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Performance Indicators for Wastewater Reuse Systems in Gaza Governorates

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Abstract
The purpose of the study was to apply performance indicators on wastewater reuse in the Palestinian Territories (Gaza) to assess on the impact of waste water and grey water projects on the ambient environment, labor costs and consumers in terms of technical, socio-economic and environmental aspects leading to safe and productive use of wastewater for crop production systems at the farm level and similar use of grey water at the household level. The study was conducted in Gaza in the period of 1 November 2012 to 1 August 2013. A field survey covered the main groups of interest for using treated wastewater, and questionnaires were designed for the target group. The questionnaires were distributed to 30 beneficiaries from Al-Zaitoun District and Khan Younis Governorate, filled, collected, sorted, and documented. Descriptive statistics were calculated from the collected data. Interesting result of data analysis that addressed key factors are discussed in this paper. Most farmers were willing to use treated wastewater in principle, and so need to be more educated and trained in the reuse of reclaimed water in terms of social, economic, environmental issues
Keywords: performance indicators, agriculture, wastewater, Palestinian territories (Gaza)

1. Introduction

A performance indicator is a measurement survey to evaluate progress toward periodic achievement of the efficiency or productivity of a process that reflects the outcome or results of the process activities. (Carol Taylor Fitz-Gibbon 1990). Performance indicators may be considered as providing key information needed to define the efficiency and performance of a facility or a system (Deb & Cesario 1997). Efficiency is the extent to which the resources of an undertaking are used to provide the service by maximizing delivery and minimizing misuse. Within this context, the International Center for Agricultural Research in the Dry Areas (ICARDA) initiated the development of a coherent performance benchmarking system for wastewater systems in Gaza. ICARDA developed the set of the performance indicators so that a consistent system comparison could be made to assist with strategic and structured planning, and to provide a framework for comparing the performance of wastewater systems and identify areas of activities where improvement is required. In addition, the performance indicators were to help assure stakeholders that the systems were performing appropriately.

Waste water and grey water reuse for agricultural purposes in Palestine is being slowly introduced for a number of reasons (Houshia 2012, 2013). Development of agriculture in Gaza (Palestine) is especially troubled by a number of challenges, the most important of which is constrained water resources since, as an arid and semi-arid country, it receives very little rain (PWA). This in turn limits the extent of rain-fed agriculture. Irrigated agriculture still has room for growth; however, it must compete with other demands for the limited available water mainly from domestic and industrial consumers. Thus, farmers understand that it is vital that all available water resources in the country be put to the most beneficial economic use, including the use of treated waste and grey water.

Agriculture is the major user of water in Palestinian territories (61% of total water use), followed by domestic (36%), and industrial (3%) sectors. The competition for freshwater has increased and has impacted on freshwater allocation to agriculture. The amount of freshwater taken away from agriculture in Gaza is diverted to uses such as household, municipal and industrial activities. Since the use of freshwater for these activities generates wastewater, the volume of wastewater has increased with population increase in Gaza.

Another important form of wastewater with potential for reuse is grey water in areas where households are not connected to the main wastewater sewerage collection system. Such water generated from household activities moves to a nearby depression area where it either evaporates or households pay for its collection and disposal in another location. Such practices pose a range of environmental and sanitation problems. Adequate treatment and reuse of this domestic wastewater has two main advantages: (1) providing a reliable supply of a water resource for home-based farming, and (2) addressing environmental and sanitation problems stemming from its disposal in a nearby area. Grey water is generated from domestic processes such as dish washing, laundry, and bathing, i.e. representing all domestic uses except toilets (water from toilets is black water). Grey water usually comprises 50–80% of residential wastewater (Houshia 2012, 2013). It is distinct from black water in the amount and composition of its chemical and biological contaminants, and gets its name from its cloudy appearance and its status as being neither freshwater nor heavily polluted.

As a consequence of freshwater shortage in the Palestinian territories, there is a shift from traditional agriculture to fruit tree production, mainly citrus, and to a lesser extent olives. More intensive agriculture is now practiced, mainly based on the production of strawberry and cut flowers in greenhouses and plastic tunnels. The amount of wastewater is increasing and its treatment is very important for the protection of health and the environment. The utilization of treated wastewater and grey water as an irrigation source adds value to productivity enhancement and environmental conservation efforts given the freshwater scarcity of Gaza. The success of the use of treated wastewater necessitates collaborative efforts of different stakeholders in agriculture, health sectors, local development and public facilities, as well as related governmental institutions and relevant non-government organizations.

