

**PERCEPTION OF SLUDGE USE AMONG FARMERS
IN NORTHERN GOVERNORATE, GAZA STRIP**

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ABSTRACT

The farmers tendency toward sludge use in agriculture as a fertilizer and/or soil conditioner in the Northern Governorate of the Gaza Strip has been investigated. A sample of 70 farmers was randomly selected. Data were collected through a questionnaire especially designed for this purpose. Despite the relatively high cost of chemical fertilizers, a substantial number of the interviewed farmers 67 (95.7%) applied them. Also, most farmers 62 (88.6%) were found to use animal manure particularly the fresh one. The use of untreated sludge seems to be very rare. Only two farmers (2.9%) from the population sample reported that they use untreated sludge. Currently, treated sludge is not available in Gaza Strip, but it will be produced in large quantities from the suggested new wastewater treatment plants that will be established in the near future. After discussing the characters and advantages of the new treated sludge and its types, the majority of farmers 61 (87.1%) indicated their acceptance to the use of this sludge especially that of type C. The expected amount of type C treated sludge to be used for vegetables is larger than that will be used for citrus. A demonstration of a model experimental farm is an actual desire for the population sample to see the benefits of treated sludge in agriculture. The production of cheap, effective and safe sludge will promote the tendency of farmers for its use.

Key words: farmers, gaza strip, sludge use.

1. INTRODUCTION

The Gaza Strip is a small piece of land with a total surface area of 365 Km². It is located in an arid to semi-arid region borderd by Egypt from the South, the green line from the North, Negev desert from the East and the Mediteranian sea from the West. The Gaza Strip is a heavily populated area; its population is estimated to be 1,261,909 for the year 2002 (Palestinian Central Bureau of Statistics, 2000). The entire population of the area depends totally upon groundwater for agricultural, industrial and domestic water supplies (Policy Research Incorporated, 1992 and Al-Agha, 1995). The groundwater is seriously getting decline as it is chronically over-exploited for deca !es and the yearly replenishment of the aquifer represents about 60% only (Kally, 1991 and Naciri & Ttlich, 2001). One third of the population in Gaza Strip is served by sewage network system which collects black and gray wastewater together. Wastewater from the rest of Gaza population is discharged into cesspools, open drains and vaults which contribute to contamination of ground water with nitrate (Al-Agha, 1995 and Nashashibi & Van Duijl, 1995).

In the previous view, wastewater treatment could be one of the main alternative options to develop and protect our water resources. Three wastewater treatment plants (WWTPs) have been established in Gaza Strip Governorates: Beit Lahia, Gaza and Rafah WWTPs. Their total capacity is approximately 20 Mm³/year. Gaza WWTP recharges the aquifer with 3.6 Mm³ of treated wastewater annually. Reclaimed wastewater produced is still not used for agriculture in Gaza Strip, instead it is drained into the sea. Gaza WWTP produces improper treated sludge from solid-liquid separation and aerobic oxidation processes whereas Beit Lahia and Rafah WWTPs yield untreated sludge left by pond infiltration. Most Sludge produced from WWTPs in Gaza Strip is dried and then disposed into landfills. Untreated or even improper treated sludge could be a potential source of heavy metals and pathogenic micro-organisms including bacteria, viruses and parasites (Watkins & Sleath, 1981; Schwartzbrod *et al.*, 1986; Sallal, 1987 and Koch & Rotard, 2001). Application of such sludge to soil with no doubt offers a serious risk for human health (Shariatpanahi & Anderson, 1986; Barbier *et al.*, 1990 and Beuchat & Ryu, 1997).

Due to the rapid population growth, the existing three WWTPs are heavily overloaded (Nashashibi & Van Duijl, 1995). Also, the

residential area is spreading closer to the plants and the inhabitants are suffering from the offensive odor and mosquito problems. There is now a master plan, introduced by donor countries, to construct three new WWTPs in Gaza Strip to replace the existing ones by the year 2020. Their total capacity will be about 116 Mm³/year and their location will be near the eastern border of Gaza Strip. The new plants will recharge the aquifer with approximately 40 Mm³ of treated wastewater annually and the rest of reclaimed wastewater will be managed to be used for irrigation. Alongside, the new plants will produce treated sludge of three types named A, B and C. Type A treated sludge will be aqueous whereas type B will be semi-aqueous. Type C treated sludge will be available in the form of dried grains. All three types of treated sludge will be used in agriculture.

Many countries including the neighbouring ones experienced the use of treated sludge in agriculture as a fertilizer or as a soil conditioner and positive impacts on agricultural production were recorded (European Economic Community, 1981; Kofoed, 1984; Abdul-Ghaffar *et al.*, 1985; Association Francaise de Normalisation, AFNOR, 1985; Bahri, 1987; Al-Salem & Talhouni, 1988 and Walsh, 1995).

