The Republic of Tunisia

Treated Sewage Irrigation Project

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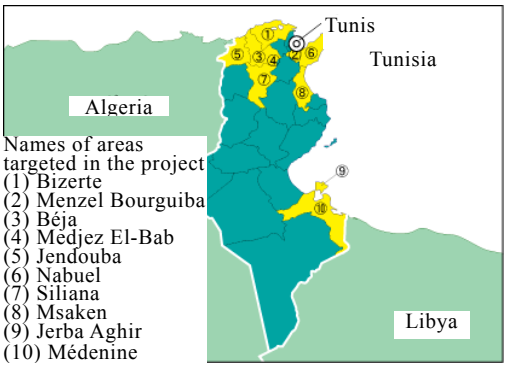
Field Survey: October 2007–March 2008

1. Project Profile and Japanese ODA Loan



Map of the project area

Water-saving irrigation drainpipes

1.1 Background

Of the total area of 164,154 km^2 (about two-fifths the area of Japan) in Tunisia, 38,000 km^2 is used to produce agricultural products. The agricultural sector plays an important role in its economy, accounting for around 11% of Tunisia's domestic national product (GDP) and a third of the working population. However, in Tunisia, which gets very little rainfall, most of the arable land is found in either arid or semi-arid areas, and agricultural regions that rely primarily on rainwater frequently suffer major damage from drought. To stabilize agricultural production and increase crop yields, development of irrigation facilities is indispensable. On the other hand, since surface and groundwater resources are limited, securing enough water for agricultural irrigation is a major challenge, especially in the dry season. Under these circumstances, treated sewage is an important source of relatively stable water supply whether in the rainy season or dry season, and so effective utilization of this water resource was sought. Around 1965, Tunisia began implementing a series of irrigation projects based on the use of treated sewage water for agriculture, and, on the basis of that experience, promoted development plans (including the present project) related to sewage treatment facilities and irrigation facilities.

1.2 Objective

In 10 areas – (1) Bizerte, (2) Menzel Bourguiba, (3) Béja, (4) Medjez El Bab, (5) Jendouba, (6) Nabuel, (7) Siliana, (8) Msaken, (9) Jeba Aghir and (10) Médenine – efforts

will be made to ensure the stable supply of irrigation water and conserve groundwater through the development of Tunisia's irrigation infrastructure (water reservoirs, pumping stations, etc.) using water treated at 12 sewage treatment facilities; thereby contributing to stable agricultural production and regional economic development.

1.3 Borrower/Executing Agency

Borrower: Government of the Republic of Tunisia
Executing Agency: Ministry of Agriculture and Water Resources

1.4 Outline of Loan Agreement

Loan Amount/Loan Disbursed Amount	1,707million yen / 1,331 million yen
Exchange of Notes/Loan Agreement	March 1998 / March 2005
Terms and Conditions - Interest Rate - Repayment Period (Grace Period) - Procurement	2.7%, 30 years (10 years), Generally untied
Final Disbursement Date	October 2005
Main Contractors (Only those with at least 1 billion yen in capital)	None
Consulting Services (Only those with at least 100 million yen in capital)	None
Feasibility Study (F/S), etc.	1994: Ministry of Agriculture and Water Resources

2. Evaluation Results (Rating: D)

2.1 Relevance (rating: a)

2.1.1 Relevance of the Plan at the Time of Appraisal

In the 9th Five-Year National Development Plan (1997–2002), the agricultural sector plays an important role in Tunisia's economic development, and the challenges it faces are: the provision of a stable supply of food including cereals through the promotion of agriculture; the spread of irrigation-based agriculture; and the development of agriculture-related infrastructure.

In the Ten-Year National Development Plan on Water Resources and Agriculture/Irrigation (1991–2000), supplying water for irrigation is cited as a priority issue. In the Water Sector's Long-term Strategy 2030 (Eau XXI: adopted in 1998), promotion of treated sewage water is advocated from the perspective of the efficient use of water. Since it aims to stabilize agricultural production through the use of treated sewage water as irrigation water, this project is consistent with the policy of the

Government of Tunisia and is therefore highly relevant.

2.1.2 Relevance of Plan at the Time of Evaluation

Continuing from the 10th Five-Year National Development Plan (2002-2006), the 11th Five-Year National Development Plan (2007-2011) regards the agricultural sector as an important sector, and cites the conservation of water resources and the expansion of irrigation based on the use of treated sewage water as being particularly important. The latter places priority on improving the productivity of Tunisian agriculture through substantial expansion of irrigated land by 2011. Moreover, in the 11th Five-Year National Development Plan, the government plans to substantially increase the amount of agricultural products produced on irrigated land by promoting the efficient use of water resources. At the same time, because of increased demand for water, the government is promoting water conservation as a matter of national priority.

In the Water Resource Development Plan (2001-12: revised in 2000), introduction of irrigation and effective use of water for agriculture through the development of water resources are given top priority, while renovation of existing irrigation facilities and expansion of irrigated land area are adopted as important measures.