Performance indicators (PI) are evaluation tools that measure potential advantages and restrictions within the preparation and implementation of wastewater reuse projects. The final verdict and success of a water reuse task depends on many different aspects such as geological, technical, economic, environmental, sociological, political, and quality as well as risks issues.

The purpose of developing these performance indicators of wastewater reuse in the Gaza Strip is to create impact estimation indicators of the project interventions on farming systems and the environment (land and water resources). The performance indicators are intended for use in a comprehensive study on the viability impacts of wastewater (WW) and groundwater (GW) projects on the environment, labors, and consumers in terms of technical, socio-economic, and environmental aspects leading to safe and productive use of wastewater for crop production systems at the farm level and similar use of grey water at the household level.

2. Methodology

Performance indicators for wastewater reuse are qualitative and quantitative indicators for assessing the quality and efficiency of the execution of treated wastewater reuse projects in the Gaza Strip. The Performance indicators are divided into social, economic, and environmental indicators – each one covers a wide range of aspects, for example, social indicators cover employment, training, quality of life, society awareness on water resources, and farmers associations. Economic indicators cover supply saving, process/service saving, infrastructure needs, economic development, and increased crop productivity. Environmental indicators cover changes in water composition (physical–chemical), ecological quality, and change in soil composition.

To fulfill the objective of the development of these performance indicators, the following activities were conducted. A field survey covered the main groups of interest for reuse of treated wastewater; and questionnaires designed for target group were distributed to 30 farmers from Al-Zaitoun District and Khan Younis Governorate (beneficiaries of ICARDA projects in the Gaza Strip), filled, collected, sorted, and documented. Descriptive statistics were calculated from the data using the SPSS software package.

The questionnaire had the objective of collecting baseline data on the users of reclaimed water, focusing on: crop types, present use of irrigation water, the timing of irrigation application, and the interest of farmers in using reclaimed water and their willingness to pay for recycled wastewater products. The survey information will be used for proposed public information and awareness programs to overcome information gaps and major social and cultural barriers that may exist with farmers and consumers. The questionnaire was designed to address the following:

- Social information on farmer’s household;
- Irrigation quantities, cost, quality, irrigation methods, and irrigation schedule;
- Previous experience with wastewater;
- Identification of impact of WW and GW projects on the environment, labors, and consumers in terms of technical, socio-economic, and environmental aspects;
- Evaluate the total saving in groundwater supply, fertilizer, and pesticide quantities per season with use of TWW;
- Identification impact of WWR on soil and groundwater quality;
- Evaluation of the farming systems, crop patterns, and fertilizer use;
- Identification of farmers’ ability and willingness to pay in wastewater reuse projects;
- Conduct economic analyses to assess previous farming practices and farm wastewater reuse schemes.

Completed questionnaires were checked, edited, and coded before the data was keyed in. Descriptive statistics were calculated for the main variables examined in the study. Averages (arithmetic means), frequencies, percentages, and histograms were used to explain and interpret the survey results. Environmental indicators in treated wastewater reuse project data were collected from the Palestinian Water Authority records and from analyzed samples (three samples per year) of the wastewater and soil using standard protocols.

3. Results and Discussion

Social characteristics were collected which only could impact on farmers' acceptance for using reclaimed water, willingness to pay for reclaimed water, training courses and membership, and health risks related to use of reclaimed water. Most farmers rely on family employees. The data analysis showed that about 38% of surveyed farmers employed more seasonal workers after the wastewater reuse project. While the remaining farmers (62%) did not change the number of employees needed. Training courses are very important for farmers using treated wastewater for irrigation. The survey data analysis revealed that, 97% of surveyed farmers indicated that they had participated in training courses (Figure 1). In addition, 69% of trainees of farmers indicated an increase in use of training courses after the reuse scheme. It is noteworthy that, for all farmers, there was an increase in membership of farmers' associations as result of the reuse projects.

The educational level, living background, and the environment played a large role in convincing farmers of the feasibility of using treated wastewater. Most farmers irrigated all their cropped areas from the beginning of reuse projects, while 34% of farmers increased their irrigated areas using treated wastewater after they ensured that it was beneficial.

Most of the crops cultivated by the farmers were citrus, olives, almonds, dates, and plums. Other fruit trees (e.g. grapes, guavas, figs, peaches, and apricots), fodder crops, and some vegetables were cultivated for domestic use, both outdoor and in greenhouses. However, about 72% of farmers did not change their crop patterns because they cultivated citrus and olives on all their land both before and after the reuse projects. Around 28% of farmers added new crops such as alfalfa.

The survey analysis indicated that most farmers who use treated wastewater were aware of groundwater problems in Gaza. Of the farmers, 83% had high levels of concern about water problems, compared to 66% of farmers who did not use treated wastewater.

