONS AND THE ACTUAL RESULTS OF WATER RESOURCES PLANNING: LOWER SEYHAN IRRIGATION PROJECT OF ADANA- TURKEY

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INTRODUCTION

It is well known that soil is the leading factor in agricultural production. Water, on the other hand, is the most important factor in increasing production, or in getting the highest possible level of yield under existing agricultural conditions. It is an important factor to help with other production inputs, and also to stabilize production in any climate.

It is natural to have enormous investments in these developments, since careful use of soil and water resources is important in increasing agricultural production.

There has been a subtantial development and improvement in the agricultural sector since the foundation of the Republic of Turkey in 1923, both in terms of expansion of arable land and increase in agricultural productivity.

During this period, agricultural land has increased from 11.7 million hectares up to 28.5 million hectares and this reflects an improvement of 2.5 times in the total area of arable land. On the other land, the population of the country has reached 60 millions, from 10.5 millions in the early 1920's, which also reflects an increase of approximately 6 times. Furthermore, the ratio of productivity and net income, per hectare, has gone up 2-10 times and 10-20 times, respectively, depending on the variety of agricultural products. All these developments have made Turkey one of the 7 or 8 countries in the world which are self-sufficient in food and fibre production.

It can be concluded that 36.5% of the total land in Turkey is suitable for agriculture while 25.9% is forest. At the same time 32% of total irrigable area is under irrigation, whereas 68% is not yet irrigated, and 16% of available water resources is used for irrigation and for other purposes, while 84% is not used.

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Realization of high-yielding, persistent and successful irrigated farming requires detailed soil surveys, selection of alternate land utilization patterns and maintenance of the suitable patterns in every stage of the irrigation projects, skilled soil management, accurate size determination of the projects area, precise determination of water supply according to encountered land utilization patterns and size of the area, efficient application of irrigation water, efficient and durable drainage, effective extension services, and the other necessary technical amendments.

Irrigation has an essential role in agricultural production in Turkey. Crop yields have increased to large amounts with irrigation.

The place of exportation of agricultural products in total export income has increased from 1.2 billion dollars in 1980 to 2,2 billion dollars in 1990. In the same period, the total exports, have increased from 2,2 billion dollars to 14.0 billion dollars.

Since 1937 many irrigation projects have been undertaken in Turkey. The Lower Seyhan Irrigation system (ASO) is the one of the first projects established during the time of the republic. Fifty five years later, the most significant project is the South-East Anatolia Project (GAP). Its construction was begun within the last ten years.

This study has been prepared for two purposes, one of it is to give an overview "On the Contradictions Between the Expectations and the Actual Results of Water Resources Planning": It is a case study on Lower Seyhan Irrigation Project of Adana, Turkey.

The second aim of the study it to give a detailed information on one of the world largest irrigation projects, namely, Southeastern Anatolia project (GAP) and its importance for Turkish agriculture.

Materialization of a high yielding agricultural system will involve solutions to existing problems related to the choice and use of technology, inputs, economic incentives, and institutional restructuring.

Experiences gained from the Lower Seyhan Irrigation Project must be used in the South-East Anatolia Projects to obtain the maximum profit expected from GAP. The schematic presentation of locations where ASO and GAP were established is shown in figure 1.

