

ATTITUDES OF FARMERS TOWARDS EFFLUENT REUSE IN THE GAZA STRIP

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ABSTRACT

The Gaza Strip is one of the most densely populated areas in the world with a population of 1,472,000 in year 2005 in an area of only 365 km². Agriculture is a major component of the Palestinian economy and agricultural land comprises nearly 46% of the total area of the Gaza Strip, much of which is irrigated by diminishing groundwater resources. Using treated wastewater is the principal option to develop the water resources in the Gaza Strip as it represents an additional renewable and reliable water source. Using treated effluent for agricultural purposes would reduce the water deficit and the decline in groundwater quantity and quality. This paper presents the attitudes of farmers towards wastewater reuse and their willingness to pay for treated effluent to be produced by a planned new wastewater treatment plant that will serve Gaza City and the Middle Governorate of the Gaza Strip. The results of the survey that was undertaken are very encouraging as the number of farmers willing to use reclaimed water is very high.

Keywords: Agriculture, effluent reuse, farmers, Gaza Strip, irrigation.

INTRODUCTION

The Gaza Strip is one of the most densely populated areas in the world with a population of 1,472,000 in year 2005 (annual growth rate = 4.5%) according to Palestinian Central Bureau of Statistics (PCBS, 2000). Agricultural land comprises nearly 46% of the total area (365 km²) of the Gaza Strip according to Ministry of Agriculture (MOA, 2005).

The Gaza Strip is located in a semi-arid area where water resources are scarce. Due to increasing groundwater pumping for urban use as well as for irrigation purposes, the extraction of groundwater exceeds the recharge

of the groundwater aquifers (COWI 2000, OUTI 1998 and JICA 1997). As a result, the groundwater level is falling and the salinity is increasing making the water unsuitable either for human consumption or for irrigation purposes. The uncontrolled discharge of untreated sewage and excessive use of fertilizers have led to high nitrate concentrations in certain areas, thus creating an additional pollution of the groundwater resources (Boliden Contech et al., 1998).

Using treated domestic wastewater could be one of the main options to develop the water resources in the Gaza Strip as it repre-

sents an additional renewable and reliable water source (IUG/CDG/ONEP, 2002). Using treated effluent for agricultural purposes would minimize the deficit and would reduce the degradation of the groundwater quality.

One of the main concerns is the willingness of farmers to use treated wastewater for agriculture. A number of surveys have been conducted in the context of studies on the reuse of reclaimed water from wastewater treatment plants in Gaza. In the Northern Governorate, the results mentioned by the authors is that 86.1% of all interviewed farmers accepted the use of reclaimed water for irrigation and a further 3.8% of them were not sure yet (Tubail et al, 2004). The Master Plan for Sewerage and Storm Water Drainage in the Gaza Governorates (Sogreah, 1998) refers to social surveys conducted in Khan Younis and in the Northern Governorate. These surveys included questions on treated wastewater reuse. From a sample of 100 farmers from Khan Younis, 77% would consider reclaimed wastewater for the irrigation of certain crops and further 5% would use it for all crops. In the Northern Governorate, 76.3% of the respondents would use reclaimed water for specific crops and further 6.8% for all crops.

This paper aims to investigate the attitudes of farmers towards treated wastewater use in the central area of the Gaza Strip. The paper concentrates on the acceptance of farmers to reuse treated wastewater and their willingness to pay. This is essential to the economic viability of installing an effluent reuse system supplied by a new wastewater treatment plant (116,000 m³/day) that is planned to serve Gaza City and the Middle Governorate.

Methodology

Farmer's attitudes and their acceptance of treated wastewater reuse in agriculture in the region are not considered adequately. To study the acceptance and willingness to use treated wastewater, a social survey was conducted on Gaza farmers. The survey studied the farm sizes and types of crops in the area, the availability and cost of existing water sources, acceptance and willingness of farmers to pay for treated wastewater. The authors prepared a questionnaire that would be clearly understood by the farmers.

Sampling Frame :

According to information provided by the Directorate of Planning - Ministry of Agriculture, the total number of farms in Gaza and Middle Governorates was 5502, with 36% in Gaza Governorate and 64% in the Middle Governorate. A sample of 90 farmers was covered, the results of which would reflect the target population at an acceptable level of precision. A stratified sample was calculated according to the farm size distribution as shown in Table 1.

For the purpose of the survey, only persons with detailed knowledge and the competence to take decisions related to each farm were interviewed, i.e. farm owners and long-term tenants. In the Palestinian context, there are two kinds of tenancy: long-term based on a written contract with the owner, and short-term (for one or two seasons) based on oral agreements with the owner. Long-term tenants control and manage cultivation, marketing, irrigation, fertilizing and harvesting. They are usually not allowed to change crop types, reclaim land, drill wells, sub-let their plots or construct on them.

Table 1. Size distribution of sampled farms

Farm size(dunums)	No. of Farms	No. of Samples	%
1 – 5	3,425	56	62
6 – 15	1,475	24	27
16 – 25	395	6	7
>25	207	4	4
Total	5,502	90	100

Out of the total of 90 respondents, 83 (92.2%) were owners and 7 (7.8%) represent long-term tenants. The majority (89%) of the respondents were household heads, 10% were the father and 1% siblings of the household head. Almost all respondents were male (98%) and for this reason no gender specific analysis of data was undertaken.

