Incentive Systems for Use of Reclaimed Wastewater in Irrigated Agriculture in Jordan and Tunisia

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Abstract
This paper analyzes and assesses the potential factors that promote or discourage the use of reclaimed wastewater in irrigated agriculture in Jordan and Tunisia as representative of the Middle East and North Africa region. To help understanding the underlying fundamental driving forces for wastewater reuse, a number of selected irrigation schemes were surveyed and methodological interviews with stakeholders were conducted as part of the fieldwork in Jordan and Tunisia. The selected stakeholders in each of the two countries represented governmental administrators, operational staff, farmers, and common public at household level. The regulatory, financial, and socio-cultural (dis)incentives were shown in the field surveys to be of great relevance in the shaping of the decisions of both the farmers – who have to buy the reclaimed water and apply certain agronomic approaches – and the public – that must decide whether to buy the crops watered with reclaimed wastewater. The most prominent factors are: (i) finding reliable users for reclaimed wastewater, (ii) awareness to change the attitudes of farmers and public, (iii) storage and reliability of supplies, (iv) farmers' accessibility to freshwater, (v) stringent quality standards and regulations, (vi) farmers' involvement, (vii) coordination and cooperation between the various institutions, (viii) the wastewater treatment approach with the discharge objective, and (ix) pricing of freshwater and reclaimed wastewater.

Keywords
Wastewater reuse; agricultural irrigation; incentives; disincentives; Jordan; Tunisia

INTRODUCTION

The crisis of water scarcity looming on the horizon threatens the stability and security of the Middle East and North Africa region (MENA) that is home to five percent of the world's people yet has less than one percent of the world's renewable freshwater (Mubarak, 1998; Brooks, 1999). As MENA's population and economy grow against finite freshwater resources, the annual per capita availability in countries like Jordan, Libya, Palestine, Saudi Arabia, United Arab Emirates, and Yemen was less than 180 m^3 in 1995, far below the benchmark level of 1,000 m^3 used as an indicator of severe water stress (World Bank, 1996).

Much of the water crisis is caused by the way water is used. More than 87% of MENA's withdrawn water is allocated to agriculture and only 13% to municipal and industrial uses, compared with worldwide 69% and 31%, respectively. This implies reallocation of freshwater from agricultural to domestic and industrial uses. According to the World Bank (1996), a reduction in agricultural water use by 15% would double the water available to households and industry in the region. This would reduce irrigated agriculture at the time many countries aim to expand it due to food security reasons. For example, Tunisia and Egypt wish to increase their area of irrigated agriculture by at least 30,000 and 880,000 hectares, respectively (Faruqui, 2000; World Bank, 2000). Besides, the MENA countries avoid inter-sector water transfer, mainly due to internal political considerations (Saghir *et al*., 2000). On the contrary, these countries adopt low water tariffs for agricultural irrigation (at least 10 times lower than that for urban use), which encourages agricultural water consumption (Gibbons, 1986). Thus, the region will increasingly suffer from water scarcity and

consequent food insecurity. This fact has converged national, regional, and international efforts in search for additional and alternative sources of water.

Most attention was turned to desalination of brackish and sea water, inter-basin transfers by pipeline, and import of water by shipment. All of these options are technically feasible, but none is affordable or easy since they are capital and energy intensive, many have severe ecological impacts, and all are politically complex (Brooks, 1999). Moreover, these options can solve the quantity dimension of the problem temporarily, but cannot prevent environmental pollution and risks to public health. The reuse of treated wastewater, on the other hand, is well recognized for having a potentially significant role in alleviating the quantitative and qualitative stress on water resources the region (Khouri, 1992; Haruvy, 1997, 1998; Mubarak, 1998; Angelakis *et al*., 1999; Bahri, 1999; Al-Hamdi, 2000). The increasing concern for wastewater reuse as an integral part of total water balance stems from the following considerations: (i) growing water scarcity in many arid and semi-arid regions of the world increases demands for additional water supplies, (ii) high population growth leads to greater quantities of wastewater production, (iii) environmental concerns increase, reflected by stricter pollution control measures, leading to larger quantities of wastewater to be treated at high expenses, (iv) a wide range of technologies now exists to purify wastewater to acceptable levels, increasing the opportunities to reclassify wastewater as a renewable water resource rather than waste, (v) the nutrients in reclaimed wastewater add attraction for use in agriculture, and consequently reduce use of chemical fertilizers, (vi) rain-fed farming can be converted into more productive wastewater irrigated agriculture, and (vii) depending on the degree of treatment, reclaimed wastewater is a reliably available resource that may be fit for irrigation, industrial, and municipal uses at relatively low costs.

In most MENA countries, the rates of wastewater reuse are still very low compared to generation, even in pioneer countries like Jordan and Tunisia (Figure 1). In order to better understand the problem, reclaimed wastewater is recognized as a commodity whose market comprises: (i) a supply side, which refers to the production, collection, and treatment of wastewater, (ii) a demand side, which refers to the use of the reclaimed wastewater, and (iii) market control and monitoring, which refers to the regulatory and institutional framework. In this case, the reclaimed-wastewater market is unbalanced; i.e., growing supply – which is demonstrated by the increasing sewerage coverage and number of wastewater treatment plants (WWTPs) – and stagnant demand – which is demonstrated by the substantial proportions of treated effluents that are not used but discharged. This paper identifies the (dis)incentives for reducing the gap between supply and demand and balancing the reclaimed-wastewater market through increasing the rates of collection, treatment, and reuse close to the rate of wastewater production.

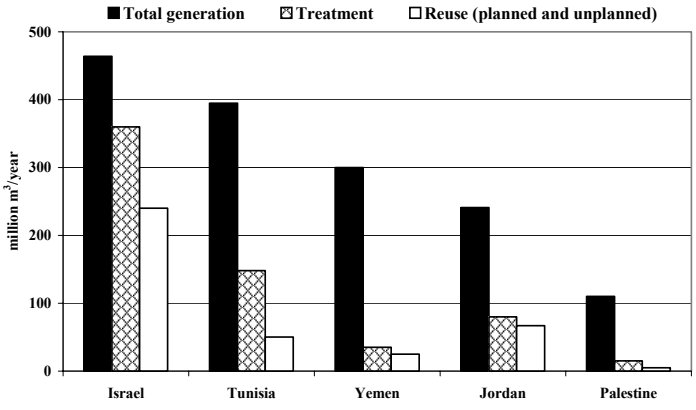

Figure 1: Wastewater reuse in selected MENA countries (MWI, 2000; ONAS, 2000; World Bank, 2001).