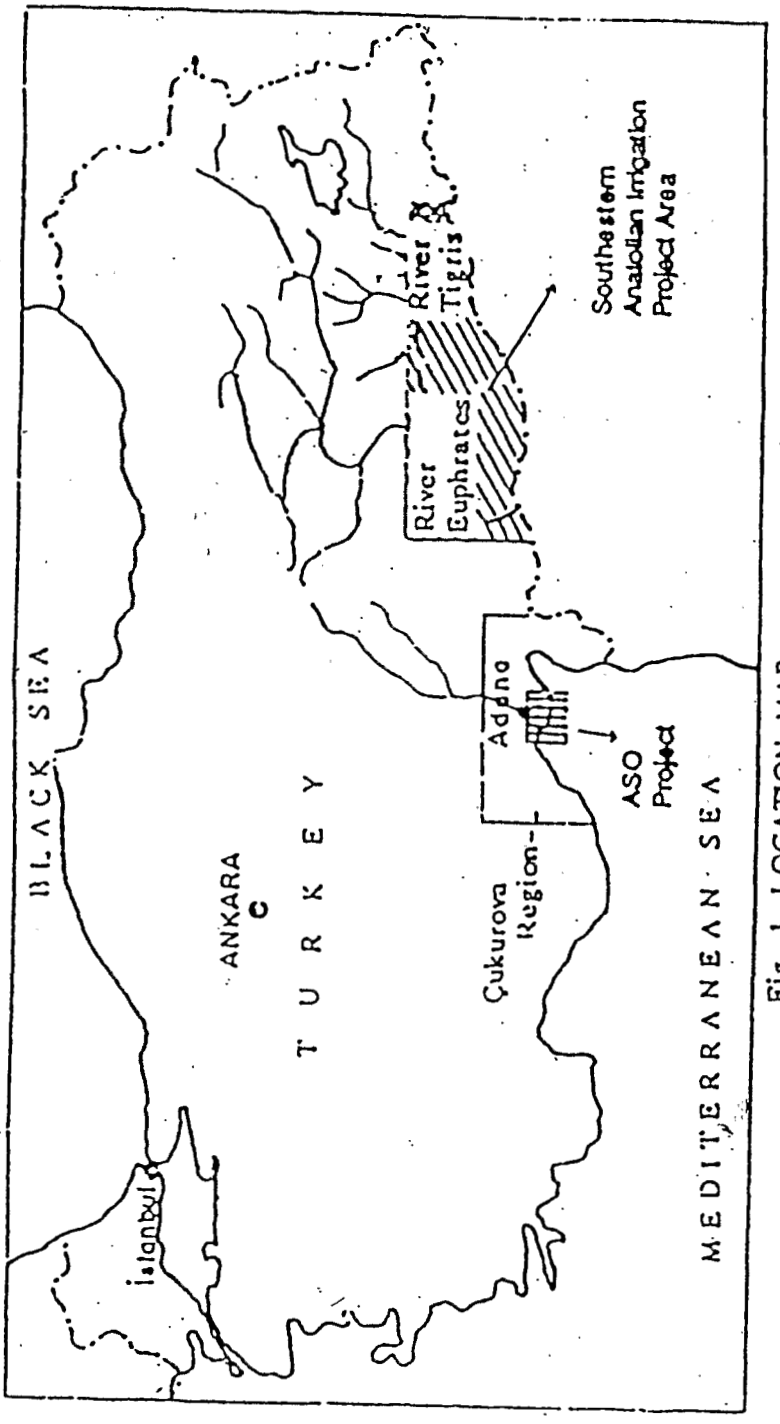

Fig. 1. LOCATION MAP.

LOWER SEYHAN IRRIGATION PROJECT

The Seyhan plain is the largest and the most important deltaic plain area in Southern Anatolia. It is bounded by southern foothills of the Tarsus mountains on the north, the Mediterranean sea on the south, the Ceyhan river on the east, and the Berdan river on the west. The whole area of the Seyhan Plain is about 210.000 ha., of which 181.300 ha. are irrigable. The Seyhan River cuts in a southwesterly direction through the Seyhan Plain, dividing it into two subplains: the Tarsus Plain of 85.000 ha. to the west of the river, and the Yüregir plain of 125.000 ha. to the east (Figure 2).

A typical Mediterranean climate prevails in the project area. The summer is hot and dry and the winter is warm and rainy, with a high humidity throughout the year.

Due to the favourable geographic, climatic, soil, and topographic conditions, the Tarsus and Yüregir Plain have attracted many well known civilizations throughout centuries. The region was one of the most important areas of Roman and Byzantine Empires and to this day it has remained as the most valuable agricultural region of Turkey. The major agricultural activity in the plains has been the raising of livestock on extensive range lands for the last few centuries. As a result of changing living conditions and habits of local farmers, the cattle raising on range lands diminished rapidly during the last 40 years and was replaced by mainly cotton and cereals, and to the less extent by vegetable and citrus growing.

