Domestic Wastewater Treatment and Its Reuse for Irrigating Home Gardens (Case Study)

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ABSTRACT

As an environmental solution to face water scarcity and threat coming from untreated domestic wastewater, the Applied Research Institute – Jerusalem (ARIJ) has put huge efforts in developing locally made wastewater treatment plants to be utilized at domestic level to help promote sustainable development and combat desertification in the occupied Palestinian territory. Developed wastewater treatment plants adopted activated sludge technology as biological process, followed by mechanical filtration as advanced treatment. This provided an environmental friendly solution to the problem of the generated wastewater at household level (ARIJ, 2010). The adoption of such approach resulted in: (1) Protecting the environment from pollution caused by the improper wastewater disposals (use of cesspits), mitigating and reducing of the environmental and health problems and risks ; (2) Providing a better management of the wastewater resources by reusing the treated wastewater for irrigation purposes economizing in domestic drinking water volumes used for irrigation, (3) Contributing in an increase of the agricultural areas as result of the new water resource,(4) Contributing in the family economy and sustainability, this was achieved by economizing the monthly expenses that benefited families used to have as concept of hiring wastewater vacuuming services and which was provided by vacuum tankers, (5) The new planted fruit trees and which are currently irrigated with treated wastewater are expected to contribute in the family food security, (6) Protecting the surface and ground water resources .

Keywords: Environmental Solution, Wastewater, Reuse of Treated Wastewater, Small Scale Onsite Wastewater Treatment Plant, Activated Sludge.

Nomenclature

(BOD_5): Biological Oxygen Demand; amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period.
(COD): Chemical Oxygen Demand; a test commonly used to indirectly measure the amount of organic compounds in water.
(TSS): Total Suspended Solids; a water quality measurement.
(NH_4-N): Ammonium Nitrogen; a primary indicator of water quality.
(TP): Total Phosphorus; the sum of all phosphorus components.

(PH): Measure of Acidity or Alkalinity
(E (%)): Efficiency percentage.
(HP): Horse Power; 1 HP equals approximately to 745.7 Watts.
(WWTPs): Wastewater treatment Plants
(MTE): Mid Term Evaluation
(oPt): occupied Palestinian territory
(PSI): Palestinian Standards Institute
(SPSS): Statistical Package for Social Sciences.
(NIS): New Israeli Sequel

1. INTRODUCTION

Despite that the sewage collection coverage has been increased in the last few years in the occupied Palestinian territory (oPt), there is still a lot of work to be done. The sewage collection systems in the absence of available wastewater treatment infrastructure used to transport the problem rather than solving it. Only 6.33% (2.836 MCM) of the generated wastewater in the West Bank is treated in centralized and collective wastewater treatment plants, the remaining 93.7% is discharged untreated into the environment using cesspits, septic tanks and sewage collection networks that are not connected to any wastewater treatment infrastructure(ARIJ, 2011). Cesspits are purposely designed and constructed without a concrete lining in order to allow seepage into the ground. With time, cesspits are filled with wastewater which necessitates periodical emptying by vacuum tankers. The collected wastewater in the tankers is often released in the nearby valleys. However, septic tanks are environmentally preferable to cesspits as their design prohibits wastewater leakage to the ground. Vacuum tankers whether with sewage from septic tanks or cesspits, if there is not close available infrastructure to receive this sewage, those pollutants are discharged into the environment. Hiring the service of vacuum tankers despite of not being a real solution to the problem is a costly service that in many cases goes beyond citizens' affordability. In the Gaza Strip, there are also discharges of untreated wastewater into the Mediterranean Sea (ARIJ, 2011).

The Applied Research Institute-Jerusalem (ARIJ) considers that the generated wastewater in the oPt; shall be treated and reused within the oPt. The adoption of such approach, will contribute in avoiding elevated costs paid to Israel as wastewater treatment concept, providing at the same time a non-conventional water resource that can be utilized for irrigation, contributing in alleviating the water scarcity problem.