Questionnaire :

The questionnaire was designed to address the following:

- " Socioeconomic information on farming households.
- " Land ownership and tenancy.
- " Crop types.
- " Irrigation quantities, cost, quality, irrigation methods and irrigation schedule.
- " Previous experience of treated wastewater reuse.
- " Perceptions and willingness to use and pay for treated effluent.

The questionnaire was discussed with local experts in order to make sure that local conditions and all possible answers were captured. A pre-test was carried out with a sample of 6 farmers and some adjustments were included in the final version of the questionnaire.

Surveyors :

Six surveyors were selected, all of them holding a degree in agricultural engineering. They all had previous experience with surveys and were familiar with the survey zones. The surveyors were trained for 3 days, including the pre-test. They were informed about the objectives of planned wastewater project and the survey. They received handouts containing guidelines on how to conduct the interviews as well as definitions of the terminology used in the questionnaire. During implementation, each questionnaire was reviewed by an experienced field supervisor and corrected together with the surveyors, if necessary.

RESULTS AND DISCUSSION

Socio-economic characteristics of farmers' households :

The survey did not intend to collect detailed socio-economic data on the target group as this may overload the already long questionnaire and takes up too much time from the respondents. Only such socio-economic characteristics were collected

which could impact on farmers' acceptance of, and willingness to pay for, reclaimed water.

As illustrated in Fig. 1, three quarters (75.6%) of the farmers are between the age of 25 and 54 years, 24.4% are older than 55 and none of the respondents is younger than 25 years.

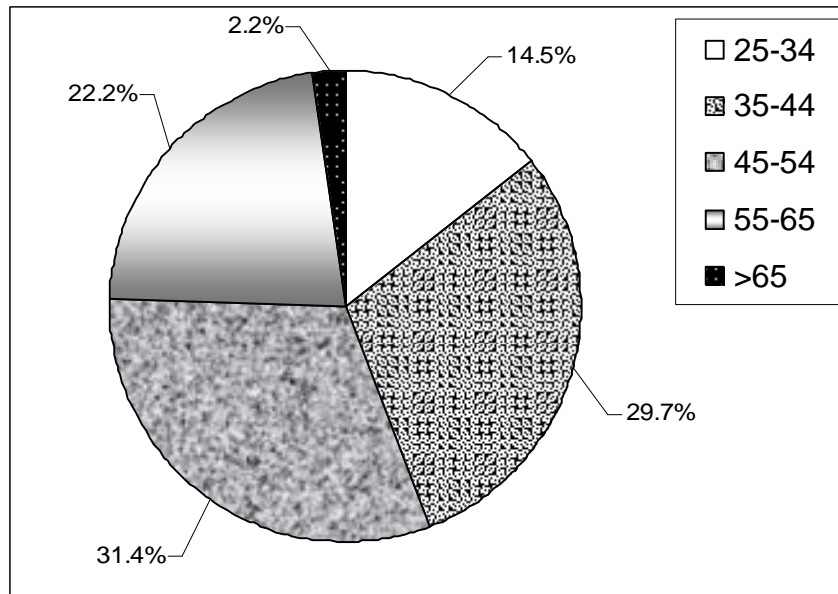


Figure 1: Distribution of farmers according to age group.

Households are relatively large with 11.1% of the respondents living in households of up to 5 persons, 58.9% of households are composed of 6 to 10 members, about one quarter (24.4%) of them has 11 to 15 members and 5.6% of all households have more than 15 persons (Fig. 2).

When asked about the main sources of household income (Fig. 3), the majority of farmers (58.4%) declared having their farm as

the only source of income. About one fifth (21.3%) of the households have additional income, either from governments or non-governmental jobs. The rest (20.3%) has other work and are not directly involved in farming. Relating this finding to educational attainment leads to the conclusion that those with a higher institute or university degree work predominantly in the public sector and their farm provides a secondary source of household income.

ATTITUDES OF FARMERS TOWARDS EFFLUENT etc

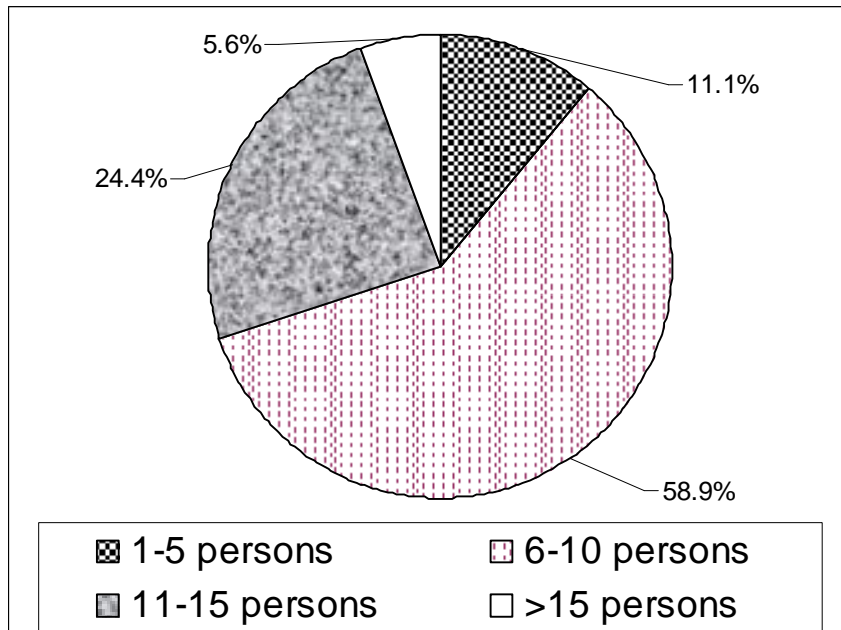


Figure 2: Household size distribution.