Average acceptance by farmers of the use of treated wastewater for irrigation was around 81%. The main reasons behind this high level of acceptance included increasing salinity level in local agricultural wells, increasing fuel prices, and maintenance costs. This is obvious in the acceptance of most farmers to pay for wastewater. In the case of the target group of farmers, average cost of treated wastewater was 0.42 NIS/m^3, while the majority would be prepared to pay ≤ 0.5 NIS/m^3.

During reuse application, about 76% of surveyed farmers said there was no failure in irrigation systems, whilst 24% indicated failure in the range of 1–4 times a year. In addition to providing a lower cost water source, reuse of treated wastewater decreases the volume of groundwater discharged, resulting in a beneficial impact on the environment and reducing the stress on limited groundwater resources. The majority of surveyed farmers reduced their abstraction from groundwater wells after the reuse project – and 70% reduced this by more than half of the needed volume. All statistical results of social indicator analyses are found in Table 1.

It is stated that using treated wastewater effluent is one of the most promising solution in integrated water management. Using TWW for agriculture is less expensive than other options and is considered an attractive source of irrigation water. When asked about savings in the cost of water, the majority of surveyed farmers claimed to save an average of 1970 NIS/season and most mentioned that irrigated agriculture was costly. Many studies have demonstrated that treated wastewater is nutrient-rich and can increase agricultural production in water-poor areas – this also increases crop yields compared to irrigation with fresh water. As mentioned before, most surveyed farmers cultivated citrus, olives, and guavas and used reclaimed water for irrigation. Surveyed farmers mentioned an increase in crop production per tree and dunum. There was an average increase in citrus production of 25 kg/tree and 662 kg/dunum (Figures 2 and 3). There was an increase of 28.7 kg/tree and 670 kg/dunum for olive production, and 51.4 kg/tree for guava.

As a precaution and to maintain plant health in crop production, almost half of farmers (44.8%) used pesticides for their crops and land. Only 15% of them saved using pesticides because they think it's very important and essential, and the analysis showed that their average savings were 6.4 NIS/dunum.

Effluent could virtually replace fertilizer use for many crops. About 62% of surveyed farmers used compost before and after reuse of treated wastewater. In addition, 44% of them saved on compost after the reuse project, with an average saving of 84.5 NIS/dunum/year. The majority of farmers used nitrogen (N)-fertilizers (96.5%) and 96.4% of them achieved high savings in N-fertilizer of an average 1233 NIS/year (Figures 4 and 5). Moreover, around 20.6 and 10% of farmers used phosphorous (P) and potassium (K) fertilizers, respectively. The average savings were 39 NIS/dunum/year for all users of P-fertilizers and 33.7 NIS/dunum/year for 67% of users of K-fertilizers (Figures 4 and 5). Thus, the use of wastewater as a supplemental source of irrigation is inevitable for increased agricultural production in Gaza where irrigation supplies are insufficient to meet crop water needs. Savings include savings in water consumption, energy, and use of fertilizers and pesticides; and the