On-Site small-scale wastewater treatment plants, which often serve a single house or building, respond to the needs and conditions especially in rural localities. They can solve the wastewater collection and disposal problems in such communities, along with the benefit of generating a water resource that can be utilized for irrigation purposes as land and agriculture are available (ARIJ, 2010). Working in this direction ARIJ implemented a project of 180 household wastewater treatment and reuse systems, this project was entitled "*Introducing Small Scale Activated Sludge Filtration System of Wastewater Treatment in the Rural Areas of Bethlehem and Hebron Governorates in the West-Bank* " this project was funded by The Mennonite Central Committee (March 2007 - September

2010). **Through this paper will be discussed some obtained results from a Midterm Evaluation (MTE) that took place in September - 2009, as well will discuss obtained results and conclusions after project completion, adopting the aforementioned implemented project as Case Study.**

2. METHODOLOGY

2.1 Case Study Project Wastewater Treatment Process Methodology Description

Each installed wastewater treatment plant in the case study project, was planned to serve a single small family of six members as maximum recommended, with a hydraulic daily flow that does not exceed one cubic meter. The adopted material utilized for the construction of the installed WWTPs was polyethylene, avoiding in this manner risks of corrosion. The Aeration device utilized has a power consumption average at full time operation of 65 Watts; the water pump utilized has a power consumption average at full time operation of 1 HP, both devises connected to one control panel. The treatment process starts with screening of certain suspended solids present in the wastewater; these suspended solids are filtered using a removable screen basket with filtering slots of 5-8 mm. With the help of a set of pipes, the recycled activated sludge is brought to just underneath the basket from the separation zone, and is mixed with the incoming wastewater. After the screening, the de-nitrification and Activation/Nitrification processes take place. In the de-nitrification zone, oxygen is removed from nitrate and nitrite to form nitrogen gas and water. From the de-nitrification zone, wastewater overflows into the aeration (nitrification/activation) zone, which is the largest zone and provides a space where the bacterial mass is aerated and maintained for the longest period of time. This allows for the maximum utilization of nutrients and conversion of the contaminants in the raw sewage into less harmful compounds; carbon oxide and water in the process of oxidation, and nitrite and nitrate in the process of nitrification. The aeration system goal was to maintain the dissolved oxygen at 2-3 mg/l, and to maintain solids in suspension and ensure proper recirculation of the activated sludge. Air was diffused from the bottom of the aeration zone. It is important to mention that the typical wastewater does not contain nitrate which means that no de-nitrification process can occur unless a nitrification process is preceded. For this reason, the de-nitrification of the treatment plant was accomplished through the use of a circulating pipe that returns the flow to the screen and therefore to the de-nitrification compartment, assuring that the de-nitrification process occurs. The half conical shape of the separation zone in the installed system ensured that the upward velocity of the sludge flocks decrease as the flocks rise until they form a stationary sludge blanket as gravitational and uplift forces reach equilibrium. As Wastewater passes through the sludge blanket, fine suspended solids are retained and the filtered effluent rises above it. The effluent is then discharged out of the system. The growing flocks of the sludge at the bottom of the separation zone are recycled by means of an air lift pump back to the screen and de-nitrification zone of the bioreactor. Also located in the separation zone is a device to skim and remove flocks of sludge occasionally breaking away and floating on the surface of the separation zone. The running of the treatment facility was controlled completely automatically, including: steering, recirculation of activated sludge, injected oxygen volumes and treated wastewater pumping. **Figure 1** illustrates the wastewater treatment plant process (ARIJ, 2005)