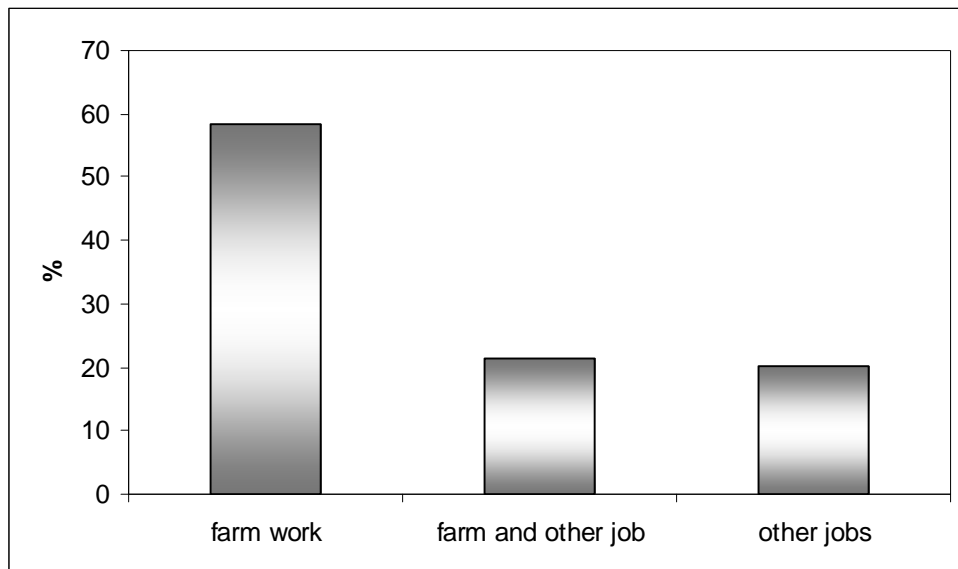


Figure 3 : Sources of household income.

All farmers answered the question regarding their average monthly household income during the past 3 years. The data in Figure 4 represent the monetary income only. It is safe to assume that households also have additional non-monetary sources of income through subsistence farming and/or assistance in kind from NGOs (Non Governmental Organizations) or relief organizations. About 28.4% of all households receive an income of

less than 500 NIS/month (NIS: New Israeli Shaqel), 27.3% have between 500 and 1000 NIS/month, 34.1% have monthly earnings of 1,000 and 2,000 NIS, and 10.2% have an average monthly income of more than 2,000 NIS (1 US\$ = 4.4 NIS).

Farm ownership and land fragmentation

As shown in Fig. 5, land ownership is mostly individual (64.4% of all farmers), and

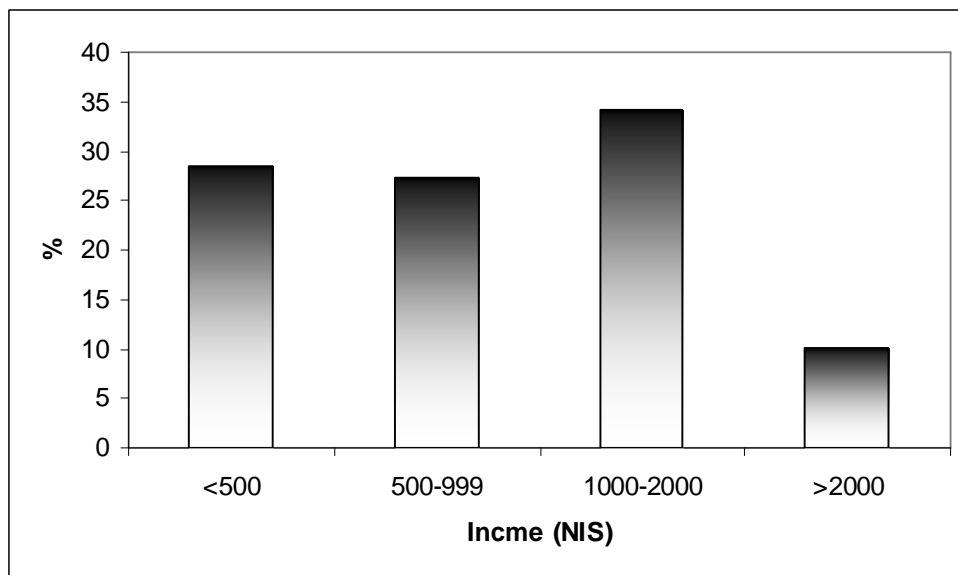


Figure 4: Average household income per month.