average savings were around 871 NIS/year (Figure 6). All statistical results of economic indicator analyses are shown in Table 2.
The quality of treated effluent is of particular importance for farmers because the impact of reusing wastewater in irrigation depends on the quality parameters and the characteristics of wastewater being used in agriculture. Not all these impacts on agriculture are negative. In the study area, average monitoring for wastewater is three times per year, and two times per year for groundwater. The Gaza Strip has a severe case of salinization. Salinity of the groundwater has increased due to seawater intrusion and mobilization of incident deep brackish water, caused by over-abstraction of the groundwater. However, wastewater is more saline than groundwater. Our analysis showed that average salinity of groundwater was 639 mg Cl^-/l, compared to 836 and 920 mg Cl^-/l for wastewater in Al-Ziatoun and Khan-Younis, respectively. For nitrate (NO_3^-), considered one of the major pollutants of water and wastewater, the average concentration in groundwater was 153 mg NO_3^-/l, compared to 0.7 and 35 mg NO_3^-/l for wastewater in Al-Zaitoun and Khan-Younis, respectively. Micronutrient concentrations were clearly higher in wastewater than in groundwater: the average increase of micronutrients in groundwater was 1.7 mg/l compared to 2.41 and 1.1 mg/l in wastewater in Al-Ziatoun and Khan-Younis, respectively. Total coliform content in wastewater was higher than that in groundwater. The average in groundwater was 60 CFU/100 ml compared to 1000 and 191 CFU/100 ml for wastewater in Al-Zaitoun and Khan-Younis, respectively. This may impose some health problems for farmers who come into contact with such wastewater.
Organic matter (OM) increases the aggregation of soil particles and the stability of the aggregates that result increases the permeability of soil to air and decreases water loss. Many other benefits of OM make it essential and very important for agricultural soil. Our statistical analysis showed that the average increase of OM in the soil irrigated with groundwater was 2.7% compared to 3.0% for irrigation with wastewater (Figure 7), representing a 1.3% increase in OM in soil irrigated with wastewater compared to groundwater.
Toxic heavy metals are those metals of greatest concern with regard to human health, agriculture, and ecotoxicology – including arsenic, cadmium, mercury, lead, thallium and uranium. The average increase in some toxic heavy metals in groundwater was 0.2% compared to 0.0058 and 0.54% in wastewater-irrigated soil in Al-Zaitoun and Khan-Younis, respectively (Figure 7). The average decrease of toxic heavy metals in soil irrigated with wastewater compared with groundwater irrigation was almost 0.2%. However, beneficial heavy metals are commonly found naturally in foodstuffs such as fruit and vegetables. Thus, agriculture productivity can be limited by deficiencies of 'essential' trace elements (often called micronutrients) such as zinc, copper, and manganese. The average increase of several micronutrients was about 0.53% in groundwater-irrigated soil, compared to wastewater-irrigated soil of 0.76 and almost 1.5% in Al-Zaitoun and Khan-Younis, respectively (Figure 7). The average increase of micronutrients in wastewater-irrigated soil compared with groundwater-irrigated soil was nearly 0.23%.
The average increase of soil infiltration capacity in soil irrigated by groundwater was around 1.1%, compared to about 1.04% and almost 0.84% in soil irrigated with reclaimed water in Al-Zaitoun and Khan-Younis, respectively (Figure 7). The average increase of sodium absorption ratio (SAR) in groundwater-irrigated soil compared with wastewater-irrigated soil was approximately 0.06 %. The average increase of cation exchange capacity (CEC) in soil irrigated with groundwater was nearly 0.54% compared to soil irrigated with wastewater of about 2.3 and 1.0% in Al-Zaitoun and Khan-Younis, respectively.
In terms of ecological quality, all interviewed farmers indicated no appearance of macrofauna and insects, specific or harmful microflora, and new plant diseases as a result of reusing reclaimed water. All statistical results of environmental indicator analyses are shown in Table 3.

4. Conclusions

Most of the surveyed farmers were willing to use treated wastewater in principle, and so they need more education and training in the reuse of reclaimed water in terms of social, economic, and environmental outcomes. The majority of farmers were willing to pay for treated wastewater – with a maximum price of 0.5 NIS/m^3. Other important aspects raised by the interviewees were safety and precautions to be taken when applying reclaimed water. Farmers must be more sensitive and careful when using reclaimed water and must abide by safety factors to avoid side effects. The OM concentration in soil irrigated with treated wastewater increased more than for soil irrigated with groundwater. The use of wastewater as supplemental irrigation is almost inevitable for increased agricultural production in Gaza, as irrigation supplies are insufficient to meet crop water needs – with average savings for one year of around 871 NIS/dunum.
Proper management of wastewater irrigation of soil and quality parameters is required to ensure successful, safe, and long-term reuse of wastewater. Intensive public awareness programs should be implemented to encourage people to use and consume crops irrigated by reclaimed water. Serious and actual implementation of reuse projects should be achieved for more farmers because it was noted that most farmers wanted to use reclaimed water to save on abstraction of well water and use of fertilizers, and to increase crop production. Controlled and

safe reuse of reclaimed and treated wastewater can help improve agricultural production. This can be achieved by periodic monitoring of important parameters as BOD, TSS, EC, NO_3^-, and TC. Continuous irrigation with wastewater may lead to accumulation of plant nutrients and heavy metals beyond crop tolerance levels – such concerns should be essential components of any management of wastewater irrigation. Farmers who use treated wastewater should decrease their use of fertilizers where reclaimed water has higher concentrations of essential nutrients and higher levels of OM. Improvement of WWTP in Gaza is imperative to avoid environmental problems and offer better effluent quantity for irrigation of many crops including citrus, olives, and almonds. Further studies must be conducted on wastewater reuse to extend the area irrigated by treated effluent in Gaza Governorates as the survey revealed that the main driving force behind farmers' acceptance of use of reclaimed water were expectations of higher income. In addition, experiences from other countries of the region should be used to provide farmers with examples of productivity increases and cost reductions.