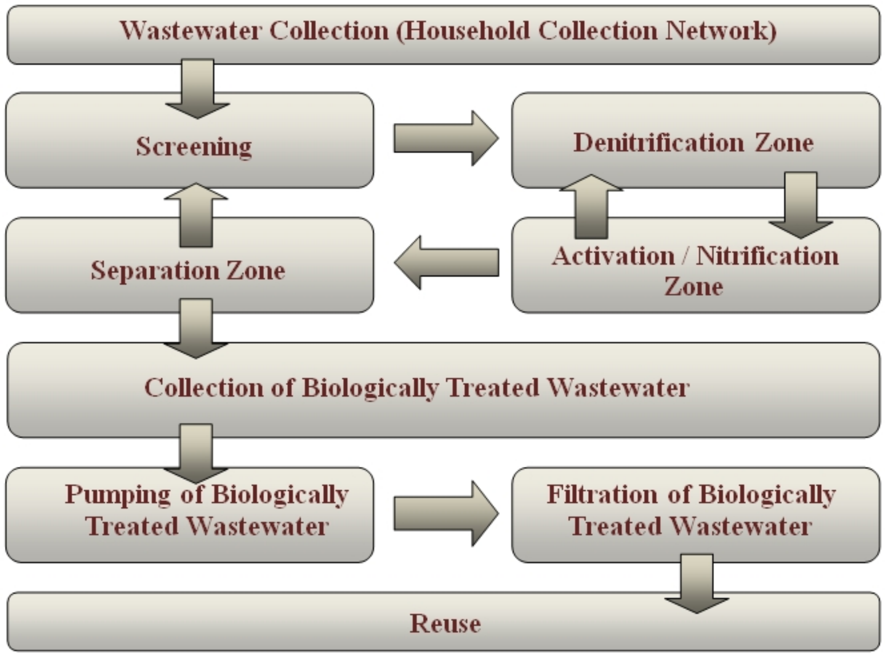

Figure 1: Illustrates the path of the wastewater and wastewater treatment plant process (ARIJ, 2005).

The secondary treatment achieved through the biological treatment afore described was followed by a sand filter that contributed in further treating the biologically treated wastewater mechanically; later on the treated effluent is pumped to irrigate trees ,of course after the adoption of the local reuse standards and recommendations (ARIJ, 2005).

Figure 2: Description of the different components of a locally made onsite wastewater treatment system(ARIJ, 2005).

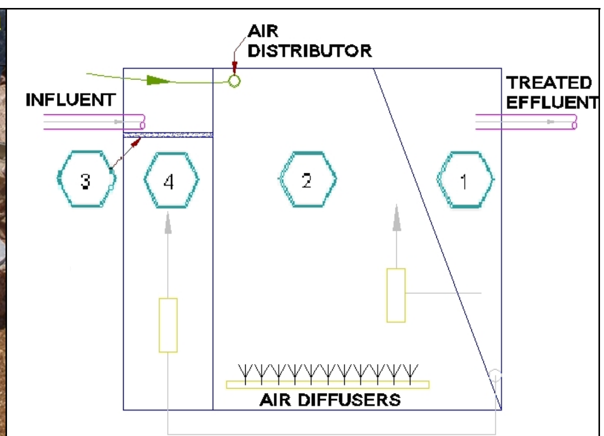

Figure 3: A cross Section of the Biological Treatment Reactor, (ARIJ, 2005).

The illustrated numbers in (Figure 3) refer to the compartments of the wastewater treatment reactor, but they do not indicate the sequence of the wastewater flow:

1) The separation zone.
2) The activation/nitrification zone.
3) The mechanical debris screen Basket.
4) The de-nitrification zone.

2.2 Methodology adopted for the Project Midterm and End Project Evaluation.

The methodology adopted for this project midterm evaluation was based on a special questionnaire that was prepared to collect information on the effectiveness of the installed units and to evaluate beneficiaries' satisfaction of the project activities. The questionnaire was filled by the evaluator during field visits and by interviewing the beneficiaries, observing the gardens and functionality of the installed units and effluent evaluation utilizing for this task the BOD5 (Biological Oxygen Demand) parameter. All gathered information was then entered on SPSS and analyzed. The sample size was 29.27% of the total installed units (36 units out of a total of 123 installed units at that stage). The evaluated units were chosen randomly from the first targeted localities. Those localities included Al- Walaja, Al-Khader, Battir, and Beit-Ummer. Most of the interrogated beneficiaries were with installed units for more than one year (ARIJ, 2009).