BACKGROUND ON JORDAN AND TUNISIA

Jordan

The Hashemite Kingdom of Jordan is located in the heart of the Middle East with a population of about 5 millions distributed over 89,556 square kilometers. Agricultural irrigation dominates about 71% of the total water use. The total production rates of municipal wastewater are about 241 million m^3 of which about 239 million m^3 are collected through sewerage (51%) and onsite systems (49%). The amounts of wastewater that receive treatment in 17 plants are about 80 million m^3 of which about 67 million m^3 are reused (in 2000). Direct reuse of the secondary-treated effluents is limited to few farms within the surroundings of the existing treatment plants. Most of the reuse (indirect) takes place after blending the secondary-treated effluents with freshwater available in wadis and dams (not for potable use), which is used downstream in the Jordan Valley for unrestricted irrigation. In Jordan, the Ministry of Water and Irrigation (MWI) is the main institution responsible for water supply, wastewater collection, treatment, and reuse. However, many other institutions are involved in wastewater treatment and reuse such as the Ministries of Health, Agriculture, and Industry in addition to the Standards and Metrology Establishment and others.

Tunisia

The Tunisian Republic is located in the heart of North Africa with a population of about 9.5 millions distributed over 164,418 square kilometers. Agricultural irrigation dominates about 80% of the total water use. The total production rates of municipal wastewater are about 395 million m^3 of which about 316 million m^3 are collected through sewerage (40%) and onsite systems (60%). The amounts of wastewater that receive treatment in 61 plants are about 148 million m^3 of which about 50 million m^3 are reused (in 2001). Direct reuse of the secondary-treated treated effluents is practiced in many irrigation schemes that are designed for this purpose. Indirect reuse is partly practiced trough blending with freshwater in the dams and in deep aquifers (not for potable use). In Tunisia, *National Sewerage and Sanitation Agency* or Office National de l'Assainissement (ONAS), which is a sub-organization of the Ministry of Environment and Land Use, is the main institution responsible for wastewater collection and treatment. Reuse is the responsibility of the Ministry of Agriculture. However, many other institutions are involved in wastewater treatment and reuse such as the Ministries of Health, Industry, Interior, and others.

METHODOLOGY

A fieldwork of five months was conducted in Jordan and Tunisia for collection of data on wastewater treatment, agricultural irrigation with the reclaimed wastewater, and crop marketing and consumption. In Jordan, a three months fieldwork was conducted in coordination with the MWI. This period was used as follows: (i) two weeks (8th-23rd January 2000) for exploratory and coordination purposes, (ii) two weeks (3rd-17th February 2000) for pilot testing of questionnaires, and (iii) two months (15th March-16th May 2000) for actual field surveys. In Tunisia, a two months fieldwork (24th May-25th July 2001) was conducted in coordination with ONAS.

Collection of basic information through literature review, and extensive communication with these countries through e-mail and phone calls prior to the country visits helped in better time use during the fieldwork. The five months were effectively utilized through devoting five working days every week for visiting WWTPs and institutions responsible for treatment and reuse in each country. The weekends were devoted to surveying irrigated farms and households (Friday and Saturday in Jordan, and Saturday and Sunday in Tunisia).

Different techniques were employed to collect the data necessary to achieve the objectives of this

study. In addition to literature review, focus discussions, and observations, four types of questionnaires were designed with the help of two specialists from the Palestinian Central Bureau of Statistics (Table 1). The prepared questionnaires were pilot-tested in Jordan on 3 WWTPs, 15 irrigated farms, 5 administrators, and 20 households. Pilot testing helped restructuring of the questionnaires which saved time during the actual survey, and most importantly, helped coming to better identification of the list of potential factors that influence wastewater treatment and reuse for agricultural irrigation in each country. The pilot-tested questionnaires were employed for conducting the field surveys. The SPSS software is used for analysis of the collected data.

Table 1: Research questionnaires, targeted groups, and sample size.

Targeted group	*Data collection technique*	*Sample size*		
		Jordan	*Tunisia*	*Total*
Administrators representing government, NGOs, research centers, plant managers, and farmers' unions	Questionnaire (**A**) + focus discussions	38	34	*72*
Wastewater treatment plants	Questionnaire (**B**) + literature	13	18	*31*
Farms irrigated with groundwater	Questionnaire (**A**) + (**C**)	12	6	*18*
Farms irrigated with surface water	Questionnaire (**A**) + (**C**)	15	5	*20*
Farms irrigated reclaimed wastewater	Questionnaire (**A**) + (**C**)	11	40	*51*
Farms irrigated with wastewater blended with freshwater	Questionnaire (**A**) + (**C**)	10	5	*15*
Households (crop consumers)	Questionnaire (**D**)	175	151	*326*
Crop markets	Observations and discussion	2	1	*3*

Notes:

A) A short questionnaire that targeted 58 administrators, 14 WWTP managers, and 104 farmers with the objective to identify potential incentives and disincentives for wastewater treatment and reuse.

B) In-depth questionnaire and checklist that targeted 31 WWTPs with the objective to collect necessary data for assessment of wastewater treatment performance.

C) In-depth questionnaire that targeted the aforementioned farmers (104) with the objective to collect necessary data for analysis of agronomics of reuse as well as to elicit the perceptions and attitudes of farmers.

D) A questionnaire that targeted 326 households with the objective to elicit the perceptions and attitudes of the public with regard to use of crops irrigated with reclaimed wastewater.

RESULTS AND DISCUSSION

Identifying the (dis)incentives for utilization of reclaimed wastewater

The descriptive analysis of the administrators' and farmers' responses identified factors that are deemed to influence decision-making and perceptions in Jordan and Tunisia (Table 2). The results show that the rank of the various factors varies between the stakeholder groups as well as the two countries. This is mainly attributed to the different interests and priorities of each stakeholder and to the limited administrators' knowledge of farmers' interests and priorities and vise versa. However, there are prominent factors that have been equally ranked by both administrators and farmers in these two countries. These factors are (Group I):

- Finding reliable users for reclaimed wastewater.
- Awareness to change the attitudes of farmers and public.
- Storage and reliability of supplies.
- Farmers' accessibility to freshwater.
- Stringent quality standards and regulations.
- Farmers' involvement.
- Coordination and cooperation between the various institutions.
- The wastewater treatment approach with the discharge objective.
- Pricing of freshwater and reclaimed wastewater.

The factors that mainly administrators and partly farmers in both countries recognize as influential are (Group II):

- Health risks to farmers and crop consumers.
- Water scarcity at national level.
- Impact on crop yield and fertilizer saving.
- Impacts on quality of soil and water resources.

