2022

DEVELOPING MARKET ANALYSIS STUDY FOR MUNICIPAL ORGANIC WASTE MANAGEMENT (DECOST)

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Executive Summary

The significant challenges of solid waste management require the adaptation of corresponding proper management practices to achieve sustainability, and to protect public health and the environment. In the West Bank, Palestine and the Hashemite Kingdome of Jordan, about 50-60% of the municipal solid waste is organic waste that can be composted. In addition, there are significant quantities of organic waste from the agricultural sector including livestock. On the other hand, there is substantial demand for fertilizers for various sectors of agriculture in both regions. As a result, composting of organic waste can be of great benefit. It can considerably help in solid waste management by reducing the burden of collection and disposal from municipalities and local authorities, and minimizing the environmental risks associated with solid waste. Furthermore, it can provide abundant amount of compost that can be used as organic fertilizer and soil conditioner. And to achieve the objectives of this project, the primary and secondary data needed for the project were collected. The primary data were collected through field visits and focus groups, while the secondary data were collected through desk review of published reports and personal communication with decision makers in various governmental offices and municipalities.

The collected primary and secondary data were then analyzed to produce the marketing strategy, in which the market segmentation, competition, marketing mix, and the expected demand for compost was analyzed. The collected data were also used to conduct the feasibility study in two cases: a composting facility in a selected location in the West Bank, and a national company that runs 6 composting facilities in the West Bank, both cases was found to be feasible. In conclusion, the raw materials needed as inputs for compost production are available in abundance in all governorates, and the there is a growing demand for compost products. We recommend conducting awareness programs for farmer (to encourage the use of compost) and citizens (to encourage the separation practices). We also recommend establishing a national company with decentralized composting facilities that produce high quality compost.

1 Introduction:

1.1 Background:

Solid waste management is a challenging issue, especially to countries lacking enhanced waste collection and treatment schemes. Developing countries suffer from serious pollution problems caused by the generation of large quantities of waste [1]. Also, there are increased burdens on the municipal budget, due to the high treatment costs [2].

In addition to the technology-based factors, the geo-political, socio-economic, cultural and legal aspects have a significant impact on the solid waste management (SWM). As a result of resource limitations, the growing quantities of municipal solid wastes (MSW) are not accompanied with corresponding and proper management practices. This poses serious public health risks and causes environmental challenges [2].

For Palestine, waste disposal in landfills is the commonly applied method for waste management. Up until 2017, the legislative framework has not forced the application of the waste hierarchy [3], [4]. The pillars of a sustainable SWM system can be acknowledged by three elements: 1. waste separation at the source, 2. actions regarding solid waste reuse and recycling, and 3. the readiness to pay fees for improved SWM services [3]. When the capacity of waste management is enhanced, these three elements could be consequently boosted. Hence, a countrywide understanding of the problem of waste and potentials of its recycling has to be attained.

The study conducted by Al-Khatib et. al., (2010) to characterize the municipal solid waste in the district of Nablus [1] indicated that the organic waste comprises about 65% of MSW, compared to 58% in the Middle East and North Africa Region [5]. The average waste generation in Palestine is about 0.93 kg/capita/day, which is higher than the global average of 0.74 kg/capita/day [5].

The average waste collected in seven Palestinian districts was 98% of all generated waste, with a collection frequency of 5.9 times per week as was reported for year 2007 [6]. Most Palestinian cities and villages dispose of their waste in two central landfills (Zhrat Al-Finjan in the north and Al-Menya in the south) which are currently overwhelmed with more than 2,000 tons of SW each day, and lack gas recovery and leachate treatment facilities. Such poorly operated landfills pose potential contamination risk to shallow groundwater aquifer and fire risk from unvented gas. In addition, they contribute to the spread of unpleasant odor, flies, mosquitoes, bird droppings, rodents and stray dogs [7,8,9]. The rest of the waste is disposed of in random open dumps lacking proper health and safety requirements. Generally, waste management organization and planning are scarce, as a reason for three main elements: (I) poor public awareness on this issue [10], (II) limited resources and financial restrictions, and (III) loose or absent regulations.