This mid-term evaluation was conducted to assess the effectiveness and efficiency of small-scale activated sludge installed systems. The MTE was designed to provide midterm feed back to the project team from benefited families, and as a project management tool with the goal of identifying, and reinforcing initiatives that demonstrate the potential for success and as evaluation tool to do corrections if needed

The special questionnaires that were utilized in the MTE included several main points that can be summarized in the followings:

a) Personal information about the beneficiary.
b) Information about the beneficiary environmental understanding, involvement and knowledge on his own treatment system
c) Information about the installed unit, maintenance, safety measurement and effluent quality
d) Evaluation to what degree the beneficiary has been benefited from the installed unit.
e) Beneficiary perception of installed unit and satisfaction degree. (ARIJ, 2009).

In March of 2011, after three years of operation of the first project installed WWTPs another evaluation took place (Evaluation after project completion), the evaluation procedure at this stage was the same adopted at the MTE, but with some differences in the parameters that were evaluated. The sample size at this time was of 34 WWTPs different users, approximately 19% of a total of 180 installed systems (ARIJ, 2011).

3. RESULTS AND DISCUSION

3.1 Results Related to the wastewater treatment technology adopted

The Project adopted prototype was first tested in 2005; the selected parameters were analyzed to study the efficiency of the small scale wastewater treatment prototype, and whether this effluent is suitable for irrigation purposes. These parameters are the Biological Oxygen Demand (BOD_5), the Chemical Oxygen Demand (COD), the Total Suspended Solids (TSS), Ammonium Nitrogen (NH_4 -N), the Total Phosphorus (TP) and the measure of acidity or alkalinity (PH) **(Table 1)**.

Table 1: Comparison table between effluents obtained from the WWTP on evaluation and PSI standards

	Quality Parameter (mg/l)		BOD_5	COD	TP	TSS	NH_4-N	PH
Recommended guidelines by the Palestinian Standards Institute For Treated Wastewater Characteristics According to Different Applications	**Fodder Irrigation**	**Dry**	60	200	-	50	-	6-9
		Wet	45	150	-	40	-	6-9
	Gardens, Playgrounds, Recreational		40	150	-	30	50	6-9
	Industrial Crops		60	200	-	50	-	6-9
	Ground Water Recharge		40	150	-	50	10	6-9
	Seawater Outfall		60	200	-	60	5	6-9
	Land Scapes		60	200	-	50	-	6-9
	Trees	**Citrus**	45	150	-	40	-	6-9
		Olive	45	150	-	40	-	6-9
Average of effluent quality obtained from the Tested WWTP			<20	22	4.35	172	5.15	7.25
Note: In this evaluation the samples were taken from the separation zone without any further treatment								
Sources: (PSI, 2005), (Al Quds University 2005).								

According to the Palestinian Standards Institution for treated wastewater, characteristics of which are shown in Table 1, the results of the effluent parameters show that the quality of treated wastewater from local small scale wastewater treatment units is acceptable for irrigation purposes without any hazardous impacts. However, the TSS concentrations were generally high, (PSI, 2005).

To improve the TSS value , was added to the process sand filtration, to improve the effluent to an acceptable treatment level that complies with reuse for irrigation purposes of course after taking into consideration the local reuse standards and recommendations

(ARIJ, 2010). Later on a composite sample of raw wastewater was done by mixing collected samples obtained from five representative households in the rural areas of Bethlehem; this composite sample was used to determine an estimated BOD_5 value for the raw wastewater in the rural areas of Bethlehem, the obtained value of this composite sample approximated the 362 mg/l (ARIJ, 2005), this value later on was used to assess the removal efficiency of the wastewater treatment plants that were installed in the rural areas of the Bethlehem Governorate (See Table 2).

3.2 Results obtained at the project MTE:

During this study, the number of installed WWTPs was 123 out of 180 planned to be installed. The average efficiency of the BOD removal in the WWTPS during the MTE varied from locality to another. An example is shown in **Table 2**.