The factors that mainly farmers and partly administrators in these two countries recognize as influential (Group III) are:

- Cropping restriction lowers agricultural profitability.
- Concern for criticism by reference/peer groups and public.
- Unavoidable use of freshwater.

Both administrators and farmers in these two countries agree on the factors of less concern. These factors (Group IV) are:

- Impact on irrigation equipment.
- Land fragmentation in the traditional inheritance system.
- Psychological aversion to wastewater irrigation and crops.
- Religion prohibition towards irrigation with reclaimed wastewater.
- Public rejection to consume crops irrigated with reclaimed wastewater.

Table 2: Administrators' and farmers' ranking of the factors that potentially influence the use of reclaimed wastewater in irrigated agriculture in Jordan and Tunisia.

Factors considered:	*Administrators*		*Farmers*	
	Jordan (n=38)	*Tunisia (n=34)*	*Jordan (n=46)*	*Tunisia (n=50)*
	%	*%*	*%*	*%*
Finding reliable users for reclaimed wastewater is often ignored in the planning of WWTPs	**100**	**100**	**100**	**100**
Awareness is needed to change the attitudes of farmers	**100**	**100**	**100**	**100**
Inadequate infrastructure for storage, conveyance, and distribution	**100**	**88**	**100**	**100**
Reuse poses health risks to farmers and crop consumers	**100**	**97**	61	20
Farmers' accessibility to freshwater makes reuse unattractive	**95**	**88**	**96**	**100**
Water scarcity at national level makes reuse attractive	**95**	**79**	28	32
Reuse increases crop yield due to fertilizers in reclaimed wastewater	**82**	**97**	13	36
The institutional conflicting interests hamper reuse	**79**	**97**	54	**72**
The stringent quality standards and regulations hamper reuse	**76**	**97**	**89**	**100**
Farmers' involvement is important and often ignored	**71**	**88**	**78**	**96**
The discharge approach of wastewater treatment hampers reuse	**71**	**94**	59	**86**
Reuse poses impacts on quality of soil and water resources	66	**88**	57	16
Cropping restriction lowers agricultural profitability	58	35	**100**	**82**
Pricing of freshwater and reclaimed wastewater influences reuse	47	**85**	**100**	**86**
Reuse poses impacts on irrigation equipment	21	9	43	10
Concern for criticism by reference/peer groups and public hampers reuse	13	6	**87**	48
Land fragmentation in the traditional inheritance system hampers reuse	3	18	15	24
People have psychological aversion to wastewater irrigation and crops	3	9	13	8
Religion prohibits irrigation with reclaimed wastewater	3	0	13	4
Unavoidable use of freshwater hampers reuse	0	3	24	**85**
Consumers will reject crops irrigated with reclaimed wastewater	0	6	48	14

Group I (dis)incentives

Finding reliable users for reclaimed wastewater. Mills and Asano (1996) emphasize that only identifying the potential water users for planning purposes is not enough, but there must be some assurance before embarking on design and construction of reuse projects that the intended users (farmers) will use and pay for wastewater. Planners of the eighties have rarely recognized the

necessity for assessing the potential market for the reclaimed wastewater, which explains in part the existing gap between the planned and practiced reuse (Bahri and Brissaud, 1996).

According to our field survey, the percentages of Jordanian farmers that accept to use the reclaimed wastewater for restricted and unrestricted irrigation are about 30% and 80%, respectively, compared with about 67% and 82%, respectively, in Tunisia (Table 3). The percentages of farmers who are uncertain are about 28% and 18%, respectively. Farmers clearly prefer to use wastewater in an unrestricted fashion rather than for restricted irrigation only as they correlate the cropping freedom with increased profit. On the other hand, only about 22% and 7% of the Jordanian farmers were found to reject reclaimed wastewater for restricted and unrestricted irrigation, respectively, compared with about 10% and 8% of that in Tunisia; these appear to be mainly farmers who have access to freshwater (surface water, and owners of groundwater wells). These results demonstrate that the farmers' acceptance has improved over the last 10 years. Thus, the results suggest a more promising era for reclaimed wastewater use for both restricted and unrestricted irrigation. However, more effort is still needed in order to improve the farmers' acceptance level through addressing the various disincentives that influence their perceptions and attitudes. The field survey (Tables 4, 5) identified the following prominent disincentives that fuel the farmers' rejection and hesitation in these two countries: (i) availability of or accessibility to freshwater, (ii) distrusted water quality, and (iii) farmers' worries about crop marketing and acceptance of public to buy crops irrigated with wastewater.

Table 3: Acceptance of farmers to use reclaimed wastewater.

Country	*For restricted irrigation*						*For unrestricted irrigation*					
	Accept		*Uncertain*		*Reject*		*Accept*		*Uncertain*		*Reject*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Jordan (n=46)	14	30.4	22	47.8	10	21.7	31	67.4	12	26.1	3	6.5
Tunisia (n=50)	40	80.0	5	10.0	5	10.0	41	82.0	5	10.0	4	8.0

Table 4: Reasons for farmers' rejection and hesitation to use reclaimed wastewater for restricted irrigation.

Factors	*Jordan*				*Tunisia*			
	Uncertain (n=22)	*Reject (n=10)*	*Total (n=32)*		*Uncertain (n=5)*	*Reject (n=5)*	*Total (n=10)*	
	Count	*Count*	*Count*	*%*	*Count*	*Count*	*Count*	*%*
Availability/accessibility of freshwater	22	10	32	***100***	5	5	10	***100***
Distrusted water quality	21	9	30	***94***	3	5	8	***80***
Concern for public criticism	8	2	10	*31*	2	1	3	*30*
Worries about crop marketing	4	6	10	*31*	8	1	9	***90***
Concern for health impacts	2	4	6	*19*	1	3	4	*40*
Religious prohibition	5	1	6	*19*	1	1	2	*20*
Psychological aversion	2	3	5	*16*	1	4	5	*50*

Table 5: Reasons for farmers' rejection and hesitation to use reclaimed wastewater for unrestricted irrigation.