The development of water resources, mechanization of farming methods, land reclamation practices, extension services and the others have brought about dramatic changes in the agricultural development of the Plains. Average annual yield of cotton was about 50-75 kg per decare in the recent past, but today the yield has reached well over 400 kg per decare in better lands. The same trend of increased yield has also been observed for all other crops of the region.

Although all other factors contributed in increasing yields, the development of water resources alone has had the biggest share in achieving this increase. The water resource development works of the Plains have included the flood protection, the Seyhan Multi-purpose Project, and the Seyhan Plain Irrigation Works.

Suitable soil, climate, and topographic conditions, joined by the rich water resources **in the plain (the Seyhan river has an estimated capacity of 6x109 m^3/year) make it possible to cultivate various plants throughout the year.**

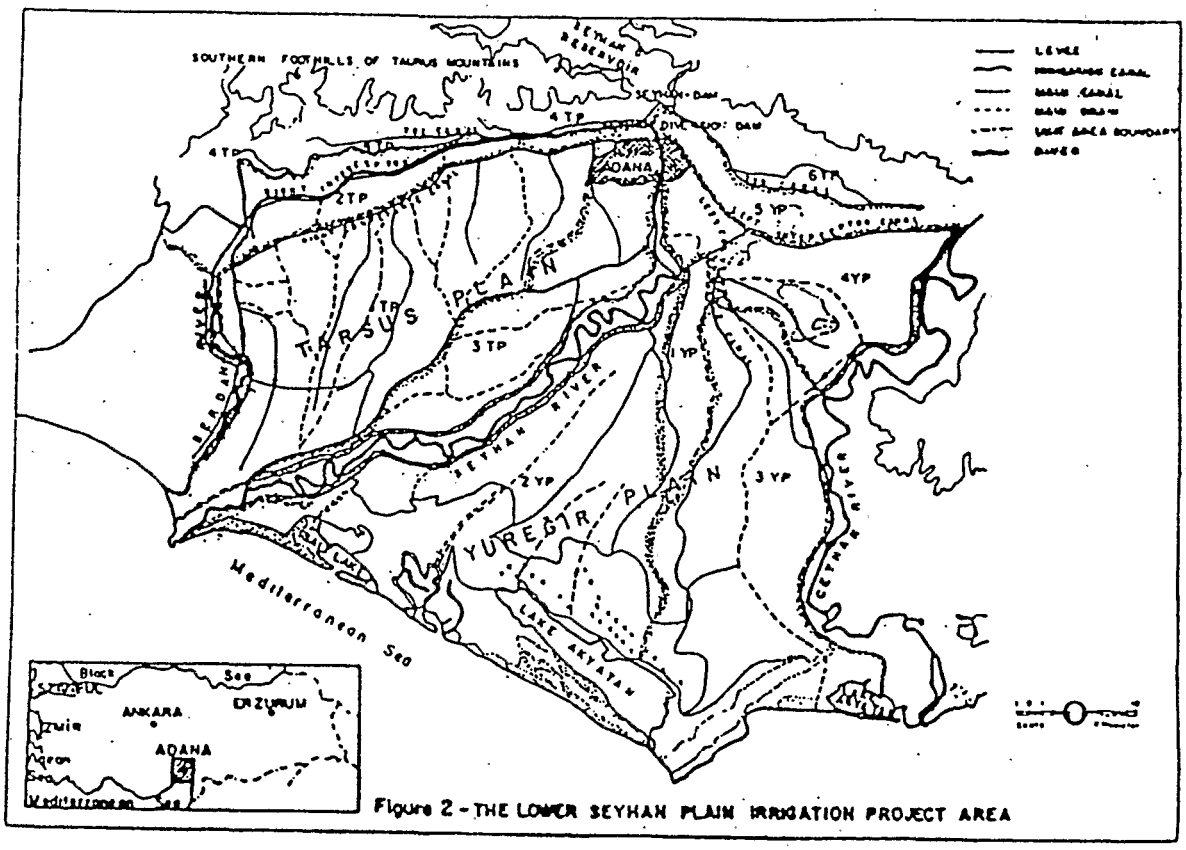

Table 1. indicates the change of sown area of the irrigated crops and the first crop pattern of the project.