For Jordan, the total MSW generation has steadily increased from 1.5 million tons per year in 2000 to about 2.6 million tons per year in 2015, and is expected to reach up to 6.0 million tons by 2039 [11]. Future projections show an annual increase in waste volume by 3-5% [12], and, as the country continues to urbanize, municipal waste generation will continue to grow from the current rate of 0.9 kg/cap/day [13]. In 2015, the average rate of SW generation was estimated at about 0.99 kg/cap/day in the urban areas and 0.87 kg/cap/day in the rural areas, while the MSW collection coverage was estimated at about 90% and 70% for urban and rural areas, respectively [14]. Waste composition varies across the country, but in municipalities it is in general, 51% organic, 15% plastics, and 14% paper [15].

A total of 21-landfill sites is available in Jordan with a total area of 756 hectares [16]. Seven of which are closed landfills. The only landfill in Jordan that meets international best practice is the Al Ghabawi landfill [17]. 85% of the generated MSW is landfilled and 10 percent is recycled, with the remaining percentage being open-dumped [16].

The Waste sector in Jordan is governed by several national authorities and defined primarily by the solid waste management activities undertaken by municipalities and by the MOLA, as well as the MoEnv [15]. Waste separation at the source is not practiced at large scale in Jordan and mixed waste is collected and dumped without any treatment. In their assessment study, Ikhlayel, et. al., (2016) found that waste separation at source, if applied, would potentially increase the recycling rate by up to 25 percent compared with recycling without waste separation at source [16].

As a result of the increase in environmental problems resulting from either burning agricultural waste such as straw or livestock waste in all its forms, or burning agricultural waste for vegetable crops, whether they are protected or open cultivation and others. As well as household waste, which is on a continuous annual increase, and solving the pollution problem resulting from the burial of these wastes, either randomly or in licensed landfills, and in both cases, they cause environmental problems. For these reasons mentioned above, many countries in the world began to convert all these types of waste into manufactured organic fertilizers called (compost) because of its many advantages through which it works to solve many problems of agricultural production of all kinds of fruit trees or field crops or vegetables, whether covered or uncovered, irrigated or rain fed. Also, these organic fertilizers are considered an attractive alternative or a safe option instead of using chemical fertilizers, due to their unavailability, non-availability and high prices locally and globally.

The compost also helps in producing agricultural crops of high quality and specifications required by many countries of the world if the farmer wants to export his products to other countries. Humanity is witnessing an increase in the production of solid waste resulting from daily human activities and through the economic activities carried out by man, which cannot be avoided, as it has become a heavy burden on the bodies that collect it for disposal, such as towns and local and village councils, and this waste increases with the increase of the population and the raising of the standard of life and progress In industrialized countries, there are advanced systems for dealing with solid waste, starting from the methods of collecting it to disposing of it and benefiting from it in various fields through recycling.

1.2 Compost

Compost is a mixture of ingredients used to fertilize and improve the soil. It is commonly prepared by decomposing plant and food waste and recycling organic materials. The resulting mixture is rich in plant nutrients and beneficial organisms, such as worms and fungal mycelium. Compost improves soil fertility in gardens, landscaping, horticulture, urban agriculture, and organic farming. During the composting process, the temperature rises to 70 degrees or more, thus completely eliminating all harmful weeds and parasites. Chemical fertilizers can also be added during the compost to raise the nutritional value of the compost, whose type and quantity can be determined based on the results of the laboratory examination of the soil.

1.3 Justifications for establishing compost manufacturing

Projects related to the manufacture and production of organic fertilizers are considered among the best projects as they serve two important axes, one of which is the economic one. This industry is characterized by its relatively low costs compared to the profits it achieves, as well as the fact that it aims to provide required and essential products that cannot be dispensed with and are not threatened by recession.

As for the second axis, it is to support the environment and achieve its benefit by recycling waste that represents a burden on the environment and converting it into useful and vital materials. It also contributes to reducing the terrible risks that arise from the use of harmful chemical fertilizers.