Table 2: Evaluation of the Wastewater Treatment Plants efficiency in both Al Walajah and Al Khader village – Bethlehem

No. of tested plant & location	WWTP BOD5 Test Result (mg/l)	Efficiency obtained in the removal of BOD
Al Walajah-1	8	E (%) = [(BOD5 influent – BOD5 effluent) / (BOD5 influent)] x 100 = [(362 mg/l –14 mg/l) / (362mg/l)] x 100 = 96.1 %
Al Walajah-2	11.6	
Al Walajah-3	20.4	
Al Walajah-4	16	
BOD5 Test Average (Al Walajah)	14	
Al Khadr-1	23.4	E (%) = [(BOD5 influent – BOD5 effluent) / (BOD5 influent)] x 100 = [(362 mg/l –18.8 mg/l) / (362mg/l)] x 100 = 94.8 %
Al Khadr-2	21.6	
Al Khadr-3	15.6	
Al Khadr-4	14.8	
BOD5 Test Average (Al Khadr)	18.8	
Source: (ARIJ, 2009)		

The results obtained through the lab tests at this stage were very acceptable and fit with what was planned for.

At that stage was needed also to evaluate the beneficiaries' involvement in the project, perception of project activities, degree of satisfaction among the beneficiaries and impact of the installed systems. To do so, the 29.27% of the total installed WWTPs at that stage were visited and information from beneficiaries was collected. Some of the result of this stage of the MTE can be summarized in **(Table 3)**:

Table 3: Some obtained results from the case project midterm project evaluation

Aspect , Subject or Indicator	%
Knew about wastewater, possibility of wastewater treatment and reuse, from school literature, TV programmers; others get some information while working in Israel	41
Aware of the negative impact of cesspits to the environment	97
WWTPs users that considered that they give periodic maintenance to the system sand filter	89
Considers that the onsite wastewater treatment plans has positive impact on the environment.	86
WWTPs users who considered that their wastewater treatment plants are working in excellent conditions (based on their own monitoring and perception of the installed Systems).	86
Beneficiary follow up of recommended safety guidelines	67
Percentage of beneficiaries that used to irrigate from time to time their home gardens before installing the WWTPs.	23
Beneficiaries that considered that they don't face bad odors problem in their installed systems	75
Percentage of beneficiaries that used to utilize cesspit as wastewater disposal method , before installing the Wastewater treatment and reuse system	83
Percentage of beneficiaries that used to hire the service of vacuum tanker to dispose the collected wastewater	27.6
Source: (ARIJ, 2009).	

From **Table 3** some positive impacts of the installed wastewater treatment plants can be concluded:

1) Installed units put a stop to pollution of cesspits to the environment, as was stated by 83% of the WWTPs interviewed users (by replacing cesspits with wastewater treatment plants).
2) Economize in the economic resources that are used for paying for the service of vacuuming filled cesspits or septic tanks, in accordance to the MTE 27.6% of interviewed users were hiring the service of vacuum tanker to dispose the collected wastewater.
3) Installed systems have provided an environmental solution to the disposal of the households generated wastewater, at the same time has provided a non-conventional water resource that can be reused for irrigation. (ARIJ, 2005)

Also in accordance with the MTE, 42% of the WWTPs users said that there is some saving in their water bill, this saving was attributed to the use of treated wastewater for irrigation of trees, economizing in this manner in the volumes of domestic tab water used for that purpose previous to the installation of the wastewater treatment and reuse systems. WWTPs users considered that this saving in the water bill can be estimated at about 30% of the total value of the water bill, but at the same time they expressed that it is hard to measure it more precisely; The remaining 58% of users could not provide information on savings as most of them were not paying their water bill regularly (ARIJ, 2009).

Based on the MTE (at that stage), was estimated a total of 78 dunums utilizing treated wastewater as irrigation water resource.

According to agronomist's estimations at ARIJ, each household can increase the production of its home garden from 220 kg/year to 722 kg/year by the periodic irrigation that can result from the household reclaimed water, obtaining an approximate increase in the home garden production of 502 kg/year. This increase in production is estimated to be equivalent to approximately 134 USD for typical home gardens that don't irrigate frequently to 440 USD for home gardens that utilized reclaimed water permanently in irrigation (ARIJ, 2010), this potential to increase in home garden production can be considered as another positive impact of installed WWTPs.