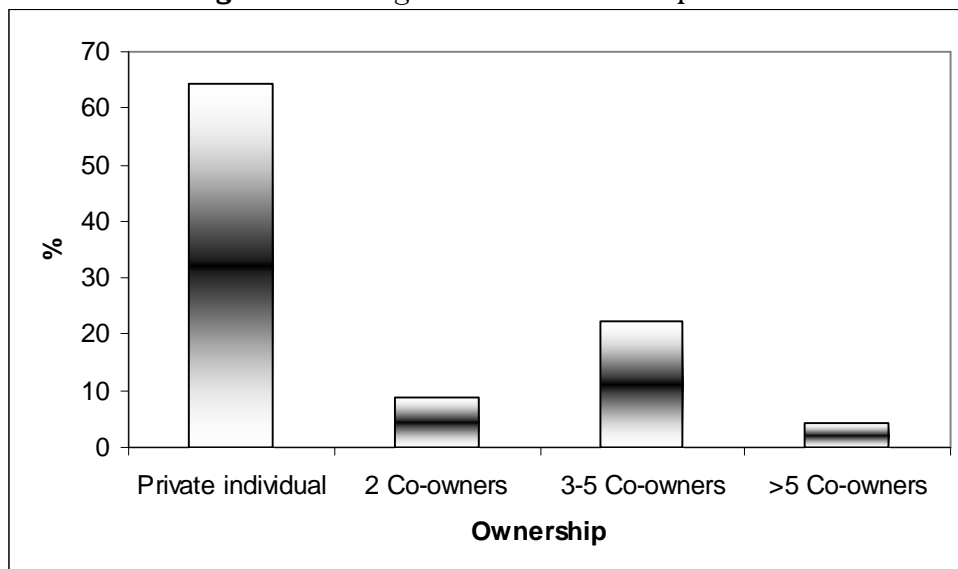


Figure 5 : Land Ownership.

22.2% of land having 3 to 5 co-owners. There is no correlation between farm size and the number of co-owners.

The land is mostly cultivated by the owners themselves (91%) but 9% of the respondents have their land cultivated by one tenant. Renting out plots to several tenants is not practiced.

Crop Types :

The crop types cultivated in the area are citrus, olives, dates and other fruit trees (such as grapes, guava, apples, figs, peach, mango,

apricots and plums), vegetables, both outdoor and in greenhouses, cereals and other field crops (such as potatoes, onion, garlic, beans, cowpeas, sunflower and mint), and fodder crops. Almonds are not cultivated by any of the respondents.

The most frequently cultivated crop types are olives, cultivated by 61.1% of the respondents, followed by citrus (34.4%) and vegetables (31.1%). Dates and cereals are cultivated by 12.2% and 14.4%, respectively, of all of the farmers. Figure 6 illustrates the frequency distribution of crop types.

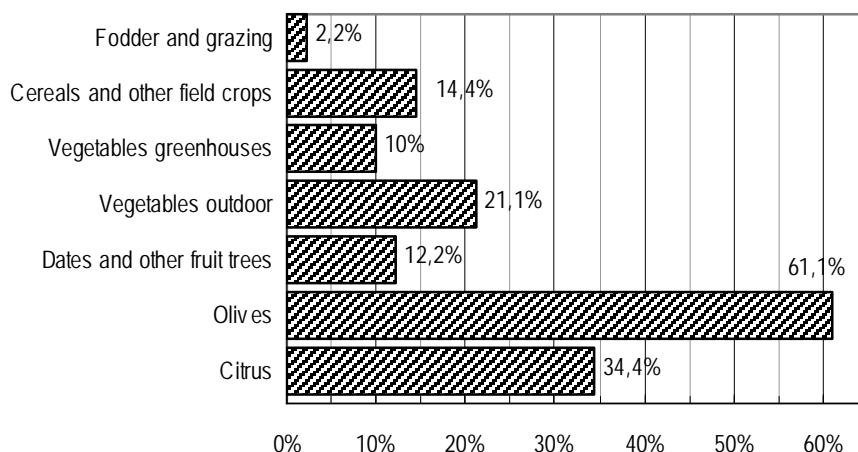


Figure 6 : Crop Types.

Irrigation water consumption, irrigation schedules and methods

According to the Palestinian National Agricultural Survey of 2005, about 70% of the total farmed area of Gaza is irrigated (MOA, 2005). In order to assess the potential demand for reclaimed water and the timing of this demand, farmers were asked about the

quantities of irrigation water they need for different crops and the irrigation schedule. Table 2 summarizes the findings of the survey.

Most of the farmers (74.2%) cultivating citrus irrigate their plots during the period of June-September, with 16.1% irrigating over a longer period (April-September) and only

Table 2: Irrigation water quantities, irrigation schedules and irrigation methods.

Crop type	Area covered by survey		Irrigation Schedule		Water Quantity m ³ /month per hectare
	Hectare	%	Duration	%	
Citrus	25	32.1	June – Sep. Apr. – Sep. Apr. – Nov.	74.2 16.1 9.7	1674
Olives	30.4	39.1	June – Sep. Apr. – Oct.	47.3 52.7	983
Dates and other fruit trees	6.2	8.0	June – Sep. Mar. – Oct. Apr. – Nov.	18.2 18.2 63.6	759
Vegetables (outdoor)	6.7	8.6	Apr. – Oct. all year	94.7 5.3	1574
Vegetables (greenhouse)	3.5	4.4	all year	100	2002
Cereals	5.8	7.5	Feb. – May	100	800
Fodder & grazing	0.25	0.3	Mar. – May	100	1160
Total	77.85	100			

9.7% for an even longer period up to November. Olives and outdoor vegetables are mostly irrigated between April and October (52.7% of farmers and 94.7%, respectively). Greenhouse vegetables are irrigated throughout the year.