There are many justifications for the establishment of a large compost production project in the West Bank, with the establishment of compost production sub-stations in each of the West Bank regions, including:

1. Reducing the burden of waste disposal costs on municipalities and local authorities.
2. Reducing environmental pollution rates resulting from burning plant residues and the rise of carbon dioxide - carbon monoxide and other gases, which cause global warming, and thus increase the temperature rise on the surface of the Earth
3. Reducing the rates of using industrial-chemical fertilizers such as urea and others, and that is the trend towards organic crops.
4. Increasing the farmer's income as a result of increasing the productivity of the land and reducing the rates of using mineral and industrial fertilizers, as well as decreasing the rates of using chemical pesticides that are free of chemical pesticides.
5. Increasing the productivity and fertility of the land as a result of the use of organic fertilizers rich in organic, nitrogenous and humic materials.
6. Preserving the environment from pollution resulting from the accumulation of plant, animal and household waste and residues by setting up compost piles or composting stacks for each farmer, where training and education will be given to each farmer to create a special and permanent compost heap Safe and hygienic disposal of waste and its economical utilization.
7. Maintaining the groundwater reserves from pollution.
8. Getting rid of insects and their stages that live on waste.
9. Maintaining a clean, unpolluted environment through the use of household waste, restaurants and hotels, and vegetable market waste in the West Bank and Jordan, in the compositing industry, instead of burying it in landfills, whether these landfills are random or licensed through recycling.
10. Preserving the environment by recycling animal waste in the compost industry instead of leaving it in nature or using it as it is without treating or burning it.
11. Preserving the environment by using plant residues in the compost industry instead of leaving them in nature as they are or burning them, which poses a threat to environmental pollution.
12. Providing organic fertilizers to Palestinian and Jordanian farmers for use in agriculture or soil conditioners, and heading towards organic farming, which will positively affect agricultural products.
13. Preserving the soil by providing organic fertilizers to the Palestinian and Jordanian farmers, which has a positive impact on the soil by not depleting it and reducing its salinity resulting from the continued use of chemical fertilizers.
14. Providing organic fertilizers and soil conditioners to the Palestinian farmer and Jordanian at low prices compared to the prices of chemical fertilizers, which are witnessing a sharp rise in prices at the local and global levels, which will have a positive impact on the soil, agricultural output, water conservation, and the provision of healthy products to the Palestinian and Jordanian consumer.
15. Reducing waste disposal costs by reducing the quantities of waste entering landfills, which reduces waste disposal costs for municipalities, councils and local bodies in transporting it to licensed landfills.
16. Working on the production of organic agricultural products, which opens the way for Palestinian and Jordanian farmers to export their products to foreign countries that require the non-use of chemical fertilizers.

17. Reducing the importation of expensive Israeli organic fertilizers.
18. Employing Palestinian and Jordanian labor by creating job opportunities for the production and marketing of compost.
19. Improving the physical properties of the soil and saving water in agriculture because compost maintains moisture in the soil, which reduces the need for water for irrigation.
20. Reducing costs for Palestinian and Jordanian farmers through the use of compost instead of completely relying on the use of chemical fertilizers, as the effect of using chemical fertilizers is quick in results, but the time effect is short, while the use of compost lasts at least for a whole year or more.
21. Promote a culture of recycling in general.

1.4 Types of organic fertilizers

There are many types of compost:

1. Animal waste is only from the remnants of cows and sheep, as well as from the ways of birds, especially the ways of laying hens, and this is considered the best type of compost at all.
2. Mixed compost (animal + vegetable).
3. Compost is from household waste, and it is called garbage compost, and this type is not good because of its remnants; Plastic, metals, gravel, sand and other metal and glass waste, in addition to the unpleasant odors emitted from them.

1.5 Compost Uses

Compost is used for all agricultural crops, fruits, green spaces, ornamental plants, nurseries of all kinds, greenhouses and covered and uncovered vegetable crops. The amount used depends on the type of soil, type of crop, plant age, irrigation method and type of service (establishment of cultivation or winter service). And recently, some feed materials are added to it and used as fish feed in fish farms

1.6 Objectives of the study

The specific objectives of this market study are:

1. To identify the market size, its structure, and its foreseen growth.
2. To provide useful evaluation of composting status in the study area for better decision-making.
3. To better identify the economic impact that the implementation of the recommended approach could have in the different market sectors.