Irrigation works of the Seyhan Plain have been planned to be completed in three stages. The works of the first stage have been completed. The second stage works were completed in 1978. Stage three was officially supposed to be started in 1978.

The input of the agricultural production of the Seyhan Plain to the national production has increased sharply with agricultural development in the recent years. The input was negligible in the late 1930s, but today it is estimated that the agricultural production value of the plain excluding animal production, has reached around 500 million dollars annually. Increase of agricultural production has also had the biggest share in the creation of agricultural industry in the region. Since the 1960s, the region has turned into one of the most important food and soft drink, textile and agricultural machinery production centers of Turkey. The Adana Chamber of Commerce reports that there were more than 180 agriculture-based industrial establishments in 1986. This industry provides jobs for about 40.000 workes and adds to Turkish economy approximately 1 billion dollars in production value annually.

Agricultural production increase and the industry have had great impact on improving the social and economic levels of the people living in the region. Along with this development, Adana which was a small city in the past became a modern city with a population of 1.000.000. As a result of this fast development, University of Çukurova was established in 1972 in order to fulfill the ever-increasing educational and research needs of the region.

Although the Lower Seyhan Project has contributed a lot to the region, it can not be said that the project itself is a perfect one. Today there are serious problems regarding the project. Various anticipated problems of the completed parts of the project are given and discussed in the following sections.

Irrigation

Due to high rate of evaporation and insufficient amount of precipitation during the growing season, a larger portion of plant water requirement should be artificially fulfilled by irrigation for optimum growth. For this reason, irrigation application practices take place

Table 1. The Change of the Sown Area of the Irrigation Crops with Years (%)

Years	Whaet	Alfa	Soybean	Melon	Cotton	Maize	Pedy	Youngtre	Citrus	Vegetabl	Other
According to Project	13	20	-	-	35	-	5	-	8	15	4
1964					94.0		1	2	1		2.0
1966				0.1	97.4		2.4	0.1	0.1		0.1
1967				0.1	94.8		4.6	0.1	0.2	0.1	0.3
1968	0.2			0.1	96.4		1.7	0.8	0.5	0.1	0.3
1969	1.2			0.2	91.6		5.5	0.3	0.7	1.0	0.5
1970				0.6	88.7	1.1	4.9	1.2	1.0	0.4	2.0
1971				0.4	97.1	0.1	0.4	0.3	1.3	0.2	0.2
1982	7.0			0.3	90.0		0.8	0.9	0.9	0.2	0.2
1973	6.3			0.8	90.0	0.1	0.4	0.4	0.9	0.3	0.7
1974	0.6			0.6	96.5	0.1	0.4	0.4	1.0	0.3	0.1
1975				2.0	84.0	3.0	5.0	1.0	1.0	1.0	3.0
1976				4.0	81.0	3.0	4.0	1.0	3.0	1.0	2.0
1977				5.0	92.0			1.0	1.0		1.0
1978				9.0	81.0	1.0	4.0	1.0	2.0	1.0	1.0
1979	1.0			6.0	66.0	15.0	7.0	2.0	2.0	1.0	
1980				8.0	82.0	2.0	2.0	3.0	1.0		2.0
1981	1.0		1.0	10.0	77.0	1.0	3.0	4.0	2.0	1.0	
1982	16.0		6.0	12.0	48.0	5.0	4.0	6.0	2.0	1.0	
1983	0.8		8.4	10.4	62.4	1.6	2.7	7.1	4.1	0.7	0.2
1984	0.7		9.6	6.5	68.4	2.0	2.4	5.3	3.4	0.9	0.2
1985	2.6		16.6	8.5	51.6	8.7	4.8	2.1	2.4	1.0	2.1
1986	11.5		12.7	5.8	41.3	16.9	0.5	3.6	4.2	1.3	22.3
1987	1.0		19.0	9.0	37.0	20.0	1.0	3.0	6.0	2.0	3.0
1988	1.0		8.0	10.0	51.0	18.0	-	3.0	6.0	1.0	2.0
1989	16.09		9.0	6.0	35.0	23.0	1.0	3.0	4.0	1.0	15.0

in the plain from May to October. Water diverted from the Seyhan reservoir is classified as C2-S1, which is considered fairly good for irrigation.