In this MTE also was stated 69.4% of WWTPs users were 100% satisfied with the idea of having the wastewater treatment plants. The remaining 30.5% were 75% satisfied for having those units. Regarding the guidelines and workshops done at that project stage, 88.9% of users considered that guidelines and workshops were enough, while the remaining 11.1% demonstrated a partial satisfaction (ARIJ, 2009).

3.3 Results obtained after three years of operation of the first project installed WWTPs:

At this time the same evaluation procedure that was utilized at the MTE was adopted, but with some differences in the parameters that were evaluated. The sample size at this time was of 34 WWTPs different users, approximately the19% of the total of 180 installed systems (ARIJ, 2011). The data compiled through the questionnaires was entered into the Statistical Package for Social Sciences (SPSS) and then analyzed. At that stage the status of the onsite WWTPs was as follow:

Around 59% of the interviewed WWTPs users stated that the onsite WWTP is operating well with high efficiency. (Figure 4)

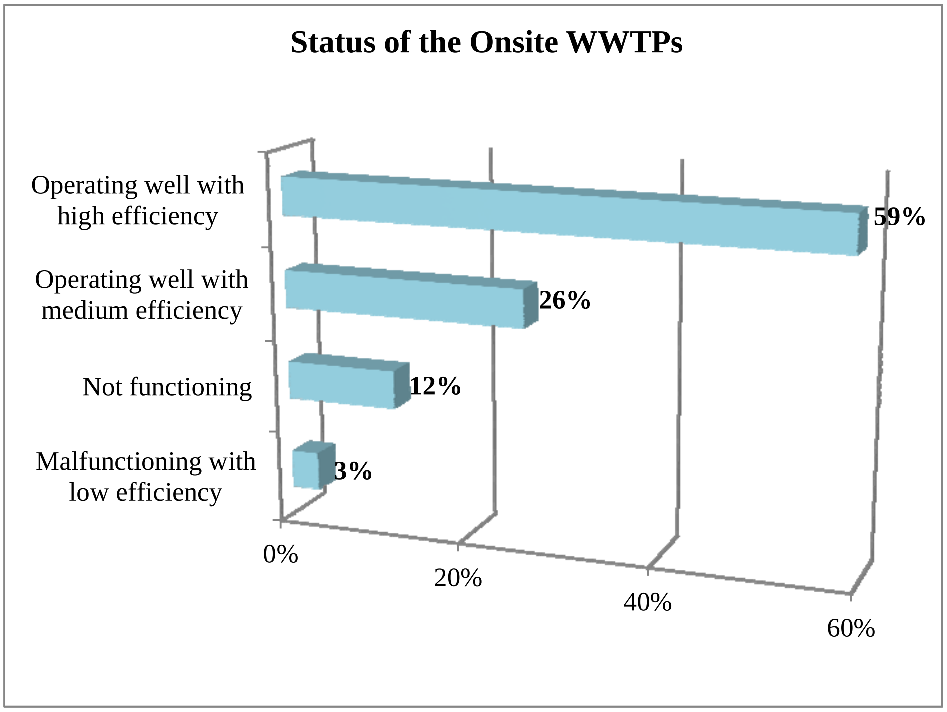

Figure 4: Status of the Onsite WWTPs (ARIJ, 2011).

Around 26% of the evaluated units were operating well with medium efficiency; variation in efficiencies from system to another could be result of:

- Systems adjustments,
- Variation in volume and composition of chemicals that the system is exposed to (Cleaning detergents, shampoos, washing machine softeners, soaps, etc.).
- Variation in the number of individuals at the household (Example (1): a household with tree persons is expected to generate half liquid waste than the expected of a household of six persons. Example (2) The WWTPs if assigned to serve a number of persons that exceeds what was originally planned for; this can lead the WWTP to operate under overloaded conditions and which can be reflected negatively in the effluent obtained).
- Variation in the concentration of pollutants in the wastewater inlet pipe and water consumption behaviors (The concentration of pollutants in the wastewater is directly linked to the water consumption behavior (for example a household inhabited of five persons that have an average water consumption of 60 liter / person /day, will have a more concentrated wastewater than if the average water consumption of the inhabitants of the same household was 250 liter / person/day). As well the real hydraulic retention time of the wastewater treatment phases will be subject to the variation in the water consumption behavior, since the reactor volumes are constant values, and the wastewater that enters the system is variable. (ARIJ, 2011).