The present investigation was carried out in Beit Lahia and Beit Hanoun; two villages in the Northern Governorate of Gaza Strip, where agriculture is the backbone of the area. Farmers use animal manure and chemical fertilizers to increase the agricultural production. Few farmers in Gaza Strip use untreated sludge for citrus, olive, almond and apple orchards (Personal communication).

Although experiences and perceptions among farmers of human wastes including sewage sludge have been studied elsewhere (Cross, 1985; Fittschen & Niemczynowicz, 1997 and Krogmann *et al.*, 2001), this is the first demonstration aimed to assess the tendency of farmers in Beit Lahia and Beit Hanoun towards the use of treated sludge in agriculture which will be produced from the new WWTP in Northern Governorate of Gaza Strip.

2. MATERIALS AND METHODS

The present investigation is a descriptive study. A sample of seventy farmers from Beit Lahia and Beit Hanoun, two villages in the Northern Governorate of Gaza Strip, was selected randomly. The

farmers were individually interviewed to fill a questionnaire. The interviewer explained questions clearly to the farmers. The interview was conducted face-to-face by one investigator himself who had a master degree in Environmental Science and is familiar with farmers. This helped to minimize the error bias and build trust between farmers and interviewer to get accurate answers. The questionnaire was designed by professionals in biological and environmental sciences with the help of the Palestinian Water Authority (PWA). Mix of structured and open-ended questions were included in the questionnaire (Backstrom & Hursh-Cesar, 1981). During the survey, the surveyor briefly introduced to farmers the sludge, its types, its application methods in addition to its environmental, economic and agricultural values. The questionnaire includes relevant information such as age, residence, size of area cultivated by different crops, type of fertilizer used, the preferred type of sludge to be used and the amount of treated sludge would be used/dunum for crops annually. Data were computer analyzed using SPSS/PC (Statistical Package for the Social Sciences Inc, Chicago, Illinois) and Excell Version 6 for frequency, cross tabulation and graphs.

3.RESULTS

The age frequency showed that the majority of farmers 50 (71.4%) in Beit Lahia and Beit Hanoun were above 30 years old. Regarding the size of farms, results indicated that farmers who own small farms (less than 10 dunums) were 27 (38.6%) and those who own large farms (exceeding 40 dunums) were 15 (21.4%). Strategic crops cultivated by farmers (n=70) in Beit Lahia and Beit Hanoun are listed in Table (1). The area cultivated by citrus constitutes the largest one (87.1%), whereas that cultivated by strawberry represents the smallest area (1.4%) of the agricultural land.

3.1. Use of chemical fertilizers and animal manure: chemical fertilizers were found to be commonly used by farmers in Beit Lahia and Beit Hanoun. As indicated in Table (2), a substantial number of farmers 67 (95.7%) admitted the use of chemical fertilizers in agriculture. Most of chemical fertilizers are imported from Israel and other countries. The cost that farmers pay to purchase these chemical fertilizers is 116,409 United States Dollars US \$ (82,560 Jordanian

Dinar JD) with an average of US \$ 1848 (1311 JD) for each farmer per year. Regarding the use of animal manure, most farmers 62 (88.6%) in Beit Lahia and Beit Hanoun reported the use of animal manure as a fertilizer. The majority of them 49 (79.0%) prefer the use of fresh manure (Table 2).

Table (1): Area of the cultivated crops (dunum*) reported by farmers (n=70) in Beit Lahia and Beit Hanoun, Northern Governorate of Gaza Strip.

Crop	Total area (dunum)	Average Area (dunum)	% of the whole area
Citrus	3005	42.9	87.1
Olives	67	1.0	1.9
Vegetables	203	2.9	5.9
Strawberry	50	0.7	1.4
Others**	126	1.8	3.7
Total	3451	49.3	100.0

* Dunum: 1000 square meters.

** Others: almonds, apples...etc. No areas cultivated with flowers or grains were encountered.

Table (2): Use of chemical fertilizers and animal manure by farmers (n=70) in Beit Lahia and Beit Hanoun, Northern Governorate of Gaza Strip.

Parameter	Frequency	%
Use of chemical fertilizers		
Yes	67	95.7
No	3	4.3
Use of animal manure		
Yes	62	88.6
No	8	11.4
Types of used animal manure		
Fresh	49	79.0
Treated	1	1.6
Both	12	19.4

3.2. Use of sludge: Data presented in this study investigate the use of untreated sludge as well as the expected use of treated sludge as follows :

3.3. Use of untreated sludge: In some areas of the Gaza Strip few farmers admitted the use of untreated or even improper treated sludge disposed from WWTPs. In an unofficial interview with two farmers, transporting improper treated sludge from the WWTP in Gaza to their agricultural land, it was claimed that the use of this sludge as a fertilizer is standing behind the increase of their agricultural production. In the case of the study area, the use of untreated sludge seems to be very rare. Only two farmers (2.9%) from the population sample reported that they use untreated sludge (Table 3); one farmer claimed that he got it from Israel and the other said that he obtained it from his own cesspool.