Factors	*Jordan*				*Tunisia*			
	Uncertain (n=12)	*Reject (n=3)*	*Total (n=15)*		*Uncertain (n=5)*	*Reject (n=4)*	*Total (n=9)*	
	Count	*Count*	*Count*	*%*	*Count*	*Count*	*Count*	*%*
Availability/accessibility of freshwater	12	3	15	***100***	5	4	9	***100***
Distrusted water quality	11	3	14	***93***	4	4	8	***89***
Worries about crop marketing	8	2	10	*67*	5	2	7	***78***
Concern for public criticism	6	2	8	*53*	4	2	6	*67*
Concern for health impacts	4	2	6	*40*	3	1	4	*44*
Religious prohibition	3	1	4	*27*	1	0	1	*11*
Psychological aversion	1	2	3	*20*	1	3	4	*44*

Awareness to change the attitudes of farmers and public. Often, public knowledge is very limited about the risks and benefits of wastewater reuse. This has been confirmed by all the surveyed administrators and farmers in Jordan and Tunisia. Therefore, raising public awareness and changing public attitudes on wastewater reuse are common objectives worldwide, even though it is recognized that there is no straightforward relationship between awareness and attitude change (Nexus Australia, 1999).

The results of this study show that perceptions and attitudes towards irrigation with reclaimed wastewater are not rigid but subject to conditional change except for some fundamental postulates and taboos. An attempt was made to understand what might change the perceptions and attitudes of farmers and crop consumers, besides the direct disincentives that have been identified previously. A list of potential factors was presented to all interviewed individuals in the sample (farmers and crop consumers) in the form of dichotomous questions since respondents were not able to scale these factors. Results suggest a number of factors that might be capable of improving perceptions (Tables 6, 7). Most of these factors are applicable to both farmers and crop consumers, but some are group-specific.

Table 6: Factors that might change farmers' attitudes.

Factors	*Jordan (n=46)*		*Tunisia (n=50)*	
	Count	*%*	*Count*	*%*
Availability or shortage of freshwater	44	***96***	50	***100***
Improved water quality and cropping freedom	44	***96***	48	***96***
Community leaders	43	***93***	21	*42*
Regulations and enforcement	42	***91***	49	***98***
Water prices and profit	41	***89***	48	***96***
Specialists	36	***78***	50	***100***
Farmers' involvement	35	***76***	48	***96***
Potential fertilizers saving	32	***70***	39	***78***
Media (TV, Newspapers, radio)	29	*63*	20	*40*
Reports, studies, brochures	27	*59*	34	*68*
Relatives	21	*46*	14	*28*
Friends	8	*17*	14	*28*

Table 7: Factors that might change public attitudes.

Factors	*Jordan (n=175)*		*Tunisia (n=151)*	
	Count	*%*	*Count*	*%*
Regulations and enforcement	167	***95***	145	***96***
Public involvement	150	***86***	54	*36*
Specialists	149	***85***	133	***88***
Media (TV, newspapers, radio)	96	*55*	116	*77*
Community leaders	89	*51*	68	*45*
Relatives	76	*43*	44	*29*
Friends	59	*34*	26	*17*
Reports, studies, and brochures	42	*24*	62	*41*

Storage and reliability of supplies. The requirements for the management of the supply of reclaimed wastewater differ from those of freshwater. Traditional water supply systems that draw water from ground or surface water often can employ the resource as source and storage facility at the same time. If the full yield of the source is not needed, the water is kept for later use. In the case of reclaimed-wastewater reuse, supplies are continuous and what cannot be used instantly must be stored as it otherwise will be disposed and lost in some way or another. Thus, the supply may be available when the demand is low and vise versa. Storage of the reclaimed wastewater must allow coping with hourly, daily, and seasonal fluctuations of water supply and demand (Friedler, 2001).

Almost all administrators and farmers in Jordan and Tunisia reported that the absence or insufficiency of storage, and the ensuing unreliability of supply, are major limiting factors for the growth of wastewater reuse. Besides, 38 out of the 51 interviewed reclaimed-wastewater farmers emphasized that they are severely affected by this problem. Currently, both countries are experimenting with storage of reclaimed wastewater in existing dams or newly built reservoirs (not destined for potable water supply) as well as with artificial recharge of groundwater aquifers.

Blending reclaimed water with freshwater is widely practiced in Jordan and Tunisia. In Jordan, most of the treated wastewater is blended with freshwater from the King Talal Dam and used downstream in the Jordan Valley. The blending ratio has allowed unrestricted irrigation and increased the reliability of water supply, which stimulated reuse (Shatanawi and Fayyad, 1996).

Groundwater recharge with reclaimed wastewater is still restricted for different reasons, such as the shallowness of the groundwater level, the use of groundwater for potable water supply, the poor quality of the reclaimed wastewater in terms of salinity, and the potential impacts on the aquifer quality (Bahri, 1999).

Farmers' accessibility to freshwater. Freshwater availability/accessibility at scheme level is the most crucial disincentive for reuse. All the surveyed farmers and administrators perceive the availability/scarcity of freshwater, next to the reclaimable wastewater, as a major factor that can influence the decision to opt for wastewater irrigation. The availability of cheap freshwater makes reclaimed wastewater less attractive and less competitive. This disincentive can be mitigated through enforcing restrictions on irrigation with freshwater wherever reclaimed wastewater can cover the agricultural water demand, and through strengthening the incentives, such as water pricing, that make reclaimed wastewater competitive with freshwater.

Stringent quality standards and regulations. Many quality standards and guidelines in the MENA countries were based on existing regulations, including: the California Standards, the WHO guidelines, the USEPA guidelines, the FAO guidelines, and others (Abu Rizaiza, 1999). The FAO guidelines that determine the suitability of a given effluent for irrigation are often used as a basis for the criteria in most MENA countries, including, pH, salinity, SAR, nitrogen, toxic ions, trace elements, and heavy metals (Ayers and Westcot, 1985). These standards are developed based on standards taken from countries with very different climatological and economic conditions and expectations. Such standards are comparatively demanding and unintentionally impose unnecessary limitations on disposal and reuse of wastewater, and they are hard to reach with the available technological capacity and financial resources. Despite the high removal efficiencies of these technologies, their effluent quality is still relatively poor due to specific circumstances of its "strong" sewage. Improving the effluent quality requires post treatment, substantially raising the capital and operational costs under conditions of scarce financial resources. At least some authors, in addition to most of the interviewed administrators and farmers in Jordan and Tunisia, believe that the unrealistically high quality requirements of treated effluents frustrate the development of wastewater treatment and reuse (Abu-Rizaiza, 1999).

Farmers' involvement. The top-down or supply-driven approach has been the conventional one in water, wastewater, and reuse projects for many decades. This approach, as described for water projects in general by Alaerts *et al*. (1991), is very typical for wastewater reuse projects. Typically, two main actors are identified in the process of planning, implementation, and operation of a water project: the government working through the administration or an agency and the beneficiary community. The roles of these actors are rather straightforward, with the agency playing the leading role and defining the policies, managing the funds, having the technical expertise, but also

being burdened with exhausting tasks. By comparison, the beneficiary community is assumed ignorant, incapable, and inactive. As a result, the beneficiary is bypassed in the hurry to "get the job done". As previously discussed, this type of approach is very common in the MENA region where reuse is often considered as an afterthought after implementation of WWTPs; the needs, perceptions, and capabilities of the beneficiaries, and the market economics that define their decisions, are routinely ignored.