During the planning stages of the Lower Seyhan Project, land utilization pattern was proposed as 35 per cent cotton, 15 per cent wheat, 12 per cent citrus, 8 per cent vegetables, 20 per cent forage crops and 10 per cent rice. However, proposed optimum land utilization pattern has not been realized up to this day. Although, cotton cultivated area changes from one year to another, generally, the cultivated area varies from 75-90 per cent of the total land. Another major crop of the region is wheat. Under the present land utilization pattern, majority of land is only single cropped. Additionally, marketing conveniences and high cash values attract farmers to cultivate the land with the same crop every year preventing them to follow up a rotation.

Furrow and flood irrigation methods have been traditionally practised on the most part of irrigated areas of the region. As it is a universally known fact that when dry farming switched to irrigated farming, majority of farmers apply more than enough water to the soil with the common misbelief that more water would result in higher yields. The same misconception on water consumption has also been observed among farmers of the region. For instance, Seyhan dam which provides water for the Lower Seyhan Plain irrigation project is designed to supply water for the irrigation of 181,300 ha of land. The allocated water for irrigation in the dam is totally used at the end of each irrigation season despite the fact that only 120,200 ha of land is being irrigated in the plain today. This fact obviously reflects unnecessary utilization of water by the farmers and thus creates severe salinity and drainage problems on some parts of the project area.

Another reason for over-irrigation problem is related with the present land utilization pattern. The capacity of Seyhan Dam was designed according to the proposed land utilization pattern in which cotton was planned for 35 per cent of the total area. Today cotton cultivation is on 35 to 90 per cent of the land, and farmer's habit to over-irrigate cotton has resulted in unexpectedly high water consumption. This over-consumption naturally lays the foundation of readily available water supply for southern farmers to use water from drainage channels which also convey industrial wastes. This misuse of drainage water has created salinity and toxic element problems in some sections.

The existing irrigation system has been designed to provide measuring devices at the heads of all main and most of the secondary and tertiary canals. However, turnouts and measuring devices are not provided for individual farms. Somehow these are excluded though they are essential for adequate distribution, equal division of water among users, and to control water application. Non-existence of these control structures provokes farmers to over consumption of irrigation water. Presently, farmers obtain water directly from canalets with syphons at their will. In addition, water cost is billed to farmers according to crop type and size of the irrigated area. This, along with low cost of water, leads to excess consumption of irrigation water.

Despite the enormous investments made toward the realization of the project, it has been observed that farmers of some sections have switched back from profitable, irrigated farming to less profitable dry farming in recent years. (Table 2). For example, irrigation facilities were brought to 57322 ha. of land, of which 90,9 per cent was actually irrigated in 1968; on the other hand, irrigation facilities were extended to 110480 ha. of land, but actually irrigated area dropped to 66.4 per cent in 1978. This unexpected situation might be attributed to government price policy, high labor cost, problems involving pesticides and insecticides, fertilizer and seeds, insufficient credits, and lack of rotation. At the end of 1989, irrigation facilities were about 137, 039 ha., but actually irrigated area was about only 120,200 ha. at the same year.

Drainage

The most essential problem of the irrigation of the plain is to maintain proper drainage of irrigated lands. The relative flatness of the major portion of the plain, the high winter rainfall, the excessive irrigation water application and seepage from irrigation water conveyance channels cause high ground-water table levels the year round. This situation has been creating serious drainage problems for optimum crop production.

State Hydraulic Works have set up an intensive ground-water observation network consisting of 1600 observation wells in order to follow up ground-water fluctuations in the project area.

Table 2. Proposed Usage of Irrigated Lands, and Actually Irrigated Area.