In the Long-Term Water Sector Strategy 2030, not only is the use of treated sewage water as irrigation water encouraged but water conservation is also urged as a way of reducing the use of irrigation water per area of agricultural land. For this reason, in Tunisia's five-year plans, water resource development plans and other major plans formulated on a national level, top priority is consistently given to the recycling of treated sewage water and introduction of irrigation based on water conservation, effective use of water resources, provision of irrigation facilities, and efforts to increase the production of farm products.

The implementation of this project, both at the time of appraisal and at the time of evaluation, is consistent with Tunisia's national plans and the like, and so the implementation of the project is highly relevant.

2.2 Efficiency (Rating: b)

2.2.1 Output

The output of this project is summarized in Table 1. While means of delivering water and irrigation drainpipes were constructed as planned, because the number of targeted areas was decreased by two, the actual output was scaled down slightly from the original plan.

The reason for the changes indicated in 1) - 3) of Table 1 is that since Bizerte is a region where the average rainfall is relatively high, it is expected that farmers there will

need some time to get used to using treated sewage water. For this reason, it was decided that the execution of the engineering works should be divided into two stages. But because there was a delay in receiving the request for engineering works, in this project, only the first stage was executed.[1]

Engineering works were not executed in Menzel Bourguiba and Jendouba. They were not executed in Menzel Bourguiba because there were only a few beneficiaries,[2] and the main reason engineering works were not executed in Jendouba is that there is a nearby river that provides water that can be used as irrigation water.

With regard to 4) of Table 1 below, as in Bizerte, it was decided that the execution of engineering works in Jerba Aghir should be divided into two stages. In the first stage, irrigation drainpipes were introduced to 60 ha of farmland (completed in 2005). If farmers request them, irrigation drainpipes will be introduced to the remaining 60 ha plus of farmland. At the time, since farmers were reluctant to use treated sewage water as irrigation water, it was decided that the engineering works should be carried out only in the first stage. However, since facilities were available upstream, it became possible to build drainpipes whenever there was request for them. Recently, in response to a request from farmers for construction of drainpipes, the government decided to execute the engineering works using its own expense in 2008.

As for changes in consulting services, a survey was conducted regarding (2) sewage increment in Jerba Aghir as planned, but a similar survey that was scheduled for Nabeul was removed from this project because a similar survey was implemented under a project funded by the World Bank. Although the survey was conducted in only one region, M/M was not reduced because considering the research service involved, the estimate was low to begin with.[3]

[1] The second stage of engineering works will be implemented when the impacts of the first stage are fully understood.

[2] Additionally, because of sharp rise in cost in those days, in this project, irrigation facilities were not constructed, but they are scheduled to be implemented at a later date.

[3] Since the price of the closing bid in a domestic competitive bidding held in 2002 was more than twice the estimate, the bidding was nulled and void. Rebidding was held by reducing the scale of the project to cut costs.

Table 1: Output

(1) Construction of Treated Sewage Irrigation in 10 Areas of Tunisia

Item	Plan	Actual	Remark
1) Treated sewage water storage facilities	10 sites	8 locations	(2), (5) canceled (1) only first stage
2) Pumping station	13 sites	10 locations	(2), (5) canceled (1) only first stage
3) Adjustment water storage facilities	12 sites	10 locations	(2), (5) canceled (1) only first stage
4) Water supply, irrigation drainpipe	187km	179km	(9) First stage
5) Irrigation sites development	1,853ha	Nearly as planned	

Target areas: (1) Bizerte, (2) Menzel Bourguiba, (3) Béjà, (4) Medjez El Bab, (5) Jendouba, (6) Nabuel, (7) Siliana, (8) Msaken, (9) Jerba Aghir, (10) Medenine

(2) Consulting Services

Item	Planned	Actual	Remark
1) Detailed design related to above-mentioned irrigation facilities construction, tendering document preparation and detailed design/tendering document preparation	52.5 M/M	As planned	Only (1), (2), (7), (9), (10)
2) Survey related to groundwater increment for using treated sewage water in Nabuel and Jerba Aghir	4 M/M	4 M/M	(6) canceled (9) implemented

Target areas: (1) Bizerte, (2) Menzel Bourguiba, (3) Béjà, (4) Medjez El Bab, (5) Jendouba, (6) Nabuel, (7) Siliana, (8) Msaken, (9) Jerba Aghir, (10) Medenine

2.2.2 Period

The implementation period planned at the time of appraisal was 67 months (March 1998–September 2003), but it was actually 92 months (March 1998–October 2005), or 37% longer than the original plan.[4] The main factors responsible for the delay include: (i) the delay in launching the consulting services; (ii) the delay in material procurement; (iii) the temporary interruption of construction because the original site of the reservoir in

[4] However, the construction period was from the first quarter of FY2000 to September 2005.

Bizerte was located under a military flight route; and (iv) the change of design, resulting in half of the reservoir being buried.