With regard to the application technology, micro-irrigation such as bubblers or drip-irrigation is usually recommended for reuse schemes. These irrigation methods require certain quality standards of reclaimed wastewater in order to avoid clogging problems. Information on the irrigation methods, which farmers are actually using indicate to which extent they will have to change to other methods in order to use reclaimed water.

As illustrated by Fig. 7, furrow irrigation is predominantly used by farmers cultivating citrus and olives, 87.1% of the farmers cultivating citrus and 65.4% of those cultivating olives. Drip irrigation is most frequently used for outdoor vegetables, greenhouse vegetables and dates, 89.5% of the farmers cultivating outdoor vegetables, 88.9% of those cultivating greenhouse vegetables and 63.6% of those cultivating dates and other fruit trees. Sprinkler irrigation is relatively rare and only used for citrus and olives. Fodder crops are irrigated by surface irrigation.

Sources and Quality of Irrigation Water

Farmers currently get their irrigation water

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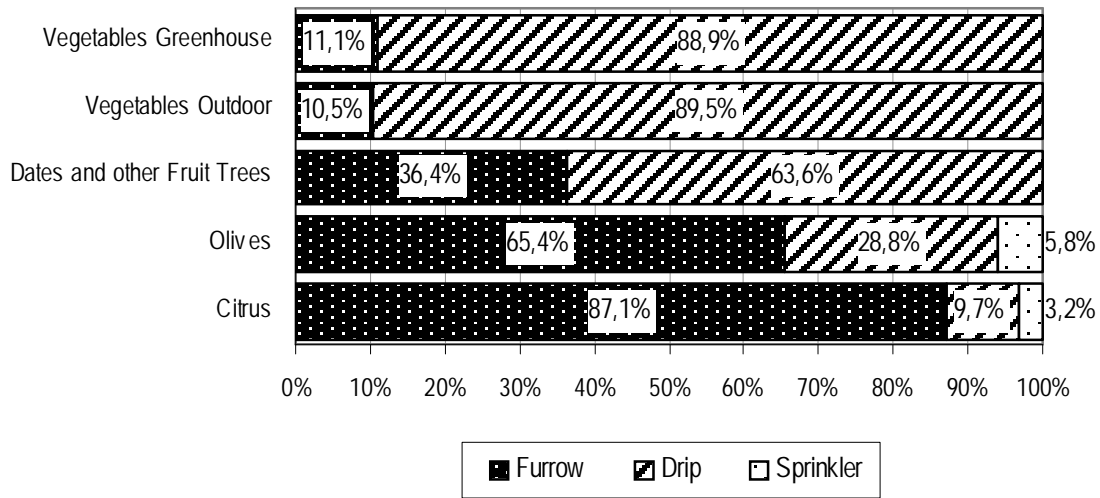


Figure 7 : Irrigation Methods by Crop Type.

from wells. These are either their own wells (45.6%), wells which they co-own with others (30%) or they purchase their irrigation water from the well of a neigh-

bor (21.1%). Only 3.3% of the respondents do not need any irrigation water because they cultivate rain-fed crops only (Fig. 8).

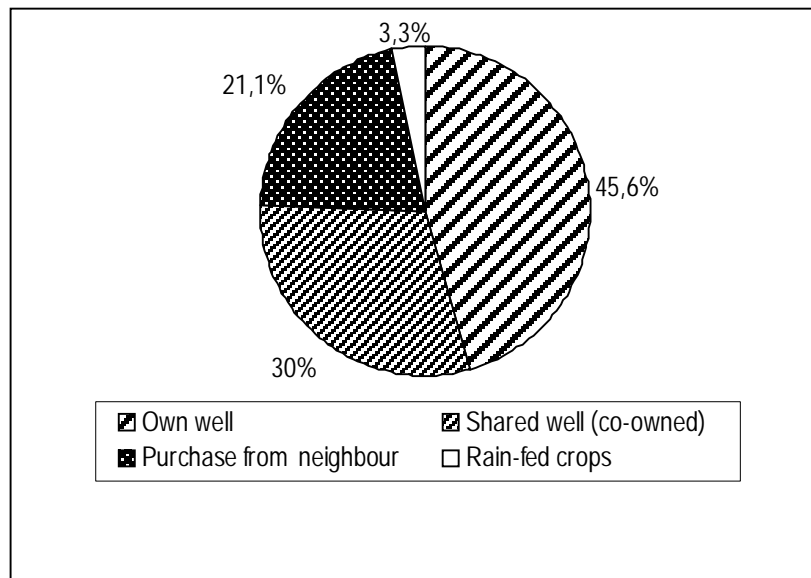


Figure 8 : Irrigation Water Source.

Figure 9 illustrates that three quarters (75.4%) of the farmers who are satisfied with the groundwater quality belong to the Middle Governorate. The reason why these farmers perceive groundwater quality as good is that they predominantly cultivate crop types that are tolerant or moderately tolerant to saline

water, such as dates, vegetables and olives. Citrus which is sensitive to saline water is more frequently cultivated in Gaza Governorate than in the Middle Governorate.