The modern participatory and demand-driven approach is becoming more accepted, however, in which the actors remain the same but the roles change. The agency remains the project initiator, but the beneficiaries play a more prominent and decisive role in all project phases (Alaerts *et al*., 1991). With regard to wastewater reuse projects, this type of approach is likely to support safer and more efficient use of reclaimed wastewater, and maximize the reuse rate (Khouri *et al*., 1994; Bahri, 1999). This approach was successively applied in the Wardanine reuse scheme of Tunisia. In this scheme, farmers were involved from the early stages of the project planning and implementation in 1996. A water user association was formed representing 25 farmers that irrigate with reclaimed wastewater. This association is headed by a committee of 7 elected members. The main tasks of the committee at the implementation phase were to: (i) contribute to the construction of the project by solving design and operational difficulties between the contractor and the local population, (ii) contribute to the opening of new agricultural roads, (iii) help in selecting the sites of reservoir and pumping station, and (iv) coordinate between the equipment providers and the farmers.

The participatory approach did not only facilitate the implementation and management of the reuse project but it also increased the willingness of farmers to use and pay for reclaimed wastewater. It has to be mentioned that the Wardanine reuse scheme is indeed the only scheme out of the surveyed schemes that made an attempt to, and succeeded in involving farmers. Therefore, there is a strong argument that farmers' involvement in all project phases does increase the opportunities for sustainability and reduce the managerial and financial burden on the government institutions. It is worth mentioning that most of the surveyed administrators and farmers in Jordan and Tunisia perceive the importance of farmers' involvement in all phases of a reuse project.

Coordination and cooperation between the various institutions. Reuse projects are pre-eminently multi-sectoral. Thus, the proper identification of the stakeholders, as individuals and as institutions, is particularly important. Stakeholders involve the public, the health, environment, agriculture, and water resources officials and decision-makers, the wastewater infrastructure managers, the farmers, and many others. Proper institutional arrangement for wastewater reuse projects entails integrated views and cooperation at intra and inter (sub-) sectoral levels of the various institutions so as to optimize the use of physical, financial, and human resources (Alaerts *et al*., 1991; Khouri *et al*., 1994). However, skills and administrative responsibilities are often spread over a large number of institutional structures that have own interests to protect even while intending to be cooperative (UNDP *et al*., 1992; Mills and Asano, 1996).

Wastewater treatment approach with the discharge objective. About 94% and 71% of the interviewed administrators as well as about 86% and 59% of the farmers in Tunisia and Jordan, respectively, were critical of the current approach adopted for wastewater treatment. The approaches towards design of wastewater treatment still have effluent disposal as the principal objective, which however is not necessarily compatible with the objective of making the effluent most suitable for reuse. Thus, these approaches are a major disincentive for reuse. Wastewater needs to be recognized as a sustainable alternative source of water for an increasing number of applications and as a viable part of the water cycle (Eden, 1996; Friedler, 2001).

Pricing of freshwater and reclaimed wastewater. Pricing policies that emphasize economic efficiency and reducing of overall water use are especially relevant for regions with increasing water scarcity such as the MENA region. Appropriate pricing entails reducing the costs of water supplies and charging the consumers the true cost of these supplies (CSWSME, 1999). However, all MENA countries avoid effective pricing of freshwater and reclaimed wastewater as well as agricultural-urban water transfers, because of institutional and political influences (Saghir *et al*., 2000). In most of the Gulf countries, the reclaimed wastewater is fully subsidized and supplied to farmers free of charge (Banks, 1991). In Jordan and Tunisia, the current tariffs that farmers pay for reclaimed wastewater can barely cover even the operational costs of conveyance and distribution (Table 8). The current pricing polices that adopt low pricing of reclaimed wastewater as a tool to make wastewater reuse attractive (Bahri and Brissaud, 1996; MWI, 1999; ONAS, 2001) are ineffectual since the prices of freshwater for irrigation are relatively low as well; freshwater tariffs for irrigation are about 10 times lower than for domestic and industrial consumption (Faruqui, 2000). Water pricing has been successively used as a tool to reduce water use and raise revenues in many parts of the world, e.g. Israel and Germany (Sanz, 1999; Ahmad, 2000). Thus, the prices of freshwater could be increased to a level that, first, does not jeopardize feasibility of agriculture, and, second, makes reclaimed wastewater more competitive. In the case studied, even the prices of reclaimed wastewater could be somewhat increased without negative effects, as long as the underlying principle is maintained.

Table 8: Costs of wastewater treatment and conveyance and distribution against tariff of wastewater sale.

Tariff/cost	*Jordan*		*Tunisia*	
	*JD/m³ **	*US$/m³*	*TD/m³*	*US$/m³*
*Tariff **	0.0–0.049	0.0–0.08	0.02–0.10	0.014–0.08
Conveyance and distribution costs				
Operational costs	0.028–0.084	0.04–0.12	0.125–0.21	0.09–0.15
Total costs incl. depreciation	0.070–0.147	0.10–0.21	0.175–0.35	0.13–0.25
Treatment costs				
Operational costs	0.014–0.238	0.02–0.34	0.042–0.24	0.03–0.17
Total costs incl. depreciation	0.035–0.665	0.05–0.95	0.056–1.30	0.04–0.93
Total costs of treatment and conveyance incl. depreciation	0.105–0.812	0.15–1.16	0.231–1.65	0.17–1.18
Conveyance and distribution costs as percentage of the total costs incl. depreciation	18.1–66.7%		21.2–75.8%	

* One US$ = 0.70 JD = 1.4 TD (exchange rates of 2001).

No single factor is likely to influence the cost of wastewater reclamation project more than the conveyance and distribution of the reclaimed wastewater from its source to its point of use. This is mainly because the system includes pipelines, pump stations, and storage facilities. The conveyance and distribution costs in Jordan and Tunisia represent, respectively, about 18-67% and 21-76% of the total costs (including investment) (Table 8). In the Irvine Ranch Water District of California (USA), the costs of the post-treatment and the distribution network are respectively 24% and 43% of the total investment cost (Bartone, 1994). In Dubai (UAE), the costs of treatment (incl. tertiary treatment), and the costs of conveyance and distribution, are 27% and 50% of the total investment, respectively (Al-Hamdi, 2000).