Years	Proposed Land Utilization(ha)	Actually Irrigated Area(ha)	Irrigation Rate %
1964	18030	18727	103.9
1965	25200	26516	105.2
1966	41512	40145	96.7
1967	51200	46776	91.4
1968	57322	52129	90.9
1969	58400	50104	85.8
1970	58400	36929	63.2
1971	58400	53041	90.8
1972	58400	58199	99.7
1973	62400	66965	107.3
1974	83550	82517	98.8
1975	95527	66650	69.8
1976	98547	45022	45.7
1977	104102	86937	83.5
1978	110480	73399	66.4
1979	110480	78573	71.1
1980	103000	84670	82.2
1981	103000	85934	83.4
1982	103000	92575	89.9
1983	115000	71919	62.5
1984	119000	95756	80.5
1985	125300	114134	91.1
1986	133431	116198	87.8
1987	132300	97979	74.1
1988	132300	102032	77.1
1989	137039	120200	87.7

The ground-water table levels have been regularly recorded at monthly intervals, and water samples from each well have been taken from time to time, to determine the chemical quality of ground water. The change of surface area having the highest critical levels of ground water from 1975 to 1989 is given in Table 3.

Table 3. Land Distribution According to the Levels of Ground Water in Plain

Years	The highest critical level equivalent (m)						
	0-1	% of Total Land	1-2	2-3	3-4	4	Total (ha)
1975-76	34530	45	33100	6950	1320	175	76075
1976-77	38617	43	46834	3846	923	545	90765
1977-78	47648	51	41727	3520	55	-	92950
1979-80	42300	50	41800	2200	400	-	88700
1881-82	53957	57	37051	2133	450	550	94141
1982-83	51459	55	38520	3673	489	-	94141
1983-84	53351	57	38308	2431	51	-	94141
1984-85	53506	54	42867	2651	549	-	99573
1985-86	46749	46	49370	4959	463	-	101541
1986-87	63294	62	34137	3583	527	-	101541
1987-88	57261	56	39731	4429	120	-	101541
1988-89	57784	57	39900	3642	215	-	101541

The ground-water level reaches its critical peak value in two different periods within a single year. One of these peaks is seen in the months of January and February, in which heavy winter rainfall takes place. The other occurs in the months of intensive irrigation, which are July and August. Most parts of the plain have a very flat and low topography, and the soil has very low diffusibility; therefore, especially when the winter rains are above the normal levels, the ground water reaches above the soil and interrupts the agricultural activities, sometimes until the end of April.

In table 4, we see land distribution in the Seyhan Plain according to the salt levels of ground water.

It can be seen in table 4 that the area with 2000 micromhos/cm salt content of ground water has increased from 22 200 ha. in 1975/76 to 30.884 ha. in 1988/89.

Though irrigation works in the plain were started in 1950s, construction of drainage system was not progressed parallel to the irrigation systems. The construction of tile drainage systems had begun in 1966 after serious drainage problems surfaced in the project area. This delay has caused sharp decreases in yield in some sections and consequently has resulted in considerable loss of income of the farmers.

Management and Maintenance

One of the reasons for excess water application in the plain could be said to come from the inadequate number of technical personnel, who could maintain controlled water distribution.

Another problem related with management is farmers' unwillingness to irrigate at night. Farmers traditionally have practiced only daytime irrigation. As a result of this practice, water in the irrigation channels is directly dumped into drainways during night hours and approximately one-third of released water from the dam is lost.

Additionally, the spacings of tertiary irrigation channels being 500-600 m, along with some farmers' refusal to respect neighbors' water rights of way, have been causing management problems in some sections of the project area.

Other problems associated with irrigation in the plain are the use of the very fertile first-class agricultural lands for urban and industrial misplacements, and insufficient extension service.