Figure 10 shows the relative importance of these factors. More than half of the farmers

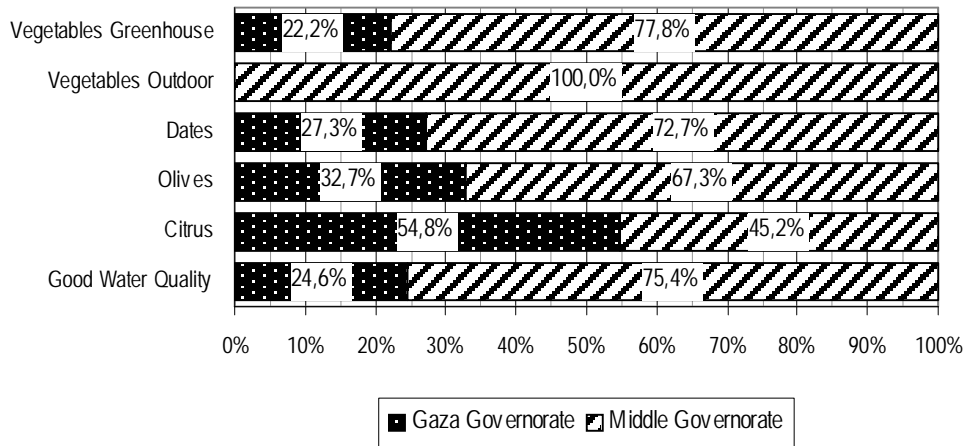


Figure 9: Satisfaction with water quality and crop types by governorate.

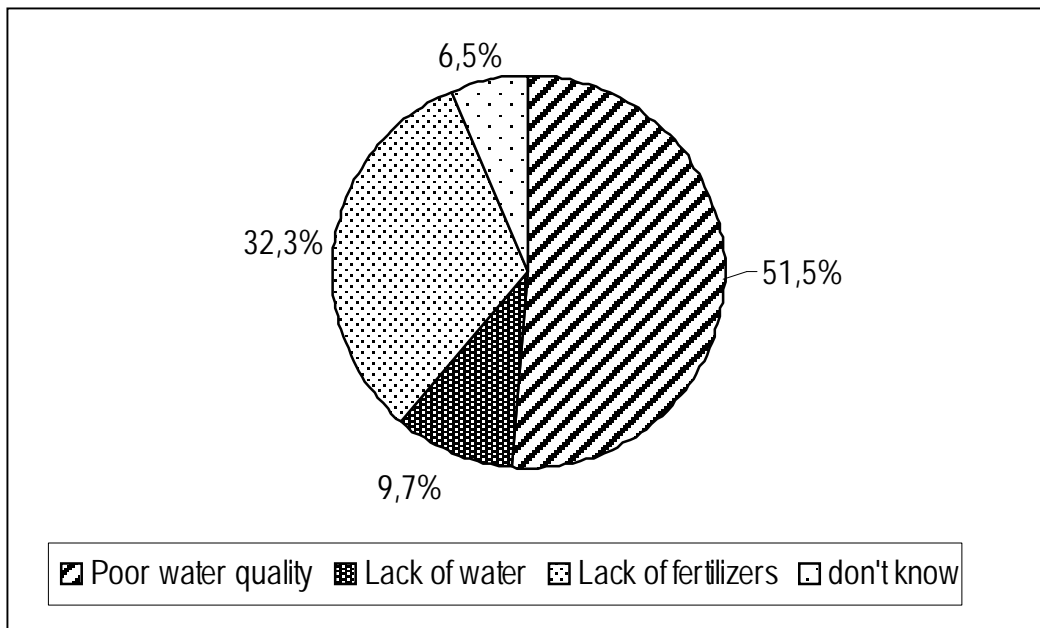


Figure10: Reasons for reduction of crop growth and yield.

(51.5%) suffering from decreasing yields think that this is mainly due to poor irrigation water quality. Another quite important cause mentioned by 32.3% of the farmers is insufficient application of fertilizers. Also, 9.7% of the farmers attribute this problem to sub-optimal irrigation due to water shortages.

Willingness to use and pay for reclaimed water

As illustrated in Fig. 11, the general acceptance level for using reclaimed wastewater for irrigation is very high (89.9% of all farmers). This finding is in accordance with the results of previous surveys. The most important rea-

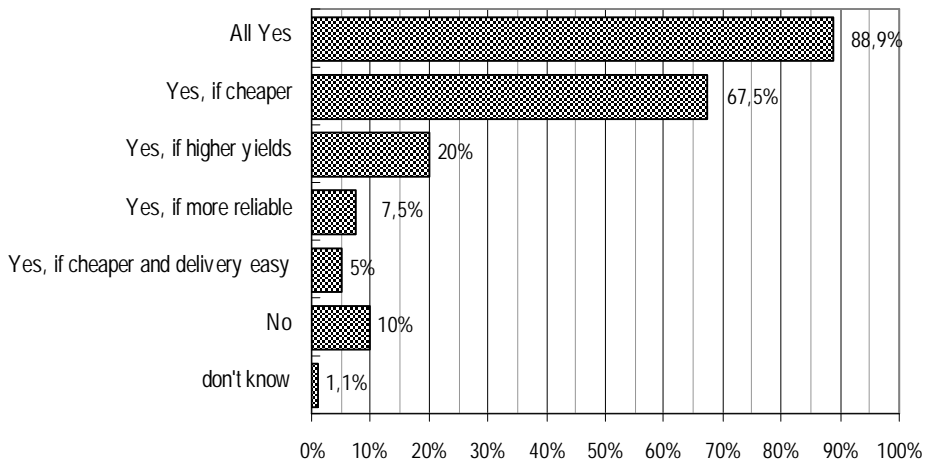


Figure 11: Willingness to Use Reclaimed Water.