2.2.3 Project Cost

The total project cost planned at the time of appraisal was 2,277 million yen (Japanese ODA loan portion: 1,707 million). The actual cost, at 1,588 million yen (Japanese ODA loan portion: 1,332 million), was 30% less than the planned cost (the planned Japanese ODA loan portion: 22% less). At all project sites, the actual expenditure exceeded the planned expenditure. The reason is the rise in the price of PVC pipes, cement and other material. Additionally, a detailed design (D/D) survey found that the actual project was different than what JBIC found in its F/S in many respects – including the sites that were originally targeted, the needs of the beneficiaries, and the quality of the land – thus forcing a number of changes in the original construction project. On the other hand, the total project cost was less than planned as it was offset by cost increases in other areas, which in turn were caused by, among other things, the cancellation of construction work in Menzel Bourguiba and Jendouba, the limited number of farmlands under irrigation in Bizerte, and the postponement of development of an additional water supply network in Jerba Aghir.

While the project was implemented more or less as planned in terms of project cost, because the period slightly exceeded the original plan, its efficiency is judged to be moderate.

2.3 Effectiveness (Rating: C)

2.3.1 Operation/Effect Indicators

2.3.1.1 Number of Beneficiaries

As shown in Table 2, owing to the cancellation of civil engineering works in Menzel Bourguiba and Jendouba, beneficiaries for the 10 sites as a whole was 39% fewer in number than planned (61% of the planned number of beneficiaries).[5]

The number of farmers who benefited from the project decreased. However, there were areas where the scope of the project was expanded because the number of farmers who wanted to participate in the project increased during project implementation, resulting in more beneficiaries. For example, in Bizerte, in the original plan, two commercial farms (one of which was changed to the second stage [which is excluded

[5] The number of beneficiaries denotes the number of farmers where it became possible to carry out irrigation-based agriculture by using irrigation facilities developed under this project. However, as is described later (2.3.1.2 and Table 3), at the time of this ex-post evaluation, there were a number of governorates where irrigation-based agriculture had not yet been launched.

from Japanese ODA loan]) were expected to benefit from the project, but since small-scale farmers were able to use the irrigation facilities, the number of farmers who benefited from the project increased 8 fold, to 16, from the number that was originally planned. Moreover, in Béjà, in response to requests by neighboring farmers to be provided with irrigation water when drainpipes were installed, the executing agency installed water feed points to supply irrigation water to farmlands, resulting in an increase in the number of beneficiaries. Furthermore, since drainage facilities are expected to be installed in 60 ha of farmland in Jerba Aghir this year, the number of farmers benefitting from the project is expected to increase further.

Table 2: Number of Farmers Who Benefitted from the Project

Governorate	Planned	Actual (2006)	Actual/Planned Ratio
(1) Bizerte	2	16	800%
(2) Menzel Bourguiba	2	—	—
(3) Béja	6	21	350%
(4) Medjez El Bab	2	2	100%
(5) Jendouba	51	—	—
(6) Nabeul[6] (SE3)	396	287	72%
(SE4)	648	323	50%
(7) Siliana	27	22	81%
(8) Msaken	100	70	70%
(9) Jerba Aghir	55	36	65%
(10) Médenine	40	39	98%
Total	1,329	816	61%

Source: Commissariat Régional au Développement Agricole (CRDA) offices of each governorate

2.3.1.2 Area under Irrigation

The area under irrigation in each governorate is shown in Table 3. The total area under irrigation was substantially smaller than planned. The area under irrigation was zero in the following three governorates:

(1) Bizerte: Although the construction of irrigation facilities was completed in 2005, the delay in the election of officials made it impossible to set up the farmers' association (GDA). Consequently, the irrigation facilities and treated water remain unused to this day.[7] With the establishment of the GDA in May 2006, the use of the irrigation facilities

[6] Both SE3 and SE4 are wastewater treatment facilities to which are given individual numbers. As is in other areas, each wastewater treatment facility adopted an activated sludge method.

[7] Irrigation water cannot be used before GDA is set up.

is expected to start in 2008.

(4) Medjez El Bab: After a trial run of the pump facilities and the like were conducted at the end of 2007, it was confirmed that there would be no problem operating the irrigation facilities. Thus, the use of treated sewage water is scheduled to be commenced in 2008.

(7) Siliana: Two large farmers are involved in a dispute over land ownership, which is hindering the cultivation of farm crops. The representative of the farmers' association lives outside of the area and cannot adequately manage and supervise the area. These are the background factors against usage of irrigation water. Since a new representative will be appointed in the near future, it is expected that irrigation-based agriculture will be promoted soon.

According to the Ministry of Agriculture and Water Resources, there are three other factors causing the actual use of treated sewage water in other areas to be lower than originally planned: (i) only 2 to 3 years have passed since the irrigation facilities was completed; (ii) the practice of using treated sewage water has not yet taken root; and (iii) this year the demand for treated sewage water was particularly weak because the areas concerned had an unusually large amount of rainfall.