Around 12% of the evaluated units were not functioning, to assess the reason behind this; a technical evaluation was done and the following aspects were considered that can lead users to stop operating their WWTPs:

- WWTPs users can consider that at winter time no need to reuse the treated wastewater, since at winter time they may rely on rain water for irrigation instead of treated wastewater, users thinking in this manner could be capable of cutting the source of power (electricity) especially in wintertime, and that is needed for both wastewater treatment and reuse process.
- WWTPs users' with lack of environmental commitment, in the absence of the enforcement of environmental practices.
- WWTPs users 'neglection to the installed systems and their lack of willingness to comply with what they were trained for in what regards the WWTPs periodic maintenance needed.
- WWTPs users may lack of willingness to invest in maintenance to the installed system, despite that the installed systems were made a manned that the needed maintenance is minimum.
- WWTPs users may face change in their willingness of having home gardens and in the absence of enforcement to the environmental practices there is a potential risk of users end operating their wastewater treatment and reuse system.
- WWTPs users lack of maintenance provided to the system ,and their lack of commitment in following the maintenance instructions can lead the WWTPs users to think that their systems are not efficient (Example : The used technology is activated sludge , therefore needs periodic wasting of sludge. Neglecting sludge removal can lead WWTPs users to think that the installed system is not efficient and this can encourage the WWTP user to stop operating the installed WWTP). (ARIJ, 2011).

3% of the installed units were malfunctioning with low efficiency, to assess the reason behind this; another technical evaluation was done and the following notes were obtained:

- Some WWTPs users' willingness to get benefit of bigger volumes of treated wastewater can lead them to connect neighboring households drainage line to the installed systems, exposing in this manner the WWTP to overloading working conditions leading at the end to effluent of low quality.
- Some WWTPs users' fears of technology and of reusing treated wastewater can encourage them to utilize a WWTP with gray water inlet instead of wastewater, altering in this manner what the wastewater treatment plant was originally designed for, and affecting in the expected system effluent (ARIJ, 2011).

3.4 Feasibility discussion related to the adopted wastewater treatment technology

Each installed wastewater treatment plant in the project was planned to serve a small family of six members at maximum as recommended, with a hydraulic daily flow that does not exceed one cubic meter. In accordance with the information provided through the MTE activities, the following was obtained: The daily wastewater generation in each household with installed WWTPs is estimated to range between (200 – 800) liters / day. Assuming an average of 500 liter / day, multiply this value with 365 days (the number of days of the year), then each installed wastewater treatment plant is estimated to treat an approximate of 183 cubic meters of wastewater per year.

The running cost of a single installed WWTP is estimated to be as follow: (1) Electricity cost is estimated to range between NIS 25 and NIS 35 per month, then assuming the average cost of electricity is 30 NIS / month, then the annual electricity cost will be NIS 360. (2) Equipment maintenance cost and / or replacement of parts if needed is estimated at NIS 330 / year. (3) Sludge removal cost: the excess sludge is needed to be periodically removed and the frequency of removal depends at the end on the plant loading; the adopted sludge removal frequency ranged between six and eight months, assuming that each time the excess sludge is removed, a vacuum tanker will be hired for that purpose *(According to information gathered trough the MTE, the costs of vacuuming an approximate of seven cubic meters of wastewater (a typical full load capacity of a common vacuum tanker used in the area on evaluation) ranged between 70 and 150 NIS depending at the end on the locality, distance of the household and distance of discharge point). By* adopting that, the average cost of hiring a vacuum tanker will be NIS 110 per load and by adopting the abovementioned sludge removal frequency, we will need to hire every two years the service of a vacuum tanker between 3 and 4 times, that means that every two years we will have to spend between NIS 330 and NIS 440. Taking the average cost of sludge removal every two years, we can estimate an approximate of NIS 193 / year spent as concept of annual sludge removal cost. Adding the three main operating costs together, we will find that the total cost of the alternative of treating the wastewater onsite, approximates NIS 883 / year (Electricity 360 NIS/year plus maintenance 330 NIS/year and periodic sludge removal 193 NIS/year).