son for wanting to use reclaimed water as an alternative to groundwater is related to anticipated higher incomes either due to irrigation cost reductions (67.5%) or improved yields (20%). However, 7.5% of those willing to use reclaimed water would only do so if water provision would become more reliable, and 5% would use it if in addition to cost reductions, it was delivered in a convenient way.

Only 10% of all respondents would not accept reclaimed water for irrigation. They mostly represent farmers cultivating vegetables for which irrigation with reclaimed water is prohibited under the current Palestinian Effluent Reuse Standards (PSA 2003).

As can be deduced from Fig. 12, farmers' willingness to use reclaimed water for irrigation does not significantly differ from their perception of water quality. Amongst the 29.1% of all farmers who think that water quality is poor, 84% of them would accept reclaimed water. Significantly, 90.2% of the farmers who are satisfied with water quality are nevertheless willing to change to reclaimed water. This leads to the conclusion that the major reason for wanting to use reclaimed water instead of groundwater is farmers' expectations to achieve higher income.

Another interesting result of the survey is that the acceptance of reclaimed water is

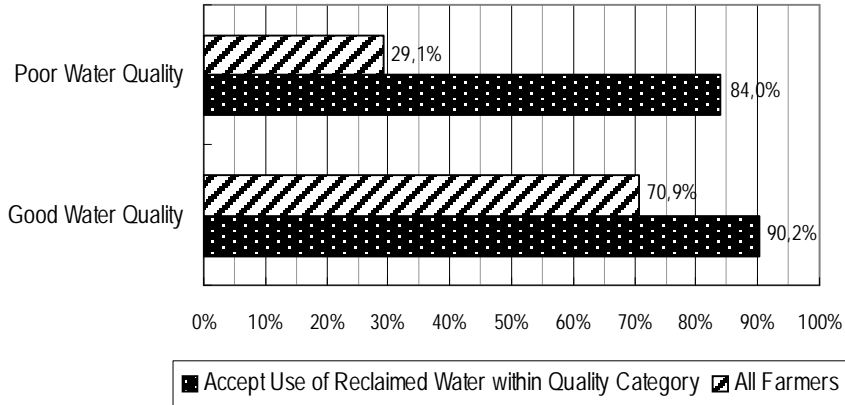


Figure 12 : Existing irrigation water quality and acceptance of reclaimed water.

independent of age, educational attainment and current household income.

Farmers expressed a number of concerns about reclaimed water regardless of their acceptance or refusal to use it for irrigation (Fig. 13). Their principal concern (47.8% of all farmers) is that customers might refuse to

buy their products if they become aware about the source of irrigation water. One quarter of the farmers fear that soil quality might deteriorate but 14.8% do not express any concerns about using reclaimed water. A small percentage do not know whether their irrigation method is suitable for the application of reclaimed water (6.8%), which precau-

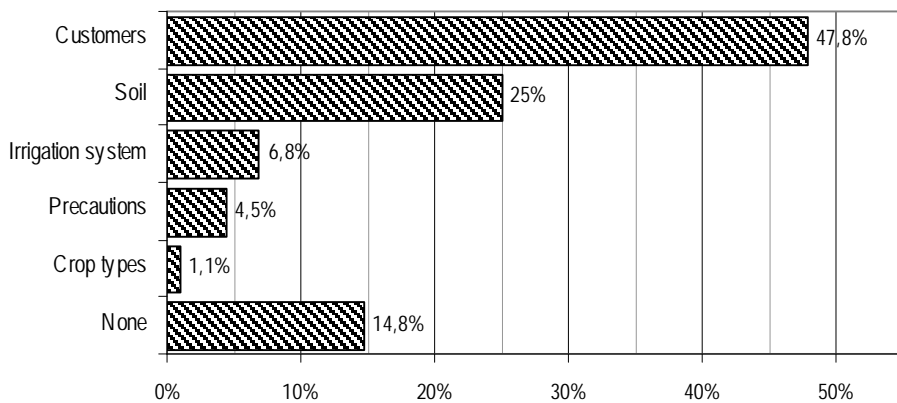


Figure 13 : Concerns about Reclaimed Water.

tions to take for the safe use of reclaimed water (4.5%), or whether crop types have to be changed (1.1%).

With regard to the delivery system of reclaimed water, there are several options: delivery to farmers' wells through groundwater by aquifer recharge; distribution through a piped network distribution system; or a combination of both, i.e. infiltration in winter and direct delivery in summer.