In Tunisia, the total area of arable land is approximately 3.8 million ha, of which about 10%, or 385,000 ha is provided with irrigation facilities, and about 2% of the country's farmland uses is irrigated with treated sewage water.

Table 3: Comparison of the Area under Irrigation (unit area: ha) (2006: actual)

Governorate	(Before Project Implementation) Cropland		Area Irrigated with Treated Sewage Water		
	Total Area	Irrigation Situation	Plan	Actual (Summer)	Actual (Winter)
(1) Bizerte	585	Rainwater	297	0	0
(2) Menzel Bourguiba	80	Rainwater	79	—	—
(3) Béjà	310	Rainwater, Water drawn from rivers	310	134	75
(4) Medjez El Bab	100	Rainwater	80	0	0
(5) Jendouba	168	Rainwater	165	—	—
(6) Nabeul	626	Rainwater, well water, treated sewage water	200 360	151	0
(7) Siliana	138	Rainwater, Partly well water	70	0	0
(8) Msaken	224	Rainwater	121	25	0
(9) Jerba Aghir	230	Rainwaer, Partly well water[8]	128	44	44

[8] More than half of the well water cannot be used due to salt damage.

(10) Medenine	187	Rainwater、 Partly well water	43	8.5	9
Total	2648		1853	362.5	128

Source: Commissariat Régional au Développement Agricole (CRDA) offices of each governorate

In addition, while a far smaller area was actually brought under irrigation than was planned, a comparison of the area under irrigation in summer (dry season) and that in winter (rainy season) shows that the area brought under irrigation with the use of treated sewage water increased in summer, and, even in winter, treated sewage water was used if there was little rainfall. It is believed that this use of treated sewage water is enabling the targeted areas to maintain agricultural production at a certain level.

2.3.1.3 Crop Yields

Crop yields are greatly affected by not only water supply but by weather (amount of sunshine, temperature, etc.), fertilizer, land preparation, cultivation techniques, and the like. It is difficult to verify how much the development of irrigation facilities has contributed to higher crop yields. Meanwhile irrigation based on the use of treated sewage water through this project started 2004 and 2005, therefore at this point, it cannot be said that the project has sufficiently yielded benefits in the form of increased crop yields and the like. However, the Ministry of Agriculture and Water Resources has released a report indicating that improvements have been made in the diversification of agricultural products, quality of agricultural products, improvements in breeding (quality improvement in dairy, meat, etc.). Furthermore, after the implementation of this project, growing of new animal feed, wheat, and (in some areas) fruit trees was launched. The use of treated sewage water as irrigation water is limited to cotton, tobacco, cereals, feed crops, fruits, trees in general, grass and flowers, and the like. Therefore, as its primary policy, the Ministry of Agriculture and Water Resources is continuing to guide farmers to adopt a system of rotating among citrus fruit, factory processed crops, and feed crops. The data for crop yields summarized in Table 4 are only a sample, but they show that in areas where the use of treated sewage water for irrigation has already started, the yields of many crops exceed the reference values; yet they are below the planned values.

Table 4: Crop Yields (unit: kg/ha)[9]

Governorate	Actual ('96)	Plan	2000	2001	2002	2003	2004	2005	2006
(3) Béja									
Sugar beet	500	650						—	250
Wheat	32	60						52	52
Animal feed	300	500						400	400
Sunflower	—	20							
(6) Nabeul									
Citrus fruit	30-110	200	100	100	120	120	135	150	150
Carrot	150		150	—	—	—	—	—	—
Onion	140								
Tobacco	150		150	170	200	200	200	200	200
Animal feed	10	400	10	10	10	15	15	15	15
Olive	8	25	8	10	11	11	11	11	11
Fruit tree			-	600	600	700	750	750	750
(8) Msaken									
Wheat	8								
Olive	17	28							
Animal feed	—	600							
(9) Jerba Aghir									
Date	10	16							
Olive									30
Barley									16
Animal feed	—	600							300
(10) Médenine									
Olive	4	7					6	75	85
Animal feed	—	600					5	52	70
Barley							4	4	4
Sorghum							2	—	—

Source: Ministry of Agriculture and Water Resources, Commissariat Régional au Développement Agricole (CRDA) offices of each governorate

2.3.1.4 Amount of Treated Sewage Water

The amount of treated sewage water and the amount used are shown in Table 5. In Tunisia, about 20% of treated sewage water is being used in agriculture.[10] Although the amount of treated sewage water used ranges from 4–36%, in most of the areas targeted in this project, it is below 20%. Despite the many times JBIC tried to confirm the reason for the low rate of utilization, the Ministry of Agriculture and Water Resources failed to provide a satisfactory explanation. In Nabeul,[11] where the Agricultural Research Center had, on an experimental basis used treated water for irrigation before this project was implemented, the rate of utility, at between 32–36%, was higher than in other areas.