1.7 Study Area

1.7.1 The West Bank, Palestine

The West Bank is a territory of Palestine bordered by Jordan and the Dead Sea to the east and by the occupied Palestinian land in 1948 to the south, west and north. It is divided into 11 administrative governorates as shown in Figure 1-1.

The topography of the West Bank ranges from 375 m below mean sea level in Jordan valley to more than 1,000 m above mean sea level in the central mountains as shown in Figure 1-2 Also Figure 1-2 shows the road network in the Wes Bank, and its land cover and agricultural land classification.

Figure 1-1 Distribution of governorates in the West Bank

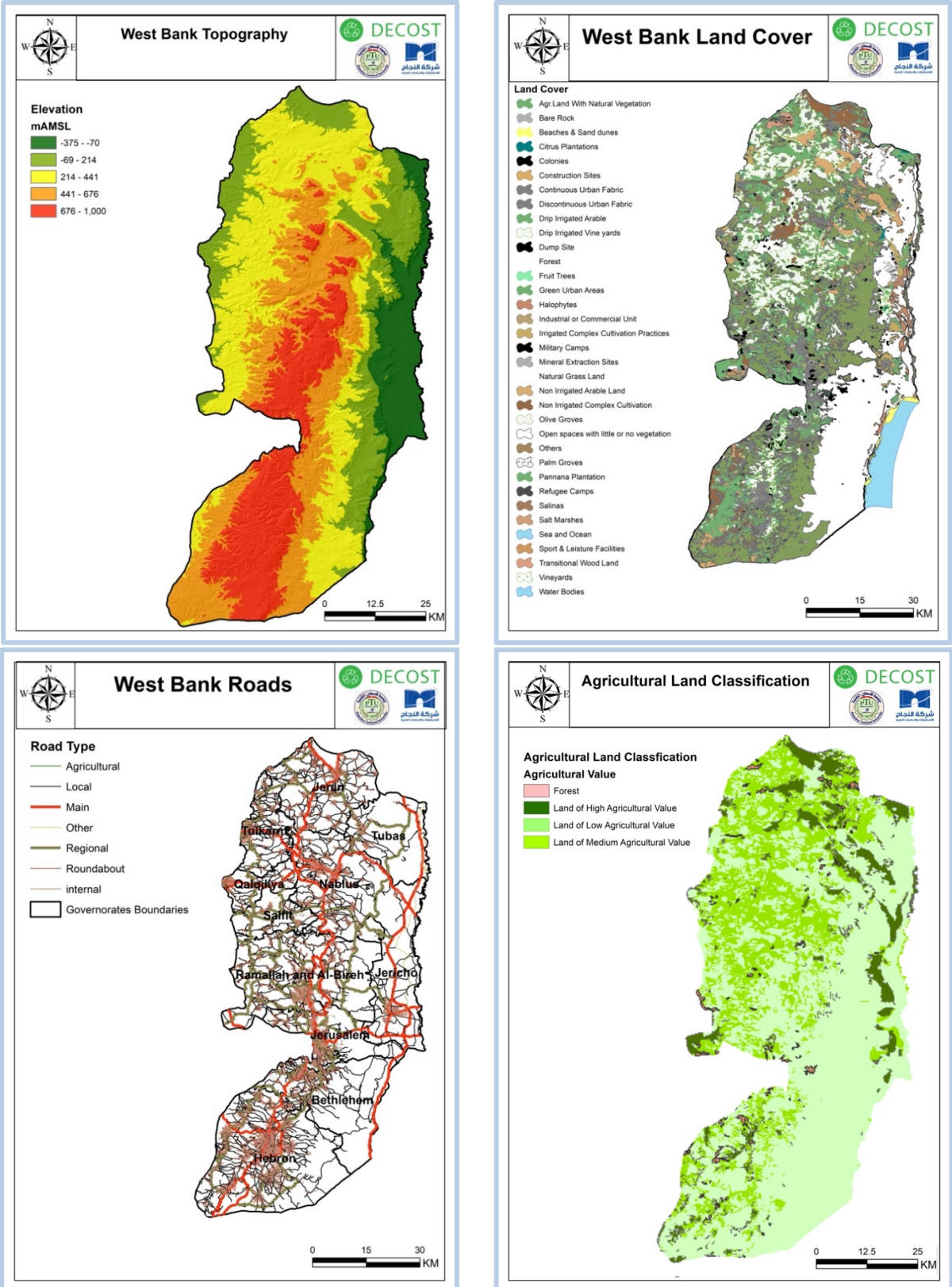

Figure 1-2 Topography, land cover, roads network, and agricultural land classification in the West Bank (source: GEOMOLG 2021)

1.7.2 The Hashemite Kingdom of Jordan

Jordan has about 89.3 thousand km^2 of land area, divided into three major geographic and climatic regions; The Jordan Valley, the Highlands and the Eastern Badia.

The Jordan Valley is the most fertile part of Jordan and extends from the northern borders of the Kingdom to the Dead Sea at altitudes ranging from 220 m below sea level in North and 407 m below sea level at the Dead Sea. Because the Jordan Valley is warmer than the rest of the regions in winter, it has the advantage of early production, especially for vegetables and fruits, compared to the rest of the regions in the Kingdom and neighboring countries. The high lands extend from north to south in the western part of Jordan, separating the Jordan Valley from the eastern Badia region. The altitude of these lands ranges between 600-1500 meters above sea level and receives the highest amount of rain and it has the largest natural vegetation cover in Jordan and hold about 90% of the population. The Eastern Badia covers about 88 of the total area of Jordan, and its land altitude ranges between 600 and 900 meters above sea level. The temperatures in these areas vary greatly between day and night and between summer and winter. Its average annual rainfall does not exceed 100 mm.