Most of the farmers (80%) willing to use reclaimed water prefer a pipe delivery of effluent while 20% prefer aquifer recharge and use through their well. However, some farmers expressed concern that if effluent was delivered by pipe, that Palestinian Water Authority (PWA) would close their well.

As pointed out above, the number of farmers willing to irrigate with reclaimed water is very high (88.9%). Almost all of them (93.8%) are also willing to pay for it and only 2.5% would not accept making any payment (Fig. 14).

In addition to their general willingness to pay for reclaimed water, farmers were also asked to give a firm price that they would be willing to pay per m³. The results show that 44.1% would pay up to 0.30 NIS/m³, 46.6% would pay between 0.30 and 0.50 NIS/m³, and 9.3% between 0.70 and 1.00 NIS/m³. On average, farmers would be willing to pay 0.36 NIS/m³ and the most frequently mentioned price is 0.50 NIS/m³ (28% of respondents).

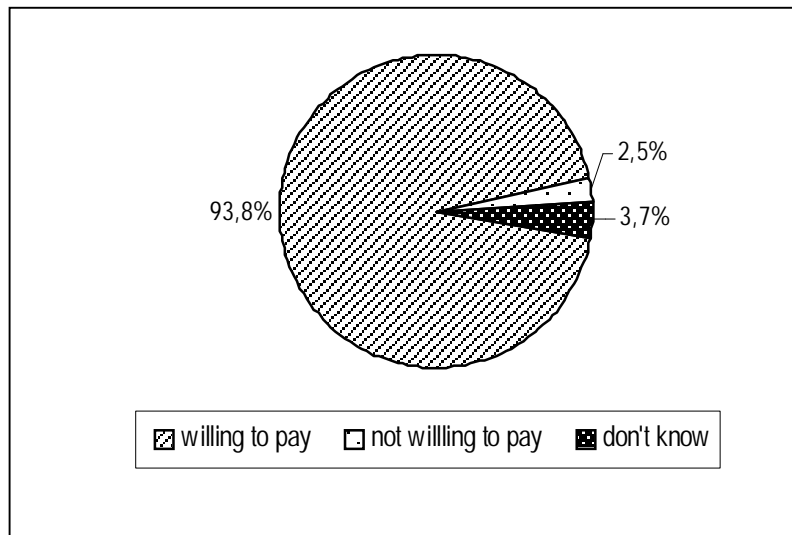


Figure 14: Willingness to pay for reclaimed water.

Conclusions

This paper aims to investigate the attitudes of farmers towards treated wastewater use as an alternative of groundwater in the central area of the Gaza Strip. The paper concentrates on obstacles to reuse and the acceptance of farmers to reuse wastewater and their willingness to pay. The following conclusions are addressed:

More than half of the farmers (51.5%) suffering from decreasing yields think that this is mainly due to poor irrigation water quality. Another quite important cause mentioned by 32.3% of the farmers is insufficient application of fertilizers. Also, 9.7% of the farmers attribute this problem to sub-optimal irrigation due to water shortages.

Only 10% of all respondents would not accept reclaimed water for irrigation. They mostly represent farmers cultivating vegetables for which irrigation with reclaimed water is prohibited under the current Palestinian Effluent Reuse Standards

Farmers' willingness to use reclaimed water for irrigation does not significantly differ from their perception of water quality. Amongst the 29.1% of all farmers who think that water quality is poor, 84% of them would accept reclaimed water.

Most of the farmers (80%) willing to use reclaimed water prefer a pipe delivery of effluent while 20% prefer aquifer recharge and use through their well. However, some farmers expressed concern that if effluent was delivered by pipe, that the PWA would close their wells

Farmers are willing to pay for reclaimed water, 44.1% would pay up to 0.30 NIS/m³, 46.6% would pay between 0.30 and 0.50 NIS/m³, and 9.3% between 0.70 and 1.00 NIS/m³. On average, farmers would be willing to pay 0.36 NIS/m³ and the most frequently mentioned price is 0.50 NIS/m³ (28% of respondents)

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الملخص العربى

موقف المزارعين نحو استعمال مياه الصرف المعالجة فى أرض غزة

عبدالمجيد نصار

خليل طبيل

أنيتا موريتز

چرمى هال

جامعة الأزهرز - غزة

يعتبر قطاع غزة من أكثر المناطق السكانية فى العالم كثافة إذ يبلغ عدد السكان 1.472.000 نسمة فى عام 2005 على مساحة 365 كم² وتمثل الزراعة العنصر الرئيسى فى الاقتصاد الفلسطينى حيث تشكل الأرض المزروعة حوالى 46% من مساحة قطاع غزة وغالبيتها تروى من الخزان الجوفى ويعتبر إعادة إستخدام المياه المعالجة هو الخيار الأساسى لتطوير مصادر المياه فى قطاع غزة حيث يمثل مصدر إضافى يقلل من العجز فى كمية المياه ويوقف التدهور فى جودتها، والبحث المقدم يعرض توجه المزارعين بخصوص إعادة إستخدام المياه المعالجة واستعدادهم لدفع تكاليف المياه المعالجة الناتجة من المحطة المقترحة لمدينة غزة والمنطقة الوسطى والنتائج المستخلصة من هذا البحث تدل على أن نسبة المزارعين الراغبين فى استخدام المياه المعالجة عالية جداً.



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