From 2008, three new areas will begin using treated sewage water as irrigation water,

[9] Many columns are blank because no records were kept; therefore, the blank columns represent N/A.

[10] FY2006 performance

[11] In Nabeul, in 1996, treated sewage water was used for irrigation on an experimental basis on 26 ha of farmland owned by the Ministry of Agriculture and Water Resources Research Center. About 350 ha of farmland was provided with facilities for utilizing treated sewage water as irrigation water, but in some parts of that farmland, agriculture was carried out by using well water for irrigation.

and the development of water supply facilities is planned for an additional 60 ha of farmland in Jerba Aghir. As a result, the amount of treated sewage water used is expected to increase in the days to come in those areas.

Table 5: Amount of Treated Sewage Water (unit: l/sec)

Governorate	Amount of Treated Sewage Water			Amount Used	
	Planned	Actual		Actual	
		2000	2006	2000	2006
(1) Bizerte	300	—	—	0	—
(2) Menzel Bourguiba	120	—	—	—	—
(3) Béjà	120	82.5	97.57	1.57	3.81
(4) Medjez El Bab	43	—	—	—	—
(5) Jendouba	89	—	—	—	—
(6) Nabeul (SE3)	190	101.07	39.89	46.55	14.32
(SE4)			150.56		48.49
(7) Siliana	30	—	—	—	—
(8) Msaken	220	39.7	N/A	1.34	7.76
(9) Jerba Aghir	120	N/A	N/A	—	3.08
(10) Medenine	100	8.66	N/A	0	0.56

Source: Office National de l'Assainssement (ONAS)

In Tunisia, secondary-treated sewage water is used as irrigation water, but as shown in Table 6, the quality of treated water does not necessarily meet the standard for water quality established in Tunisia. The ONAS periodically inspects water quality,[12] and if the contamination exceeds the reference value, usage of irrigation water is stopped. The farmer is notified of the reason for the discontinuance of water service and the date he can expect for the water supply to be resumed. According to ONAS, the water service is stopped two or three times a year, for three days at the longest. Sewage consists mostly of household effluent, but there are areas where sewage-treatment plants accept industrial effluent from leather and apparel manufacturing industries, in which the improvement of water quality becomes difficult. ONAS is making efforts such as renovating existing facilities to improve water quality, but it also recognizes the need to improve the country's sewage treatment technology and make its water quality standards more rigorous in the future. The CRDA is planning to conduct water quality inspections in cooperation with the Centre International des Technologies de l'Environnment de Tunis (CITET), and is committed to supporting efforts to improve the quality of water used for

[12] The law requires water quality to be inspected once a month.

irrigation by strengthening the monitoring of water quality,

Table 6: Water Quality Standards in Tunisia (2006)

Governorate	BOD	COD	SS	Salinity
Water quality in Tunisia	30	90	30	2.5
National average	39	131	45	—
(1) Bizerte	23	70	18	2.56
(2) Menzel Bourguiba	—	—	—	—
(3) Béjà	27	113	16	0.84
(4) Medjez El Bab	34	94	31	1.21
(5) Jendouba	—	—	—	—
(6) Nabeul (SE3)	23	110	34	2.38
(SE4)	20	115	30	1.87
(7) Siliana	42	116	60	1.7
(8) Msaken	16	86	14	1.7
(9) Jerba Aghir	10	51	17	1.8
(10) Medenine	32	74	24	2.6

Note: BOD stands for Biochemical Oxygen Demand, COD for Chemical Oxygen Demand,[13] and SS for Suspended Solids,[14] and the higher the values of all three indicators, the more advanced the water contamination. The underlined numbers indicate a value that exceeded the water quality standard.

2.3.2 Internal Rate of Return

The project's economic internal rate of return (EIRR) at the time of appraisal and at the time of evaluation are shown in Table 7. Expenditure is calculated as comprising of construction cost, consulting services fees, and operation and maintenance expenses, while the benefits are calculated as an increase in revenue gained from the sale of agricultural products. The data submitted by the Ministry of Agriculture and Water Resources were used. The EIRR decreased because of the long period required to spread the use of treated sewage water for irrigation, which in turn delayed the full manifestation of its benefits.

Table 7: Internal Rate of Return

	At the Time of Appraisal	At the Time of Ex-post Evaluation
EIRR	17.8%	10.3%

[13] The COD value is strongly affected by wastewater that enters the disposing facility.

[14] When the SS value is high, there is a risk that the pipes in a drip irrigation plant may be clogged.

2.3.3 Qualitative Effects

The Ministry of Agriculture and Water Resources reports that, by introducing the use of treated sewage water for irrigation, the following benefits were obtained in the project areas:

(1) Preservation of water resources through recycling of water
(2) Expansion of irrigated area and the securing and expansion of means for agricultural production in target areas
(3) Improvement of living conditions through increased irrigated agricultural production and income
(4) Introduction of irrigation-based agriculture
(5) Enhancement of livestock farming through the introduction of herbage and animal feed production in summer
(6) Improvement of production and economic activity

2.4 Impact

2.4.1 Environmental impact

The environment impact assessment (EIA) has been prepared for all project areas and approved by the National Environment Protection Agency.