Jordan has an arid and semi-arid Mediterranean climate, where rainfall does not exceed about 200 mm per year on 90% of its area. About 5.5 percent of Jordan's area is considered Dry Land with precipitation ranging between 200 mm and 300 mm annually, while 4% of its area (northwestern highlands) receives rainfall amount that exceeds 300 mm annually, and may reach to about 600 mm annually in the northern highlands. These rains are characterized by the varying amounts of precipitation in different regions and their severe fluctuations from year to year in terms of quantity and distribution within one agricultural season.

Jordan is divided into 12 administrative governorates as shown in Figure 1-3

Figure 1-3 Distribution of Governorates in Jordan

1.8 Palestinian Standards for compost

The Palestinian standards institution has issued standard for compost in 2011 (PS-2652-2011) and updated it in 2019 (PS-2652-2019). And according to this start standard there are physical, chemical and biological qualities that should be maintained.

Physical characteristics:

1. Color: brown to black
2. Smells like wet soil with no bad odors
3. The moisture content is 35 to 40%
4. Spongy soft structure with well graded particles most of them less than half an inch in diameter
5. Impurities should be less than 5%
6. The temperature of ready compost should not be higher than room temperature
7. The density of Reddy compost should be 0.7- 0.75 g/cm^3

Chemical characteristics:

1. The pH should be between 5.0-8.5
2. The electrical conductivity (EC) should be between 1-7 dS/m
3. C:N Ratio should be not more than 25:1
4. Heavy metals concentrations should not exceed the recommended values

Biological characteristics:

1. Fecal coliforms should be less than 1000 CFU/gm
2. Salmonella should be less than 3 CFU/gm

1.9 Legal Frame

In Palestine, the Agricultural Law number 2/2003 contains 4 articles (23, 24, 25, and 26) about fertilizers. The law was amended in Law number 14/2018, especially articles 7 and 18. Finally, The Cabinet resolution number 16/2018 was dedicated entirely to fertilizers, including organic fertilizers. In these laws, organic fertilizers (compost) are defined as fertilizers produced organically from animal and/or plant waste, or organic municipal waste. The laws allows the use of compost only if it follows the Palestinian standard (PS-2652-2011 or PS-2652-2019).