Table (3): Perception of sludge use among farmers (n=70) in Beit Lahia and Beit Hanoun, Northern Governorate of Gaza Strip.

Parameter	Frequency	%
Use of untreated sludge		
Yes	2	2.9
No	68	97.1
Perception of treated sludge use		
Yes	61	87.1
No	9	12.9
Perception of treated sludge types		
A	3	4.9
B	1	1.6
C	57	93.5

3.4. Prospective use of treated sludge: At the present time treated sludge is not available in Gaza Strip. After introducing the environmental, economical and agricultural values of treated sludge and its types, which will be produced from the new WWTP in Northern Gaza, the farmers seemed to accept the use of this sludge. This was apparent when only 9 farmers (12.9%) rejected its use, while the rest of farmers 61 (87.1%) accepted it (Table 3). A total number of 57 (93.5%) farmers out of those who accept the use of treated sludge prefer the use of type C sludge. Considerable variation was found among farmers in the amount of type C sludge to be used. As can be depicted from (Fig.1) the expected amount of type C treated sludge to be used for vegetables is larger than that will be used for citrus. When farmers of the population sample were asked about constructing a

model farm by PWA to show them the positive results of using treated sludge, a total number of 63 (90.0%) farmers accepted the idea and showed their desire to see this project as soon as possible. The rest of farmers 7 (10.0%) either rejected the idea or think that there is no need for a model farm.

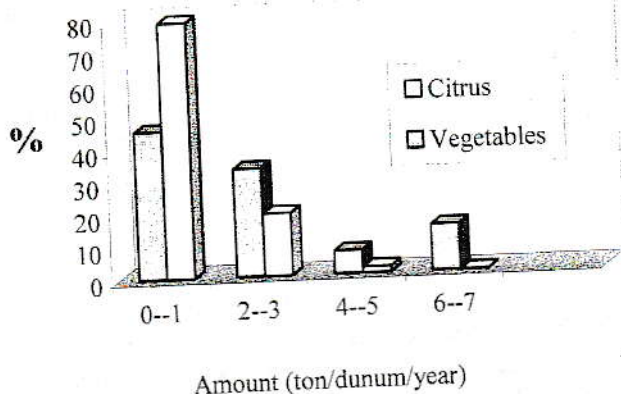


Fig. (1): The expected amount of type C treated sludge to be used by farmers (n=57) in Beit Lahia and Beit Hanoun for citrus and vegetables.

4. DISCUSSION

The present work was conducted in the Northern Governorate of Gaza Strip, a poor area with limited water resources. The residents there depend mainly on agriculture as the source of income. This may explain the engagement of a large number of old farmers who have better experience in production of cash crops than the young ones. The warm climate of the study area favors the cultivation of many crops including citrus, olives, almonds, in addition to other subtropical fruits and vegetables. Citrus occupies the largest area of the agricultural land in Beit Hanoun and Beit Lahia. This could be

attributed to the dominance of quaternary soil with clayey material increasing towards the eastern border of the Gaza Strip (Al-Agha, 1997).

Soil in the Gaza Strip is becoming less fertile than it was in the previous decades due to the intensive agriculture, where sometimes two or more crops are cultivated annually. Accordingly, the majority of interviewed farmers in the Northern Governorate of the Gaza Strip is using chemical fertilizers to increase their agricultural production. Extensive use of chemical fertilizers in agriculture in Gaza Strip has been reported (Abdul Hadi, 1997). Vegetables, strawberry and citrus are exported to Israel and Europe to earn good money. Foreign currency increases the farmers' income and enable them to meet their growing demand for expensive chemical fertilizers. However, heavy use of chemical fertilizers could contribute to groundwater contamination by nitrate (Johnson & Kross, 1990; Levallois *et al.*, 1998 and Halwani *et al.*, 1999).

In general, the use of animal manure (Zibble), mainly from cows and chicken, as a fertilizer was found to be common among farmers in the Northern Governorate of Gaza Strip. However, most farmers accept the use of fresh manure than the treated one which get special treatment to modify the percentages of its macro- and micro-nutrients and to remove undesirable components. Although animal manure is useful for maintaining soil fertility, its negative impact on the environment has been reported (Jongbloed and Lenis, 1998).