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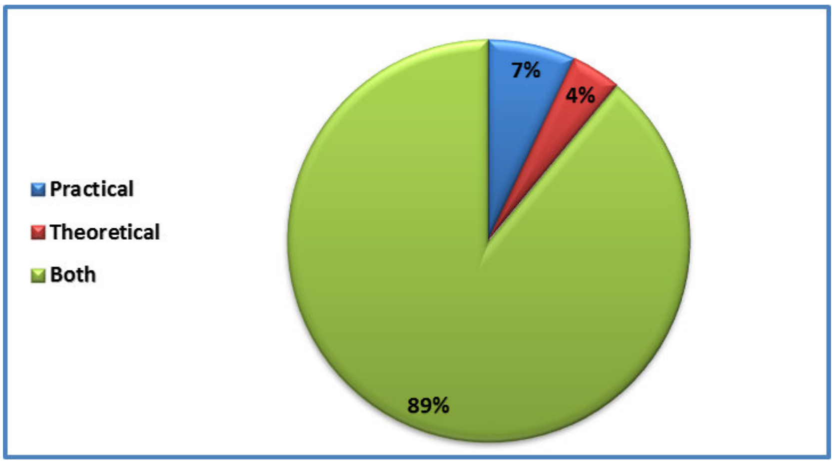

Figure 8. Farmers Training Course Types

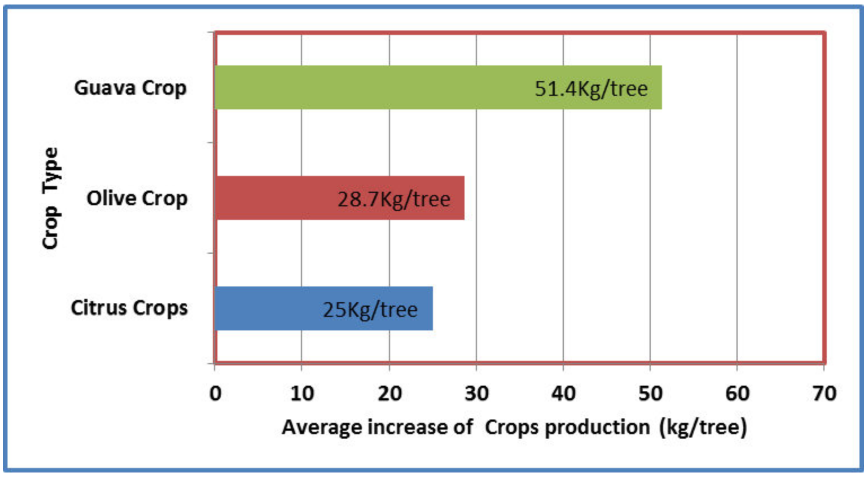

Figure 2. Average Increase of Crop Production (kg/tree)

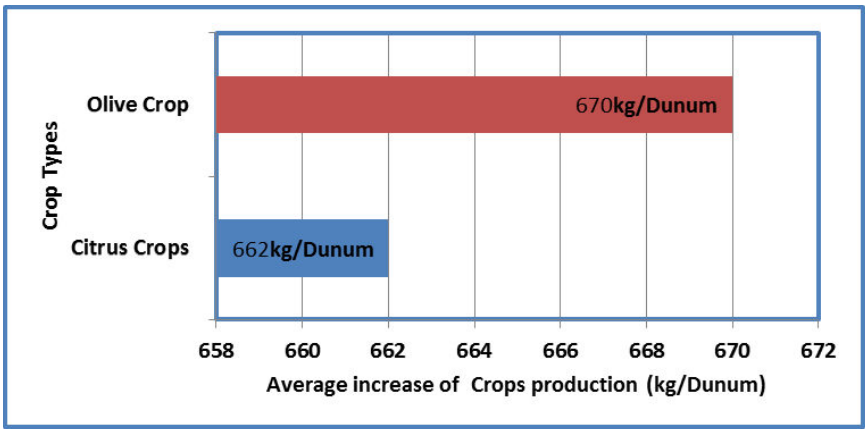

Figure 3. Average Increase of Crop Production (kg/dunum)