In the field survey, it was pointed out that the air was filled with a foul odor during the hot summer months whenever treated sewage water was used. In Tunisia, which has about 40 years of experience in the use of treated sewage water as irrigation water, a whole host of surveys and research are conducted. In research and studies conducted thus far, there has been no report of harmful effects on health, contamination of soil and agricultural products and the like caused by the use of treated sewage water.

As for preventive measures, under the Ministry of Public Health directives, all farmers are required to be immunized against infectious diseases such as tetanus that one may develop when one comes into contact with treated sewage water. Under the directives, farmers are also required to wear gloves and boots when they use treated sewage water. However, despite the efforts of CRDA and GDA, many farmers apparently refuse to be inoculated as required because of doubts and lack of understanding on the necessity of immunization,.

2.4.2. Beneficiary Survey

In the ex-post evaluation, a survey of beneficiaries was conducted at four sites (Nabeul, Msaken, Béja and Médenine) in randomly selected areas (from October 2007–February

2008) where treated sewage water was used as irrigation water.[15]

2.4.2.1. Economic Impact

Sixty-one percent of farmers surveyed said that crop yields improved after the completion of the project, and 75% responded that the project is contributing to regional development of agriculture. With many farmers cultivating new fruit trees and the like (peach, apple, almond), the range of cultivated crops has become more diversified. Most farmers responded that they increased their production of existing farm products. Many of those engaged in livestock husbandry responded that the project is having a positive effect on their business. They cite as evidence the doubling of harvests, cultivating of crops that hitherto were not possible to cultivate in terms of livestock food, as well as increase in production of dairy and meat products and improvement in their quality. Seventy-five percent of respondents pointed out job opportunities increased under the project and 92% cited improvements in living conditions.

2.4.2.2. Social Impact

Although the level of awareness concerning environmental conservation was low, 17% of respondents said the project was contributing to environmental conservation. The main reason for this positive assessment is that farmers in the Nabeul and Msaken areas, who are faced with a serious water shortage, cited groundwater conservation and improvement of salt damage as examples of the positive effects the project brought.

A view that was expressed by many in the survey on beneficiaries pertains to the difference of opinion and approach between the generation that engaged in farming relying on rainfall and the younger generation that is trying to make the switch to irrigation-based farming that relies on the use of treated sewage water. Although younger farmers are eager to tackle new things (like irrigating farmlands using treated sewage water), it seemed that ultimately they are forced to accede to the views of the older generation that stick to the traditional way of farming.

However, as in the case of farmers in Medenine, there are farmers of the generation that adhered to the traditional method of farming and were reluctant to accept the use of treated sewage water as irrigation water, but were forced by severe water shortages to begin using such water and actually saw their crop yields increase. In this case, some farmers had been engaged in irrigation-based farming using well water, but as the level of

[15] An interview survey was conducted on 100 farmers in four areas where treated sewage was used for irrigation: Nabeul, Msaken, Beja and Medenine. All 100 interviewed were farmers who used treated water (95% were men, 5% were women, and 66% had primary and secondary school education), and 77% were land-owning farmers; 69% cultivated less than 5 ha of land, 29% cultivated less than 1 ha, and 7% cultivated more than 10 ha.

groundwater became alarmingly low, their olive yields began to plunge.

There have been reports of improvements in the livelihoods of farmers under this project by enabling famers to engage in agriculture production throughout the year; thus contributing to, among other things, increasing the production and income of farm households, thus halting the depopulation of rural areas. Thus, while benefits to the areas and people targeted under this project are recognized, the actual effects of this project are limited in comparison with the expected effects, and the effectiveness of this project is low.

At the time this project was planned, some land acquisition was assumed necessary, and indeed land acquisition was carried out as planned after the detailed design was completed. There was, however, no need for residential relocation.

Farmers drawing water from an irrigation facility (in Medenine)

Treated sewage reservoir (Medenine)

2.5 Sustainability (Rating: a)

2.5.1 Executing Agency

2.5.1.1 Operation and Maintenance System

The Commissariat Régional au Développement Agricole (CRDA), the local office of the Ministry of Agriculture and Water Resources, is in charge of the management, operation and maintenance of the pumping stations and the reservoir, while the GDA is in charge of the guarding of facilities and the operation of facilities inside the irrigated site such as distribution pumps and small- and medium-scale operation and maintenance. The CRDA and the Ministry of Agriculture and Water Resources are responsible for operation and maintenance that require large-scale funding. The GDA is run by a council comprised of a chairman, an accountant, and a number of officials selected by association members. The Office National de l'Assainssement (ONAS), which is under the Ministry of Environment and Sustainable Development (MEDD), is in charge of the monitoring and supervision of sewage treatment and water quality.[16]

[16] ONAS was established in 1974 as an independent sewage public corporation. In 2004, the MEDD was

The activities of the CRDA in the areas targeted by this project are summarized in Table 8.[17] The CRDA has two departments of management: (1) Exploitation des Perimetres Irrigues (EPI), which is mainly engaged in awareness and advertising campaigns; and (2) the Maintenance des Equippements Hydrauliques (MEH), which is responsible for operation and maintenance. In CRDAs which do not have MEHA sections, the EPI bears the operation and maintenance function. Electrical engineers, mechanical engineers, plant engineers and civil engineers are stationed at CRDA offices at all times. Technology exchanges are promoted by assigning staff members of one CRDA office to another.

