

I gone through the comments and tried to consider all of them

[comments marked red colour and underlined]

Potential of solid waste composting in the Gaza Strip- Palestine

Abstract

The paper discussed ?? the potential of solid waste composting in the Gaza Strip. More than 60% of Gaza solid waste is organic as 360,000 tons of domestic organic waste is generated yearly in addition to 440,000 tons of organic agriculture waste. In Gaza the compost is sold for 3 USD /20 kg bag. Composting municipal and agriculture waste in the Gaza Strip will produce around 900,000 ton/year and the agriculture demand is only 160,000 ton/year (18%). To be able to avail a higher quantum it would be required to also look at the potential of compost markets in the West Bank and Egypt in the future. The main barriers to market development for organic “waste”-derived compost in Gaza are the low availability of high quality compost, limited information on compost usage and its benefits and finally lack of incentive to separate waste at source. Some thing could be done by researchers to justify its publication]

Key words: Compost, market, Quality, Solid waste, Gaza Strip

1. Introduction

Waste management services in Gaza are under great stress, as most other public services, due to the closure and economic restrictions imposed on Gaza. With donor support solid waste collectors are assigned on a temporary basis, using mainly donkey and push carts to collect the waste. The Municipal Council of Gaza City operates around 150 donkey carts for collection and transfer of municipal waste [3,4]. An open dump site area in the city is used as transfer station, from which about 20 vehicles transport the waste to the Johr aldeek central dump site. The Rafah municipality operates similar means to collect and transport waste to the central dumpsite at Al Fukhari [5,6]

[Re arranged]

Materials and method

Statistics

The Gaza Strip consists of five governorates, including a total of 33 villages and municipalities with total surface area is 365 km² [1]. Table 1 presents the population of the Gaza Strip based on location type.

Table 1: Gaza Strip Population in 2007

Governorate	Number of households	Population 2007			
		Urban	Rural	Camps	Total
North Gaza	40,262	225,502	2,811	41,933	270,246
Gaza City	76,809	448,221	12,542	34,648	496,411
Middle Area	32,082	129,050	1,873	74,612	205,535
Khanyounis	43,203	218,061	15,213	37,705	270,979
Rafah	26,864	132,506	6,308	34,558	173,372
Total	219,220	1,154,340	38,747	223,456	1,416,543

Source: [2]

The current operational central dump sites are Jahr El Deek landfill (3 million tons of waste so far), located southeast of Gaza municipality, the Deir El Balah dump site (1.6 million tons of waste), located east of Deir Al Balah municipality and the Al Fukhari landfill (300.000 tons of waste) located east of Rafah municipality [7]. These sites are currently exceeding their maximum capacity, while the Johr El Deek and Deir El Balah dumpsites face difficulties with the Israeli border military due to their location within the buffer zone next to Israel. Due to the limited access to the three overloaded central dump sites a substantial part of the waste is dumped temporarily at transfer sites throughout Gaza without further control or protection, or at new locations, such as Sheikh Ajleen near Gaza City [8].

Primary collection of waste is done through the use of containers located along the streets, most of which have been constructed locally in Gaza. If there is a delay in collection, it is noticed that people tend to burn the waste in containers to make room for more space [9,10]. One of the related problems is that most of the vehicles and equipment used for primary and secondary collection have become old and rickety which leads to high maintenance cost, and reliance on donkey carts for primary waste collection [10,11].

In Gaza a few composting initiatives have been identified. Some are currently in operation others are planned for the near future; until now less than 1% of the total solid waste flow is actually being composted in Gaza [12].

Organic waste constitutes the majority part of solid waste and composting of such quantities will minimize the problem of limited area of landfilling. In the same time, farmers in Gaza import a huge amounts of compost material to improve the soil conditions [13]. The research aims to study the potential of composting the solid waste in Gaza. To study the potential of solid waste compost in Gaza; the author collected data about quantities and qualities of solid waste and agriculture land in the Gaza Strip. Data about quality of compost imported and produced locally in Gaza Strip is collected. Based on the available data, the researcher studied quantities of local market needs and potential of producing compost locally.

Materials amd method

2.Results

Solid waste in the Gaza Strip as everywhere compose from paper, plastic, organic waste, metals, among others. table 2 shows the composition of solid waste in the Gaza Strip based on analyses conducted in 2007, 2010 and 2011.