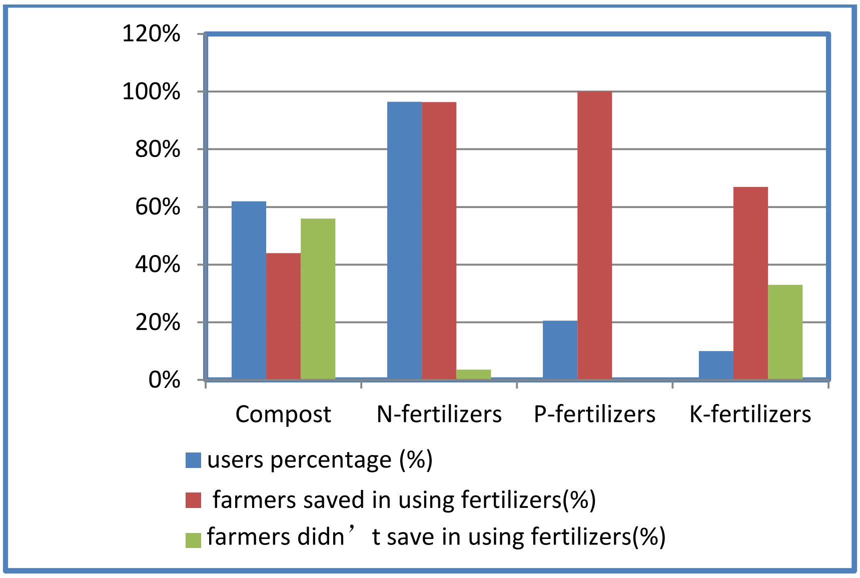

Figure 4. Percentage of Fertilizer Users and Those Who Saved on Their Use

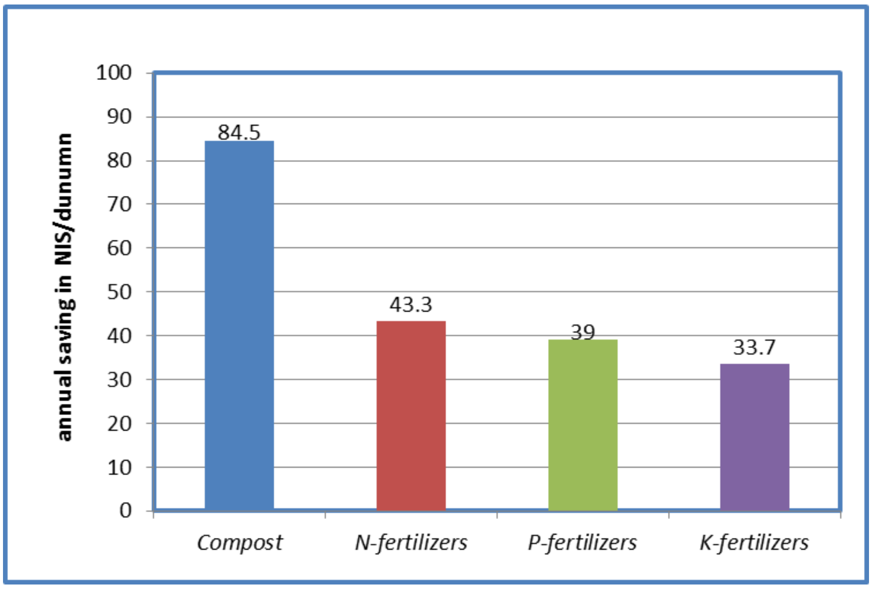

Figure 5. Average Saving in Fertilizer Costs

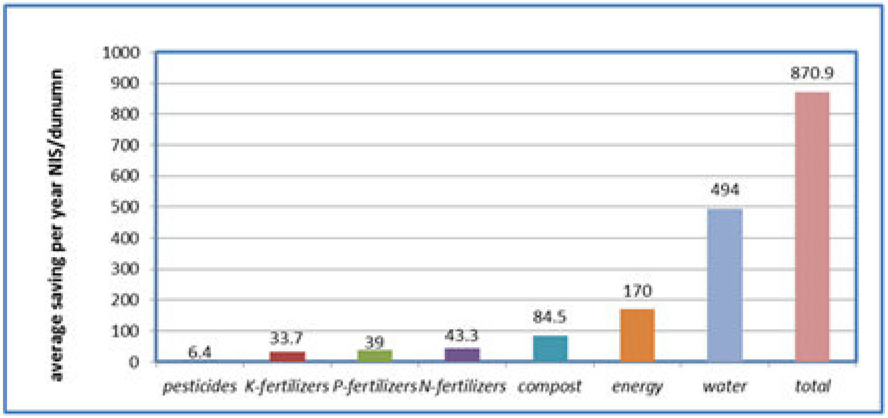

Figure 6. Average Annual Saving per Dunum

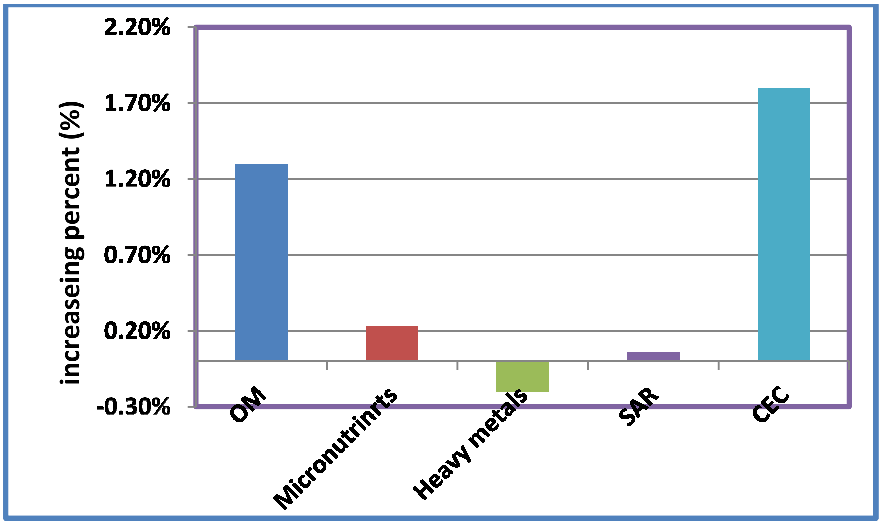

Figure 7. Increasing percent of soil irrigated with WW compared to soil irrigated with GW

Table 18. Results of Statistical Analysis of Social Indicators on Treated Wastewater Reuse Projects

Serial	Aspects to be measured		Indicators	Comments
1.	Employment	1.A	Numbers of Employees in the Farm before and after reuse projects.	About 38 % of surveyed farmers employ more workers after wastewater reuse project.
2.	Training	2.A	Farmer participation in training courses.	Around 97% of surveyed farmers indicated that they participated in training courses.
		2.B	Numbers of Training Courses before Reuse and after reuse projects.	Around 69 % of trainee's farmers pointed that there are an increase in training courses after reuse scheme.
		2.C	Kind of Training courses.	Around 7% of the surveyed farmers participated in practical training courses, 4 % participated in theoretical training courses whilst 89% participated in both of them.
		2.D	Farmers Compliance with recommended safety measurements.	About 83% of surveyed farmers comply with recommended safety results.
3.	Quality of Life	3.A	Areas irrigated by treated wastewater.	Around 34% of farmers mentioned that there is an increase in irrigated areas by treated wastewater due reuse projects