Although most WWTPs in Tunisia are located quite a distance away from the agricultural land, the government constructed conveyance and distribution systems at all irrigation schemes. In most cases, this was done with support of external aid agencies. As an incentive to promote reuse, augment water availability, control pollution, and encourage agricultural production, the capital and operational costs are subsidized. Nonetheless, the utilization rates of reclaimed wastewater are still low. In Jordan, on the other hand, the infrastructural requirements for conveyance of treated wastewater for direct irrigation are more limited since most WWTPs are located close to the

agricultural land. Nonetheless, direct reuse is limited to one to a few farms within the surroundings of some WWTPs, and large schemes do not exist. The agricultural land irrigated with blended water lies at a distance from WWTPs, but the use of gravity conveyance systems (wadis and canals) drastically reduces the supply costs. Here, the rates of wastewater utilization are high.

These results show that the conveyance and distribution costs can be a major disincentive for irrigation with reclaimed wastewater in cases where the infrastructure requirements are high and the financial resources to build them are limited. However, this is not a reclaimed-wastewater-specific disincentive since it is also valid, to certain extent, for freshwater irrigation. Thus, as far as possible, using the reclaimed wastewater in the vicinity of the WWTPs overturns this disincentive and even makes wastewater irrigation more attractive.

Group II (dis)incentives

Health risks to farmers and crop consumers. In both countries, farmers that have experienced reclaimed-wastewater irrigation seem to be more realistic than administrators and freshwater farmers. The survey results show that 100% and 97% of the interviewed administrators in Jordan and Tunisia, respectively, believe that wastewater reuse poses health risks to farmers and crop consumers. The conservative opinions of the administrators do not necessarily reflect a high level of knowledge about the actual health impacts associated with wastewater irrigation. Interestingly, farmers have significantly less conservative opinions; 61% and 20% of the surveyed farmers in Jordan and Tunisia, respectively. The freshwater farmers that have not experienced irrigation with reclaimed wastewater also have conservative opinions; the aforementioned 61% and 20% of farmers in Jordan and Tunisia are mostly freshwater farmers. Apparently, the administrators in both countries are cautious about public health, therefore they adopt more conservative opinions than farmers. This, in effect, imposes a financial penalty on the country because (i) the overly restrictive standards require expensive wastewater treatment, and (ii) farmers are forced to use more expensive freshwater. However, the knowledge of administrators and farmers is often narrow since they mostly recognize the short-term impacts related to some types of infectious diseases, while few recognize the possible long-term impacts associated with the various constituents in reclaimed wastewater. For instance, the health impacts also have important economic consequences. The heavy parasitic burden caused by helminthes can cause digestive and nutritional disturbances, abdominal pain, vomiting, diarrhea, and loss of weight eventually leading to anemia. The anemic condition further prevents victims from developing, both physically and intellectually. This raises costs associated with medical treatment and the loss of the ability to generate revenue as an adult (Shuval *et al*., 1986).

In conclusion, the concern for health impacts associated with the reclaimed wastewater is a disincentive for reuse. In order to overturn this disincentive, more research is needed on the actual impacts to farmers and crop consumers, and awareness is needed for administrators as well as for farmers and crop consumers.

Water scarcity at national level. Even if all produced wastewater were collected and reclaimed, it could only modestly contribute to the augmentation of national water resources. The maximal production of wastewater is still very low compared with the total water demand, especially for agriculture. However, each unit of reused wastewater avoids using a similar volume of freshwater and avoids pollution of water resources, in addition to the fact that it brings its rich nutrients content to the field. Because of this triple positive effect, the contribution of wastewater to alleviating water scarcity makes more sense. Thus, most water and environmental policies of the region recognize wastewater as a non-conventional resource. In other words, in arid and semi-arid regions, water scarcity functions as an “incentive” for wastewater reuse, though several obstacles

may hamper implementation of such policies. This incentive was recognized by most of the surveyed administrators and only about third of the farmers in each country, thus it functions better at national government level.

Impact on crop yield and fertilizer saving. Considerable research has been undertaken into the value of nutrients in reclaimed wastewater and their effect on crop yield. In Mexico, the productivity of alfalfa, corn, wheat, oats, and tomato increased by 70-140% when irrigation was switched from freshwater to reclaimed wastewater (Jiménez, 1995). In Jordan, the effect of reclaimed-wastewater irrigation was studied on the crop yield of sweet corn, cotton, soybean, watermelon, and tomato (Fardous and Jamjoum, 1996; WERSC, 1989, 1998). Reclaimed-wastewater irrigation produced higher crop yield than freshwater irrigation. However, only 13% and 36% of the surveyed farmers and 82% and 97% of the surveyed administrators in Jordan and Tunisia, respectively, did recognize the commercial value of the nutrients in the wastewater.

Our study shows that there is about 65% saving in actual fertilizer expenditure when irrigating fruit trees with reclaimed wastewater compared to irrigating with fresh groundwater. Also, interestingly, many farmers irrigating with blended water persist to use fertilizers with the same magnitude that is used in freshwater irrigation despite the high nutrient content in the reclaimed wastewater. Those farmers seem to not have confidence in the quality of reclaimed wastewater, or they unconsciously attribute their high crop yield and agricultural profit to the application of the artificial fertilizer; this is consistent with the observation that they tend to use less fertilizer for low-value fodder crops than for fruit trees and vegetables. Some of those farmers reported that reclaimed wastewater have negative impacts on the quality of their crops; this is an important issue since crop quality is directly linked with crop marketing and profit. Thus, more effort is needed to raise farmers' awareness on the contents in reclaimed wastewater as well as on the costs and benefits associated with these contents.

Impacts on quality of soil and water resources. Irrigating with reclaimed wastewater can have a significant impact over time on the quality of soils and groundwater if the application load of certain constituents in the wastewater is very high (USEPA, 1992; Fardous and Jamjoum, 1996; Siebe, 1995; Haruvy, 1997; Bahri, 1998; Hussain and Al-Sati, 1999). However, this factor does not seem to be a major disincentive for reuse.

Group III (dis)incentives

Impact of cropping restriction on agricultural profitability. Some of the permitted crops can be more profitable than vegetables and cash crops, and thus, cropping restriction does not necessarily imply less profit. Indeed, the field survey shows that the profit from restricted irrigation can be similar to, and sometimes better than, unrestricted irrigation. The high frequency and yield of harvests, the low price of the reclaimed wastewater, and the lower fertilizer demand, make fodder very profitable. Cropping restriction/freedom clearly influences the willingness of farmers to use and pay for reclaimed wastewater; subsequently, the degree of freedom in cropping is an important incentive to make the market more receptive for reclaimed wastewater. In conclusion, the field evidence from Jordan and Tunisia contrasts with the common assumption that cropping restrictions necessarily are a disincentive for irrigation with reclaimed wastewater.