Table 4. The Change of Surface Area According to the Salt Content of Ground Water (ha)

	salt level of ground water (micromhos/cm)					
Years	0-1000	1000-2000	2000-5000	5000-10000	10000<	Total Land (Ha)
1975-76	26925	22200	15995	5960	5265	76975
1976-77	28567	30039	20568	10623	948	90765
1977-78	38391	32373	13634	7271	1281	92950
1979-80	35300	23440	22100	5600	2360	88700
1971-82	28241	26482	24017	10586	4813	94141
1982-83	31671	33035	19498	6417	3520	94141
1983-84	28703	34655	23839	4628	2316	94141
1984-85	41501	33121	16883	5987	2081	99573
1985-86	47304	37396	9536	5051	2254	101541
1986-87	48484	32959	13504	5038	1563	101541
1987-88	60712	23202	12606	3172	1849	101541
1988-89	55876	30884	12841	1502	438	101541

CONCLUSION

Favorable climatic, soil and water resource conditions of the Seyhan Plain permit year around cropping of wide variety of plants. It is no doubt that the described water resources development works of the plain have brought enormous changes in the economy of the region. However, these works alone have not been able to bring solutions to the deficiencies associated with the development.

Today's irrigation practices provide substantial production increase as compared to dry farming. However, attention is not given to the necessary steps which are essential for prolonged productivity. Yield increase in the initial years of irrigated farming is an unexpected event for farmers who were accustomed to get whatever natural fluctuations of weather would permit. From this point on they would not make any special effort to increase the yields further.

Recent developments in agriculture have increased the yield of irrigated farming in considerable amounts. Unfortunately this side of irrigated farming has not been considered as important as engineering aspects of conveyance and distribution of water in Turkey. Historical development of irrigated farming has shown that success of the projects depends on giving equal importance to both engineering and agronomic aspects, realization degree of the objectives proposed in the planning stages, extension, and close coordination of related agencies working on the project.

In view of the realities discussed above and evaluation of the experience gained from planning and application stages of the Lower Seyhan Project, it can be concluded that this project and others similar to this would be the most profitable if the following measures are taken into consideration.

1. Construction of irrigation and drainage systems should be started and carried on simultaneously.

2. An administrably and finacially independent extension service organization should be formed at the planning stage of project. Extension service should begin its

activities immediately without waiting the application stage of the project. Additionally, technical personnel of the service should be in close ties with Research Organizations and Universities, and opportunities should be provided to its members for frequent on-job training programs.

3. In order to obtain optimum economic and technical usage, alternate land utilization patterns, which would be suitable to local conditions and to the capacity of water supply, should be selected instead of classical preference of one. Proposed patterns should be realized voluntarily otherwise necessary legislative actions should be taken.

4. Detailed alternate feasibility studies should be conducted before selecting the irrigation methods for the project area.

5. Necessary measures should be taken to maintain the original form of land leveling on places where levelling is essential for uniform application of irrigation water through surface irrigation methods. For this purpose, farmers have to be trained about proper ways of tillage and rotary tiller.

6. Measuring devices and structures should be installed on every required place and water cost should be collected from farmers on the basis of consumed water.

7. On large irrigation projects, where huge sums of money are invested for irrigation facilities, actual irrigated area should be kept as high as possible. If declining trend of actual irrigated area is seen immediate actions should be taken to overcome reasons of reduction.

8. Land consolidation works reduce overall project cost by at least 15 per cent on areas where irrigation is to be introduced. Hence, land consolidation works should be executed either voluntarily or legislatively.

9. Drainage criteria should be determinated by considering regional conditions. Especially, precaution has to be taken in respect of hydrogeologically complex deltaic plains.

10. In order to determine possible chemical and physical changes along the soil profile, detailed soil surveys should be conducted some time after irrigation facilities enter into service. If data necessitate, practised irrigation method should be altered.

11. Legislative actions should be taken to prohibit placements of urbanity and industry on fertile agricultural lands during the planning stage of project. Placements should be carried on according to land use maps based on soil surveys.

12. Number of technical personnel and size of machinery park in the first stages of project should be updated according to the needs of the advanced stages. A maintenance unit should be established for tile drainage system in addition to establishing of drain maintenance teams.

13. Close cooperation should be maintained among responsible agencies for optimum service.

Some of the above mentioned measures were taken into consideration in the planning and application stages of the Lower Seyhan Project but unfortunately no special efforts have been made toward realization of them. Even, Required attention has not been given to majority of the measures up to this day. It is a reality that the project has not contributed up to its real potential yet despite the fact that large amounts of money have been invested. Optimum benefit from the project would be obtained if and only if the proposed measures are considered as vital as engineering works.