If we assume that to prevent pollution, a household of the same aforementioned characteristics (with an approximate annual wastewater generation of 183 cubic meters) will utilize a septic tank to collect the generated wastewater instead of a cesspit, and later on this collected wastewater will be vacuumed by a vacuum tanker to an assigned accorded discharge point; adopting the vacuum tanker of the same abovementioned characteristics (tank capacity of seven cubic meters per load) and with the same average cost per load of NIS 110, then we can estimate that the frequency needed to hire the services of a vacuum tanker approximates 26 times/ year (183 cubic meters of wastewater generated annually divided by 7 cubic meters, that is the maximum load of adopted vacuum tanker) ; translating this into costs, we will have an annual approximated cost of 2860 NIS needed as annual vacuuming household cost. Comparing both approaches (Onsite wastewater treatment & Vacuuming of generated wastewater), we find that onsite wastewater treatment is more feasible than adopting vacuum tankers to dispose the generated wastewater and the annual difference between the two approaches is estimated to be NIS 1977 in favor of onsite wastewater treatment; this is done without considering the additional benefit of the generated treated effluent that will be generated and can be reused for restricted irrigation.

4) CONCLUSIONS & RECOMENDATIONS

The results obtained after evaluating the effluent of the installed activated sludge wastewater treatment plants, indicates that: (a) the quality of the effluent can be improved to an acceptable degree, (b) the onsite wastewater treatment is more feasible than adopting the use of vacuum tankers as wastewater disposal method. The adoption of such technology in the oPt, can contribute in: (1) generating a new water resource that can be reused in restricted irrigation (2) solving a big portion of the problem resulting from the disposed volumes of untreated domestic wastewater, preserving the environment by protecting the ground water and surface from pollution due to disposed wastewater collected in cesspits and other non-environmental wastewater disposal practices,(3) economizing in the volume of the consumed drinking water used in irrigation, by replacing it with treated wastewater, contributing in improving the water resources management,(4) the household economy and sustainability by economizing wastewater vacuuming expenses and contributing in an increase of home gardens production by providing treated wastewater that can be reused after the adoption of local standard reuse recommendations ,(5) increasing of the agricultural areas as result of the non-conventional water resource that can be obtained,(6) provide an alternative solution to solve the wastewater problem especially in localities where buildings are dispersed and is unfeasible to construct wastewater collection networks ,(7) mitigating and reducing of the health problems and risks resulting from bad wastewater disposal practices. Laws enforcement, law legislations, water utilities and authorities' encouragement to WWTPs users, subsidies and awareness campaigns can contribute in a more sustainable wastewater sector. Huge efforts are needed to increase the public awareness and involvement and that can contribute in enhancing the public attitude and behavior in what regards to the environment. From this study, it can be concluded that wastewater treatment and reuse is possible in the oPt, but special attention and efforts shall be done to guarantee an environmental involvement of the onsite WWTPs end users to guarantee a proper use of installed systems and its sustainability.

ACKNOWLEDGMENT

This research has been done with the contribution of different departments at the Applied Research Institute –Jerusalem (ARIJ), among them: 1) The Water and Environment Research Department (WERU) 2) Monitoring and Evaluation Department (M&E) 3) Biodiversity and agriculture Department (BARU).The contribution of different donors as The Mennonite Central Committee (MCC), The Spanish Agency for International Cooperation and Development (AECID) and The Ministry of Education and Higher Education (MoEHE) are also appreciated.

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