Table 2: Solid Waste Composition in the Gaza Strip

Component	EQA 2007	MoP 2010	UNDP 2011
Paper	8.0	10.0	8.4
Plastic	8.0	12.0	16.1
Organic Waste	40.0	65.0	65.4*
Metals	3.0	5.0	2.8
Glass	6.0	3.0	2.3
Other Inorganic	5.0	5.0	5.0
Total	100	100	100

*Including diapers (11.4%) [13,14,15]

Organic waste is the most component which reach more than 60 of total domestic solid waste.

Within the Gaza Strip many types of fruits, vegetables and other plants are cultivated. For some vegetables, the farmers use greenhouses, which means that more than one crop can be raised each year. The Ministry of Agriculture

(MoA) compiles yearly statistics for the crops and areas under cultivation in each district in the area. Table 3 summarizes data about the agricultural land use for the main crops

Table 3: Agricultural land areas in the Gaza Strip in Dunums (10 dunums= hectare)

Crop type	North area	Gaza	Middle Area	Khan younis	Rafah	Total
Citrus	11847	11950	5917	955	1400	32070
Olive	1022	9500	5400	7920	3050	26892
Date Palm	0	150	1650	645	190	2635
Almonds	37	150	1000	1665	1650	4502
Guava	330	0	500	3170	500	4500
Grapes	400	2600	934	4	20	3958
Other fruits	621	600	88	158	360	1827
Vegetables in green houses	1029	531	3338	3491	6584	14973
Vegetables	4498	5895	6769	5302	8351.5	30815.5
Strawberries	1611	0	0	24	31	1666
Field Crops (cereals)	4605	4010	5530	28970	9850	52965
Total	26000	35386	31126	52304	31987	176803

Source: [16]

From table 3, it is noticed that field crops (cereals) occupy the greatest area of land, with nearly 53,000 dunums under cultivation. Other major crops are citrus fruits (approx. 32,000 dunums), vegetables (approx. 31,000 dunums), olives (approx. 27,000 dunums) and green houses vegetables (approx. 15,000 dunums). Less than 5,000 dunums are used for cultivation of each of the other crops grown within the Gaza Strip.

In the Gaza Strip, compost is used on agricultural land. Some of this compost is produced locally, while the majority are imported from outside the Gaza Strip. Around 1% of solid waste is composted in Gaza as part of the compost is produced from agriculture waste. Table 4 presents the quality of imported and produced locally compost.

Table 3: Quality of compost used in Gaza

Parameter	Imported Compost			Local production	
Electrical conductivity mS	36.4	29.8	40.4	20.5	27.6
Fungi nurse CFU/g	Nill	Nill	Nill	Nill	Nill
Bacteria F.C CFU/g	Nill	Nill	Nill	Nill	Nill
TKN %	1.5	0.76	1.5	0.9	0.69
Total organic matter %	48.2	15	47.6	16	33
Ash %	51.8	85	52.4	84	66.7
Moisture %	32%	23%	42%	20	17
pH	7.8	6.9	7.5	7.01	6.6
Wild seeds	Nill	Nill	Nill	Nill	Nill
Plastic and impurities %	0.12	0.12	0.2	0.01	0.01
wood%	3.1	0.04	2.1	0.6	1.7
Gravel and sand%	2.9	0.03	3.8	0.01	0.24

Source: [17]

Is it possible to give data on NPK % of the compost?

Result ?

What is your result and contribution?

3.Discussion

3.1 Quantities and types of organic waste

The total population in Gaza is approximately 1.7 million people who generate domestic waste amounting to 600,000 tons per year. With an organic waste percentage of approximately 60 % this corresponds to 360,000 tons of organic waste in the domestic waste. By 2040 the population figures are estimated to grow to 3.2 million [2], which will result in 1.3 million tons of waste and thus approximately 800,000 tons of organic waste. A 50 %

separation percentage of the organic waste (= 30 % of the total waste) is assumed possible for the long term (UNDP, 2011). Based on the estimated domestic waste generation amount calculated for 2040, it will require a compost capacity of 200,000 tons/year in Gaza in the future.

Furthermore based on the Ministry of Agriculture figures, an additional 440,000 tons of organic agricultural waste is produced in Gaza each year. The major part of this (appr. 90 %) is burned at the farms (and partly transported to landfills without being registered). Approximately 10 % is collected by the Ministry and used as fuel or as fodder for animals. Only a small amount (appr. 2 %) is currently being composted in the pilot composting plants [16,18].