Concern for criticism by reference/peer groups and public. The majority of people in the MENA region are Muslims. Farmers are mostly located in rural and peri-urban areas where the social and traditional ties are stronger than in urban areas. Therefore, farmers' attitudes and perceptions, and any changes thereof, tend to be strongly influenced by religion, culture, politics, and influential

reference groups within the society. This factor was identified by about 13% and 6% of the administrators as well as by 87% and 48% of the farmers in Jordan and Tunisia, respectively. There is no specific classification of these reference/peer groups since they vary from one society to another, and one individual may feel guided by other reference groups than another individual. However, our study could tentatively identify three categories of reference groups to farmers and crop consumers: (i) community leaders that include religious preachers, clan leaders (*Hamolah Sheiks*), and local politicians, (ii) relatives, and (iii) friends. The results of the field survey show that in Jordan, about 31% and 53% of the farmers that are unwilling and uncertain to irrigate with reclaimed wastewater for restricted and unrestricted irrigation, respectively, attribute their decisions to concern for public criticism; in Tunisia, it is 30% and 67%, respectively (Tables 4, 5). The results also show that the percentages of farmers who feel concern for the opinions of community leaders, relatives, and friends in Jordan are about 93%, 46%, and 17%, respectively, and in Tunisia are about 42%, 28%, and 28%, respectively. For crop consumers, they are about 51%, 43%, and 34%, respectively in Jordan and 45%, 29%, and 17%, respectively, in Tunisia. There is no significant difference between the two countries, except for more tribute to community leaders by the Jordanian farmers than the Tunisians, which may be attributed to the strong tribal ties in the Jordanian rural communities. The significant difference between the responses of farmers and crop consumers with respect to opinions of community leaders can be attributed to the fact that all the surveyed farmers were located in rural and peri-urban areas while the surveyed crop consumers where from rural, peri-urban, and urban areas. Results also show that concern for public criticism is a strong disincentive to some users of reclaimed wastewater and related crops. Although the influence of this disincentive is diminishing, it still exists and has to be taken into account. These results suggest that involving the reference groups in decision-making and planning of a reuse project as well as in awareness campaigns might mitigate the socio-cultural disincentives.

Unavoidable use of freshwater. The fact that reclaimed-wastewater farmers may still have to buy expensive freshwater for supplementary irrigation and/or preparing pesticide and insecticide solutions has been emphasized by about 24% and 85% of the surveyed farmers in Jordan and Tunisia, respectively; mostly reclaimed-wastewater farmers. Surveyed farmers that irrigate fruit trees, especially apples and peaches, reported that they avoid using the reclaimed wastewater for irrigating the recently planted trees since they believe such water is fatal for such plants. Therefore, farmers start applying wastewater gradually after the first or second year, after which they depend more on reclaimed wastewater. Because of this problem, surveyed farmers of the recently-planted fruit trees, especially apples and peaches, in the Murnag scheme (Tunisia) reported that each farmer buys about 15 m^3 freshwater/ha every two weeks from private vendors at a high price (TD2.7/m^3 or US$1.9/$m^3$). In Yemen, farmers avoid irrigating cash crops, especially grapes and *Qat*, with undiluted effluent since it "burns" the leaves on the *Qat* tree and changes the taste of grapes (Al-Hamdi, 2000). This means that some framers will have to invest in an additional supply system for freshwater to supplement reclaimed-wastewater supplies, otherwise they rely on expensive water from private vendors.

Recently, the Tunisian regulations force farmers using reclaimed wastewater to connect to the potable water supply system so as to avoid domestic use of wastewater under emergency conditions. As an incentive, the government subsidizes the construction of these connections, whilst farmers pay for the metered water consumption. However, the fact that farmers are charged the bulk tariff for the potable water supply makes supplementary irrigation with this water unfeasible. It can be concluded that in all cases, partial use of freshwater is inevitable, which is a disincentive for wastewater irrigation. Once again, the influence of this factor seems to be minimal compared to the other (dis)incentives being studied, especially in Jordan. Interestingly, none of the surveyed administrators in Jordan and only about 3% of that in Tunisia agree with this conclusion.

Group IV (dis)incentives

Impacts on irrigation equipment. According to the health criteria of the WHO (1989), selection of the appropriate irrigation system is very important. Flooding involves the least investment, but probably exposes field workers to the greatest risk. Sprinkler irrigation should not be used on vegetables and fruits unless the effluent meets the guidelines for unrestricted irrigation, and flood irrigation should not be used for vegetables. Subsurface or localized irrigation, particularly when the soil surface is covered with plastic sheeting, can give the greatest degree of health protection, besides using water more efficiently and often producing higher yields. Drip irrigation equipment requires high degree of removal of suspended solids that may cause clogging of the drip openings. According to the Tunisian standards, in areas where sprinkler irrigation is to be adopted, buffer zones surrounding the irrigated area must be created. These standards also prohibit direct grazing of animals on land irrigated with reclaimed wastewater.

In Jordan and Tunisia, furrow and flooding systems are frequently used for irrigation of fodders and cereal crops, and in rare cases sprinkler irrigation was observed. Sprinkler systems are often applied for irrigation of golf courses in Tunisia. Drip and sprinkler systems are in practice frequently used for unrestricted irrigation with blended water. Furrow and flooding systems were observed in a few farms. However, most surveyed farmers comply with the regulations and guidelines that impose certain irrigation systems.

Land fragmentation in the traditional inheritance system. This factor was identified by 3% and 18% of the surveyed administrators as well as by 15% and 24% of the farmers in Jordan and Tunisia, respectively. The fast population growth and high demand for land have increased land value. Consequently, the area of land available for agriculture continuously decreases, especially in peri-urban areas. Simultaneously, urbanization opened up new job opportunities that compete with farming jobs. Finally, the traditional inheritance system in the Arabic/Islamic cultures causes progressive land fragmentation. It also encourages a reduction in the agricultural land acreage since some of the new landowners prefer to move to the cities leaving their land uncultivated or used for housing and other investment projects. Thus, the new landowners do not necessarily have the same attitudes and perceptions as the preceding generation.