		3.B	Crop Pattern changed:	Only 28% of surveyed farmers changed crop patterns whilst 72% don't change
4.	Society awareness on water resources	4.A	Farmers concern about water as resource and welfare base.	Average concern of farmers who didn't use treated wastewater is 66% Average concern of farmers who use treated wastewater is 83%
5.	Acceptance	5.A	Social willingness to the use of treated wastewater.	Average acceptance is 81%
		5.B	Willingness to pay for treated wastewater.	Average pay is 0.42 NIS/m3, the majority of farmers accept to pay less than or equal 0.5 NIS. Max= 0.5 NIS
6.	Water supply	6.A	Volume of groundwater supply per season after using treated wastewater.	The majority of surveyed farmers reduce the quantity of GW source after reuse project, Also 70% of them reduce it more than half the needed quantities.
7.	Technology risks (failures in the system) for reclaimed user	7.A	Technology failure causing incidences in the water supply and quality.	About 76% of surveyed farmers said there is no failure whilst 24% of them indicated there is failure (ranges from one to five times/year)
8.	Farmers Associations	8.A	Partnership in Farmers Associations before and after reuse projects.	The total of surveyed farmers had increase in their partnership of farmer associations as result of reuse project.

Table 19. Results of Statistical Analysis of Economic Indicators on Treated Wastewater Reuse Projects