3.2 Compost market potential

The potential market for compost application in Gaza is relatively small due to the high population density resulting in a high waste generation and therefore high potential compost production per surface area. About 29 % of the Gaza surface area consists of arable land (crops replanted after each harvest) and another 21 % is cultivated for permanent crops [19,20]. With a total surface area of Gaza of approximately 36,000 ha [21]. This results in a total surface area for the potential compost market of 18,000 ha. The ministry of agriculture has indicated that the total surface area, which is really used as agricultural land is approximately 16,000 ha. On average about 10 tons of compost can be applied on each ha of agricultural land per year. This results in a potential maximum compost application of 160,000 tons of compost per year. This can be filled when a maximum separation and composting percentage of 18 % for both household and agricultural waste is taken into account.

3.3 Market Conditions

In general the best market conditions are in the spring or autumn. Currently approximately 5,000 tons of compost is produced in Gaza [16]. The compost is sold to some international financiers, who further distribute the waste to farmers. the compost is often given to the farmers for free. Attempts to have farmers directly pay for the compost have failed so far, due to questions about the compost quality and the poor economic circumstances under which the farmers operate.

In Gaza, the compost is sold for 10NIS/20 kg bag (about 3 USD/20kg bag) which corresponds to 500 NIS/ton, while in the West Bank, about 50 USD/ton is being paid [18,22]. At this moment it is difficult to get people to pay for the compost partly as a result of the poor economic situation. However, compost

in bags is imported from Israel with a current price of 250 USD/ton. The costs for compost production in Gaza are calculated on approximately 68 USD/ton of compost. It should therefore be possible to create a sustainable compost market if good quality compost can be produced in Gaza and if the farmers can be convinced of the quality of the compost produced. An overview of this comparison between costs and profits is given **in table 5**.

Carry out study on nitrogen transfer economics of trading between Gaza, Israel and Egypt.????

Table 5: Costs of compost production compared with the price currently paid for compost

Compost Prices	USD/ton compost
Price paid in Gaza for locally produced compost	150
Price paid in West Bank for locally produced compost	50
Price paid for Israeli produced compost	250
Costs for compost production	68

The low willingness to pay may also be influenced by a low level of acceptance of compost made from “waste” in Gaza. In general farmers are well informed on the benefits of compost application for soil improvement and the positive influence it will have on crop growth [10]. However the compost produced at this moment has a low organic matter and nutrient content. The Ministry of Agriculture has indicated that farmers will accept compost as soil improver and will accept the idea that compost application is better than using artificial fertilizers if they are informed on this topic. This will also require an increase of the quality of the compost. This can **partly** be done by carefully selecting the base material for the compost, increasing the organic matter content. By mixing the compost with manure the organic matter content can be increased further and the compost can be enriched with nitrogen and phosphorus [21]. The marketing potential may be **enhanced** by this because a farmer then only has to use one soil improver for both organic matter and nutrients.

3.4 Total amount of organic material to be composted

The total amount of organic material (separated collected organic fraction of domestic waste and agricultural organic waste) that eventually might be available for composting in Gaza is calculated on a total of 620,000 tons/year, resulting in a compost production of 310,000 tons/year. This production exceeds the potential compost market, calculated for Gaza, with a factor 2. It

would therefore be required to also look at the potential of compost markets in the West Bank and Egypt if these compost quantities would be produced. However the penetration of these compost markets outside Gaza is not considered realistic on short notice under the current political situation. Therefore a separation and composting percentage of 18 % for both household and agricultural waste is taken into account for the composting Strategy for Gaza. Based on the **projected** domestic waste **quantum** calculated for 2040 this results in a total required composting capacity of 240,000 tons/year of the organic fraction of domestic waste and of 80,000 tons/year of agricultural waste. This results in a potential total compost production of 160,000tons/year in Gaza in the future, which could just be absorbed by the compost market potential in Gaza.

4. Conclusions and Recommendations [Write separate conclusion and and recommendation]. But, researchers have done nothing to base their recommendation.

Composting municipal and agriculture waste in the Gaza Strip will produce around 900,000 ton/year and the agriculture demand is only 160,000 ton/year (18%). To be able to make a higher percentage possible it would be required to also look at the potential of compost markets in the West Bank and Egypt in the future.

The quality of the compost is therefore of utmost importance to create market potential for compost application. Separation at source of the organic waste is therefore essential for development of the good compost market.

[Which quality character is most important?]

The main barriers **to** market development for organic “waste”-derived compost in Gaza are the low availability of high quality compost, limited information on compost usage and its benefits and finally lack of incentive to separate waste at source.

[Is the compost production technology appropriate?]

The production of high quality compost can be increased by expanding the current pilot projects and supporting the larger scale initiatives, which are being started up in Gaza at the moment. An important role can be played by NGO's and private companies who are interested in the compost market

[Describe the pilot project, and limitation]

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[What lessons have been learnt from references and how it is used in this manuscript?]