Based on some questions and discussion conducted by the interviewer, most farmers talked about certain factors standing behind their rejection to use untreated sludge. They said that a) sludge is a "najas" material (spiritual pollutant) and there is no psychological acceptance for its use, b) sludge will deteriorate and may kill their agricultural crops. A farmer aged 75 years from Beit Hanoun mentioned that the soil of his citrus orchard will be destroyed if he uses sludge, and c) sludge is a material containing pathogens, attracting insects and produces offensive odors. These views are in accordance with perceptions recorded from people including farmers elsewhere (Hanafi, 1985; Hamlin, 1990; Reid, 1991; Fittschen & Niemczynowicz, 1997 and Krogmann *et al.*, 2001).

The quantity and characteristics of sewage sludge produced from municipal wastewater treatment plants depend on the nature of the raw wastewater and the treatment units employed (Al-Sa'ed, 1999

and El-Gohary *et al.*, 2000). Treated sludge which will be produced from WWTPs in Gaza Strip should be largely free of pathogens (Downs, 1997 and Nelson & Darby, 2001) and the amount of heavy metals should be minimized to the recommended limit values (United States Department of Agriculture, 1980 and Kitada *et al.*, 2001). Although treated sludge improves soil fertility, its accumulation could be a burden on the environment. Therefore, understanding farmers' perceptions and choices regarding land application of treated sludge is a key to developing locally accepted strategies for sludge management. Definite response will emerge when the interviewer displays full information on the environmental, economical and agricultural values of treated sludge and its various types. Here, the majority of farmers seems to accept the use of treated sludge particularly of type C due to its unique characteristics including its fertilizing value, lack of smell, ease of packaging, storing and transportation and diverse and safe application.

Availability of alternatives to the expensive chemical fertilizers will offer more choices and will be of economical value. Experimental model farm will no doubt convince the farmers how effective the treated sludge will be and will promote the future use of sludge in the area. Also, the tendency of farmers toward the use of treated sludge will be high if a) sludge is inexpensive b) sludge is effective and can improve agricultural production c) sludge is environmentally compatible *i.e.* safe from pathogens and hazardous chemicals d) sludge is rich in macro and micro-nutrients required to plants and e) sludge is easily transported and is easily applicable to crops.

Upraising public awareness about the efficiency of sludge use on agriculture and environment is essential. Training programs to ensure safe and effective use of sludge are highly appreciated. Environmental and biological monitoring to identify the possible impacts of sludge on the environment and biota is recommended. Enhancement of the role of the Ministry of Agriculture and extension services toward sludge use is required. Treated sludge should be available to farmers all the time and in the quantities they need to fertilize their agricultural lands. Further research is needed to inspect farmers' perceptions and attitudes towards sludge use in the other Governorates of Gaza Strip. Hence, the whole picture will be completed for future strategies on sludge use.

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إدراك المزارعيين تجاه استخدام الحمأة في محافظة الشمال في قطاع غزة

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ملخص

بحشت هذه الدراسة إدراك المزارعيين تجاه استخدام الحمأة في الزراعة كمخصب أو كمحسن للتربة في محافظة الشمال في قطاع غزة. تم إختيار ٧٠ مزارعا عشوائيا لإجراء الدراسة وجمعت البيانات في إستبيانات صممت خصيصا لهذا الغرض. على الرغم من الثمن الباهظ نسبيا للمخصبات الكيميائية إلا أن العدد الأكبر من المزارعيين ٦٧ (٧٠ و٩٥%) يستخدمونها، ووجد أيضا أن معظم المزارعيين ٦٢ (٦١ و٨٨%) يستخدم روث الحيوانات وخاصة الجديد غير المعالج وأن استخدام الحمأة غير المعالجة هو نادراً جداً حيث أظهر ٩ و٢% من العينة أنهم يستخدمونها. ومع أن الحمأة المعالجة غير متاحة حالياً في قطاع غزة، لكنها سوف تنتج بكميات من محطات معالجة مياه الصرف الصحي المقترح إنشاؤها في المستقبل القريب. بعد مناقشة خصائص ومميزات وأنواع الحمأة المعالجة الجديدة مع المزارعيين، أبدى معظمهم ٦١ (٦١ و٨٧%) قبوله لإستخدامها وخاصة النوع (س)، الكمية المتوقع إستخدامها من الحمأة المعالجة من النوع (س) للخضروات أكبر منها للمضيات. كما أبدى المزارعون أهمية عمل مزرعة تجريبية لكي يروا فوائد استخدام الحمأة المعالجة في الزراعة. إن إنتاج حمأة معالجة رخيصة وفعالة وأمنة سوف يحث ميول المزارعيين تجاه إستخدامها.