Serial	Aspects to be measured		Indicators	Comments
1.	Supply saving	1.A	Total saving in water supply per Season before reuse projects.	The majority of surveyed farmers saved in water supply per season after reuse project, Average is 494 NIS/ doumm.year
2.	Process / Service saving	2.A	Direct saving in energy from treated wastewater use.	The results showed that 66% of surveyed farmers save in energy from treated wastewater use, average saving is 170NIS/doumm.year
		2.B	Direct cost saving in fertilizers (Compost, N-Fertilizer, P-Fertilizer and K-Fertilizer) from treated wastewater use	**Compost**: 62% of surveyed farmers use it before and after reuse of treated WW, 44% of them saved in using compost after reuse project with an average increase of 84.5NIS/doumm.year. **N-fertilizers**: (96.5%) of farmers use N-fertilizers. 96.4% of them achieve high saving in using it with an average equal 43.3 NIS/doumm.year **P fertilizers**: 20.6% of farmers use phosphorous fertilizers. The average savings in using P-fertilizers is 39 NIS/doumm.year for all users. **K fertilizers**: 10 % of farmers use potassium fertilizers. The average savings in using K-fertilizers is 33.7 NIS/doumm.year for 67% of the users
			Pesticides use before after reuse schemes.	Almost 44.8% of farmers use pesticides. Only 15% of them saved in using pesticides. The average savings of this percent of farmers is 6.4NIS/doumm.year
3.	Economic development from using treated wastewater	1.A	Economic welfare.	Around 86% of surveyed farmers have increased in economic revenue
4.	Increasing of crop productivity.	1.A	Increase of Citrus Crops productivity.	Average increase of Citrus production =25kg/tree Average increase of Citrus production =662kg/dumm
		2.B	Increase of Olive Crop Productivity.	Average increase of Olive production =28.7kg/tree Average increase of Olive production =670kg/dumm
		3.C	Increase of Guava Crop productivity.	Average increase of Guava production =51.4 kg/tree

Table 20. Statistical Analysis Results of Environmental Indicators on Treated Wastewater Reuse Projects

Serial	Aspect to be measured		Indicator(s)	Comments
1.	Changes in water composition (physical-chemical)	1.A	Salinity level in ground water and treated wastewater.	The average salinity of groundwater (GW) is 639 mg Cl^-/l, while its 836 mg Cl^-/l for treated wastewater (TWW) in Al-Ziatoun and 920mg Cl^-/l for Khan-Younis.
		1.B	Nitrate level in ground water and treated wastewater.	The average concentration of GW is 153mg $NO3^-$/l. while it is 0.7 mg $NO3^-$/l and 35 mg $NO3^-$/l for TWWof Al-Zaitoun and Khan-Younis, respectively.
		1.C	Increase of microelements in ground water and treated wastewater.	The average increase of micronutrient in GW is 1.7mg/l. For TWW, the average increase is 2.41mg/l in Al-Ziatoun and 1.1mg/l in Khan-Younis.
		1.E	Presence / increase of Total Coliforms in ground water and treated wastewater.	The average of total coliform in GW is 60 CFU/100ml, while its average in TWW is 1000CFU/100ml and 191CFU/100ml in TWW of Al-Zaitoun and Khan-Younis, respectively.
2.	Ecological quality	2.A	Biological monitoring of ground water and treated wastewater.	Average number of GW monitoring is twice per year.
		2.B	Number of ground water and treated wastewater monitoring in year.	Average number of treated WW monitoring is three times a year.
3.	Change in the composition of Soil	3.A	Increase of organic matter (OM) in soil irrigated by Fresh water and soil irrigated by treated wastewater	The average increase of OM in the soil irrigated with GW is 1.7% and 3% for soil irrigated with TWW. The increase of OM in WW irrigated soil compared with which in GW irrigated soil is 1.3%.
		3.B	Increase in heavy metals in soil irrigated by fresh water and soil irrigated by	The average increase in toxic heavy metals in GW is 0.2% while its 0.0058% in TWW irrigated soil in

Table 3-continues

			treated wastewater	Al-Zaitoun and 0.54% of Khan-Youniss' soil irrigated with TWW. Average decrease of heavy metals in WW irrigated soil compared with GW irrigated soil is 0.1942%.
		3.C	Increase in micronutrients in soil irrigated by Fresh water and soil irrigated by treated wastewater	The average increase of several micronutrients is 0.53% in GW irrigated soil, while its 0.76% in WW irrigated soil in Al-Zaitoun and 1.5% of Khan-Youniss' soil irrigated with WW. Average increase of micronutrients in WW irrigated soil compared with that in GW irrigated soil is 0.23%.
		3.E	Changes in cation exchange capacity in soil irrigated by Fresh water and soil irrigated by treated wastewater.	The average increase of CEC in soil irrigated with GW is 0.54%. 2.3% in soil irrigated with treated WW in Al-Zaitoun and 1% in Khan-Younis. Average increase of CEC in WW irrigated soil compared with that in GW irrigated soil is 1.8%.
4.	Ecological quality	4.A	Appearance / Decrease of specific macrofauna, insects and microflora.	The whole interviewed farmers (100%) indicated that there is no appearance of macrofauna, insects and specific or harmful microflora as a result of reusing reclaimed water.
		4.C	Appearance of new plant diseases.	The whole interviewed farmers (100%) indicated that there is no appearance of new diseases as a result of reusing reclaimed water.
		4.E	Examples on new plant diseases.	No diseases found at all.