Additionally, efforts are being made to deepen farmers' understanding of the project's importance by holding workshops at CRDA offices, taking the members of the CRDA board of directors and its rank-and-file members to farms where treated sewage water is being used, and undertaking sustainable awareness-building activities concerning ways to operate irrigation facilities and the benefits of using irrigation water.

The Maintenance Service Department of EPI is responsible for the operation and maintenance of CRDA offices. There are two implementation methods, direct implementation and outsourcing implementation to contractors, but most operations that require special equipment and materials are implemented by outsourcing. In accordance with the policy of the Ministry of Agriculture and Water Resources, in recent years, the percentage of the CRDA's shared operation that is outsourced has tended to rise as the GDA's share of operation and maintenance has increased.

Table 8: Commissariat Régional au Développement Agricole (CRDA)
EPI and MEH Staff

Governorate	Irrigated area during summer months (ha)	Engineers	Technical Experts	Experts in agriculture, etc.
(1) Bizerte	0	2	5	39
(3) Béja ([4] Mejez El Bab is also under this jurisdiction)	134 0	2	16	62
(6) Nabeul	151	2	1	3
(7) Siliana	0	1	3	51
(8) Msaken	25	1	1	6
(10) Médenine ([9] Jerba Aghir also under this jurisdiction)	44 8.5	1		6

2.5.1.2 Skills in Operation and Maintenance

founded, under which all public health policies and investments were henceforth established.

[17] In Bizerte, Béjà and Siliana, where there are dams and other such infrastructure, there are more experts than in other project areas.

The GDA Control Center, which is comprised of four engineers from the Direction General du Genie Rural (DGGR), provides technical assistance, including preparation of operation and maintenance manuals and technical guidelines, and training of personnel for inspecting facilities. There are no operation and maintenance problems concerning irrigation facilities that run on treated sewage water. Training, including periodic training for the GDA members, is also offered at the CRDA. For example, in Msaken, operation and maintenance personnel are trained at the Technical Education Center.

In Siliana, a committee has been established to provide project follow-ups, and a team of experts in cultivation of agricultural products has been formed to support farmers in the cultivation of agricultural products by teaching them which crops are suited for irrigation-based agriculture and how to conserve water. Although inspection of facilities by the GDA technical personnel is generally satisfactory, since the GDA was established relatively recently and they still lack experience, periodic operational guidance by the CRDA is indispensable.

2.5.1.3 Financial Status of Operation and Maintenance

In order to promote the use of treated sewage water, the water-use rate is set low.[18] The billing collecting rate is favorable, and the money the GDA collects covers about 20–50% of its operation and maintenance expenses; and the CRDA covers the rest. For instance, in Siliana, the CRDA office pays the electrical power charge and the labor cost required in guarding the irrigation facilities. In this way, the CRDA supports the operation and maintenance of the facilities carried out by the GDA. Furthermore, with regard to development of irrigation facilities, including terminal channels, the government is promoting expansion as well as operation and maintenance of these facilities by offering financial assistance, tax exemption, loan provision and rate subsidy.

Table 9: Expenses for Operation and Maintenance of Irrigation Facilities (unit: DT)

CRDA	2005	2006
(1) Bizerte	560,000	440,000
(2) Menzel Bourguiba	-	-
(3) Béja	796,641	507,840
(4) Medjez El Bab*1	N/A	N/A
(5) Jendouba	-	-

[18] The rate for using treated sewage water is 20 milim (at 20/1000 of 1 DT, about 2 yen) per 1 m^3. The rate was reduced from 60 milim in 1997 by an executive order to promote the use of treated sewage water.

(6) Nabeul	263,000	346,000
(7) Siliana	1,089,186-*3	469,843
(8) Msaken	226,000	245,000
(9) Jerba Aghir*2	N/A	N/A
(10) Médenine	194,000	77,000

*1. Operation and maintenance of irrigation facilities in Medjez El Bab is under the supervision of the CRDA office in Béja.

*2. Operation and maintenance of irrigation facilities in Jerba Aghir is under the supervision of the CRDA office in Médenine.

*3. Operation and maintenance expenses in Siliana are for the entire area.