Psychological aversion to wastewater irrigation and crops. Some of the interviewed farmers and crop consumers expressed psychological aversion towards reclaimed wastewater and crops irrigated with this water, respectively. This aversion is a resultant of (i) the questionable origin of the reclaimed wastewater, (ii) health concerns, (iii) religious beliefs, and (iv) cultural values and traditions. The results of this study demonstrate that in Jordan and Tunisia, about 3% and 9% of the surveyed administrators, respectively, as well as 13% and 8% of the farmers, respectively, think that people have psychological aversion to wastewater irrigation and related crops. The results also show that that psychological aversion is a reason for about 16% and 50% of the farmers that are unwilling and uncertain to use reclaimed wastewater for restricted irrigation in Jordan and Tunisia, respectively, against 20% and 44% for unrestricted irrigation, respectively (Tables 4, 5). However, this is particularly observed among freshwater farmers who did not yet experience irrigation with reclaimed wastewater; i.e., those who don't know are most likely to have negative prejudice. Thus, education and awareness are capable of mitigating this disincentive. Likewise, in the two countries, the percentages of public that reject raw-sewage crops due to psychological considerations are about 81% and 97%, respectively, against 22% and 35%, respectively, for treated-wastewater crops. These results reveal that psychological aversion to wastewater-irrigated crops stems from concerns for quality of the irrigation water. Thus, improving the quality of treated wastewater together with public awareness might overturn this disincentive.

Religious prohibition towards irrigation with reclaimed wastewater. The effect of religion on the feasibility of reuse in Islamic countries is frequently cited as an example of socio-cultural factors that can limit the application of wastewater reuse in these countries (Khouri *et al*., 1994). The results of the study reveal that in Jordan and Tunisia, about 3% and 0% of the surveyed administrators, respectively, as well as 13% and 4% of the surveyed farmers, respectively, think that religion prohibits irrigation with reclaimed wastewater (Table 2). The farm-surveys also show that religious prohibition is a reason for about 19% and 20% of the farmers that are unwilling and uncertain to use reclaimed wastewater for restricted irrigation in Jordan and Tunisia, respectively, against 27% and 11% for unrestricted irrigation, respectively. The percentages of consumers who reject crops irrigated with raw sewage due to the same reason are about 25% and 17% in the two countries, respectively, against 19% and 5%, respectively, for treated wastewater. These results, even though small, are unrealistic since the Islamic religion does not, in principle, forbid wastewater reuse. The Organization of the Eminent Scholars of Saudi Arabia has approved the reuse of wastewater, after adequate treatment, for all purposes including *Wodoo'* for Islamic prayers (Wilkinson, 1978; Farooq and Ansari, 1983). According to Al-Hamdi (2000), Islam characterizes water into three main categories, namely *tahur*, *taher*, and *mutanajjas*. *Tahur* is the cleanest of the three and fits all uses including ritual purposes. *Taher* is considered to be clean enough to be used for domestic uses such as cooking, washing, and bathing but not fit for ritual purposes. *Mutanajjas* is considered unclean and not fit for use due to contamination that has changed one or more of its properties (color, taste, or odor). Nevertheless, both *taher* and *mutanajjas* water can be converted into *tahur* water if adequate dilution with *tahur* water takes place, and if impurities are removed through treatment. However, untreated wastewater is used in many Islamic countries where extreme water scarcity conditions prevail, such as Palestine and Yemen.

It can be concluded that the attitude of Islam towards reuse of wastewater should not be considered an impediment for acceptance of farmers and crop consumers.

Public acceptance/rejection to consume crops irrigated with reclaimed wastewater. The field survey results revealed that 81.7% and 71.5% of the interviewed public in Jordan and Tunisia, respectively, are willing to buy crops irrigated with treated wastewater, which is a high level of acceptance (Table 9). In contrast, the willingness of the same respondents to buy crops irrigated with raw (untreated) sewage dropped significantly to 2.9% and 0.7% in these two countries, respectively. The unwilling respondents were asked for the reasons or "disincentives" that drive their decisions. The most prominent disincentive was the availability of freshwater crops. There are other disincentives, but they are more pronounced for use of raw-sewage crops than that of treated-sewage crops: (i) concern for health impact, (ii) psychological aversion, (iii) affordable prices of freshwater crops, (iv) religious prohibition, and (v) concern for public criticism. It can be concluded that the crop marketing systems and the high public acceptance to use reclaimed-wastewater crops are incentives for reuse, and, thus, farmers' worries with this regard are not justified. Thus, more effort is needed to make farmers realize this incentive.

Table 9: Acceptance of the Jordanian and Tunisian public to use crops (n=326).

Country	*Crops irrigated with raw sewage*				*Crops irrigated with treated sewage*			
	Accept		*Reject*		*Accept*		*Reject*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Jordan (n=175)	5	2.9	170	97.1	143	81.7	32	18.3
Tunisia (n=151)	1	0.7	150	99.3	108	71.5	43	28.5

CONCLUSIONS

The regulatory and socio-cultural (dis)incentives were shown in the field surveys to be of great relevance in the shaping of the decisions of both the farmers – who have to buy the reclaimed water and apply certain agronomic approaches – and the public – that must decide whether to buy the crops watered with reclaimed wastewater. These incentives could be possibly more influential than the technical ones. The most prominent incentives, on one hand, are: (i) national water scarcity and high demand for additional water supplies, (ii) wastewater is well-recognized by all countries as a non-conventional resource of water, (iii) the existing wastewater treatment plants in each country of the region produce substantial amounts of secondary-treated effluents that is suitable for restricted irrigation, (iv) the perception of farmers and crop consumers seem to be positive towards acceptance of reclaimed wastewater and related crops, respectively, (v) in the existing crop-marketing systems, the public cannot distinguish between the crops irrigated with freshwater and those irrigated reclaimed wastewater, and (vi) the attitudes of Islam are positive towards wastewater reuse. The disincentives on the other hand are: (i) the wastewater treatment objective with the discharge philosophy; wastewater treatment plants are often designed and implemented for protection of public health and the environment whereas reuse is often considered after the implementation of these plants, (ii) many farmers have access to freshwater at low tariff within the schemes that propose irrigation with reclaimed wastewater, (iii) the existing standards and guidelines are overly-restrictive and permit only the use of reclaimed wastewater for restricted irrigation (crops that are not eaten raw), (iv) inadequate institutional performance caused by the large number of involved departments that lack for coordination and cooperation and each has its own interests to protect, (v) insufficient storage of the treated effluents that causes unreliable supply, (vi) insufficient level of awareness and education amongst farmers and public on the costs and benefits of wastewater reuse, (vii) over-reliance on donors' financing due to limited local funds and poor recovery of costs, and (viii) some farmers and crop consumers have a psychological aversion towards wastewater reuse and have concern for criticism by the society.

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