Table 10: Share of Operation and Maintenance Expense

(unit: DT, 2006 data)

Area	Operation and Maintenance Expenses	Water Use Expense	Government Budget
(1) Bizerte	N/A	N/A	N/A
(2) Menzel Bourguiba	-	-	-
(3) Béjà	64,860	30,000	34,860
(4) Medjez El Bab*	58,430	10,000	48,430
(5) Jendouba	-	-	-
(6) Nabeul	12,000	1,200	10,800
(7) Siliana	N/A	N/A	N/A
(8) Msaken	N/A	N/A	N/A
(9) Jerba Aghir	N/A	N/A	N/A
(10) Medenine	N/A	N/A	N/A

Source: CRDA

* Forecast

2.5.2 Operation and Maintenance Status

There are no problems in either the capacity or the operation and maintenance system of the executing agency. Thus, the project is expected to demonstrate a high degree of sustainability.

3. Feedback

3.1 Conclusion

Because many of the sites had just started to reap benefits from the project, the effects of the project at this point are deemed to be limited. Thus, at this point in time, it would have to be said this project is evaluated lowly. Moreover, while the comments of beneficiaries suggest the effectiveness of the project, remarks about the effects of the project going forward, including expansion of the area under irrigation, need to be monitored continuously.

3.2 Lessons Learned

-Despite the fact that Tunisia has experience in the use of treated sewage for agriculture, it cannot be said that Tunisian farmers are adequately informed about the benefits of using treated sewage as irrigation water, including the increase in crop yields, improvement in the quality of agricultural products, and the absence of harmful effects on heath. Consequently, to expand the use of treated sewage water in the days to come, it is important to promote understanding and participation in the project by undertaking awareness-building activities for farmers. In particular, since the lack of understanding of the effectiveness of using treated sewage water on the part of the generation that adheres to traditional farming methods sometimes serves as a factor blocking the switch to irrigation-based farming using treated sewage water, it is important that awareness-building activities be undertaken by targeting the older generation of farmers.

-It is essential that ONAS and competent authorities, which have a decisive impact on the effectiveness of the project, cooperate closely in monitoring and improving the quality of treated sewage water used for irrigation. They must promote efforts to relieve farmers' anxiety by for example, enabling the Ministry of Agriculture and Water Resources to be involved in the monitoring of the quality of treated sewage water, the discontinuation of water services when the quality fails to meet the standards, and the implementation of water quality improvement measures.

3.3 Recommendations

・In order to further spread the irrigation of farmland using treated sewage water, it is important to reduce the sense of anxiety about using treated sewage water for irrigation – especially among the older generation of farmers who adhere to the traditional methods of farming – by promoting understanding of the benefits of using treated sewage water as irrigation water. It is essential to deepen farmers' understanding of irrigation based on the use of treated sewage water by, for instance, conducting tours of areas where such

irrigation is already being implemented, promoting exchange of information and views among the same generation of farmers, and periodically offering training in raising agricultural products suited for irrigation and their cultivation methods.

Comments from the Ministry of Agriculture and Water Resources:

Promotion activities targeting the beneficiaries for this project are carried out fully. The strong partnership with ONAS is valued for the improvement of water quality and this partnership is expected to become stronger in the coming years. Considering the climate of Tunisia and the scarcity of water resources, there is a continuous need to raise the value of and to effectively utilize the existing resources.

Comparison of Original and Actual Scope

Item	Breakdown	Original	Actual
1. Output	(1) Construction of treated sewage irrigation facilities in 10 areas in Tunisia		
	(a) Facilities for storing treated sewage water	10 sites	8 sites
	(b) Pumping stations	13 sites	10 sites
	(c) Adjustment water storage facilities	12 sites	10 sites
	(d) Water supply and irrigation drainpipes	187 km	179 km Jerba Aghir; implemented only in the first stage of construction.
	(e) Irrigation sites development	1,853 ha	Nearly as planned
	(2) Consulting services	52.5 MM	As planned
	(a) Detailed design related to the above-mentioned irrigation facilities, tendering document preparation and detailed design/tendering document preparation (local) (5 subprojects: Bizerte, Menzel Bourguiba, Jerba Aghir, Siliana, Médenine)	4 MM	4MM
	(b) Survey related to groundwater increment for using treated sewage water in Nabuel and Jerba Aghir		Survey of Jerba Aghir was implemented as planned. Survey of Nabeul was cancelled because it was included in a project funded by the World Bank.
2. Period	March 1998 – Sept 2003 (5 years and 7 months) 67 months	March 1998 – Oct 2005 (7 years and 8 months) 92 months	
3. Project cost		*[19]	
Foreign Currency	215 million yen		
Local Currency	2,062 million yen (Foreign currency: 18.749 million DT)		
Total	2,277 million yen	1,588 million yen	
ODA Loan Portion	1,707 million yen	1,332 million yen	
Exchange Rate	1 DT = 110 yen (As of March 1998)	1 DT = 92.95 yen (Average March 1998 – October 2005)	

[19] There are no data on the breakdown.