1.10 Jordanian Standards for organic fertilizers:

Ministry of Agriculture (MoA) is the ministry responsible in permitting the establishment of manure composting plants. The main requirement for the permit is to have the site away from residential areas with certain distance and the factory land should be covered with an impermeable layer. MoA regulation # Z/6/2016, on the production of treated animal manure and plant compost are as following:

Jordan Treated Manure Standards:

- OM (organic matter) not less than 50% (w/w)
- Ash not more than 50% (w/w)
- Humidity not more than 20%
- C/N ratio is 15: 1
- Salinity not more than 15 dS/m
- N, P2O5 and K2O, not less than 2%, 0.9% and 05% from weight
- As, Cd, Cr, Se, Pb, Hg, Ni not more than 15, 3, 100, 4, 120, 1.5, 50 (ppm)

Table 1-1 Jordan Compost Specifications and Standards

No	Indicator	Value
1	pH	5-8.8
2	Salinity (dS/m)	< 10
3	C:N ratio	30:1
4	Organic Matter Content (w/w)	30-65%
5	Humidity % (based on wet weight)	30-60%
6	Particle size (less than ¾" passes by the screen/dray weight%)	98%
7	Seeds and Seedlings germination %	≥ 80%
8	Inert Materials from dry weight	< 1%
9	Chemical Contaminants As Cd Se Pb Hg Ni	Maximum Limit (ppm) 41 39 100 300 17 420
10	Biological Contaminants Fecal Coliform (max count/1 gm of dray matter) Salmonella (max count/4 gm of dray matter)	Maximum Limit < 1000 < 3

Source: Official Gazette/ Jordan Ministry of Agriculture

2 Methods of Composting

Generally, most agricultural waste and animal manure can be composted. The materials that can be composted can be classified into two sources:

1. Source rich with nitrogen (N) such as green plants and animal manure
2. Sources rich with carbon (C) such as hay and dry plants

The optimum C:N ratio for composting is 30:1 (30 carbon to 1 nitrogen). If the percentage of nitrogen increased it means that ammonia will be released which will result in bad odors. On the other hand, if the nitrogen percentage decreased it will slow the composting process due to less bacteria activity.

The factors that affect the efficiency of the composting process are:

1. The components of the mixture: C:N ratio of 30:1
2. The moisture of the mixture: 55-60%
3. The availability of oxygen: >10%
4. The temperature of the mixture: 20-30 ^{o}C to begin composting
5. The pH of the mixture: 5.5-8.5

Compost can be manufactured in different levels starting from small scale on the balcony to a big plant for large municipalities. In all different scales there are common stages that need to be followed:

1. Preparedness: to fully understand the process and its goals.
2. Choosing a suitable location for composting.
3. Preparing the location for composting.
4. Collecting the components for composting.
5. Preparing the compost mixture by adding the components into 10 to 15 cm layers.
6. Adding moisture to the mixture.
7. Constantly monitoring the mixture in terms of temperature, smell, moisture, animals.
8. Constantly turning the mixture for better ventilation.

Composting can be achieved through one of these methods:

1. Holding units: small containers that can be perforated for ventilation.
2. Rotating units: small containers provided with mechanical means for turning
3. Compost piles: up to 1.5 m in height.
4. Compost strips: adding the components on top of the soil and tilling
5. Compost ditches: digging 30 to 50 cm trenches and adding the compost components into the trench and then covering with soil.

3 Methodology and data collection

To achieve the objectives of this project, the methodology shown in Figure 3-1 was followed. In the first phase, a kick off meeting with the client was held, followed by desk review for all the available material and planning for the data collection.

After that, in the second phase, the primary and secondary data needed for the project were collected. The primary data were collected through field visits and focus groups, while the secondary data were collected through desk review of published reports and personal communication with decision makers in various governmental offices and municipalities.

The collected primary and secondary data were then analyzed in phase 3 to produce the marketing strategy and the feasibility study. And finally, in phase 4 this final report was written.

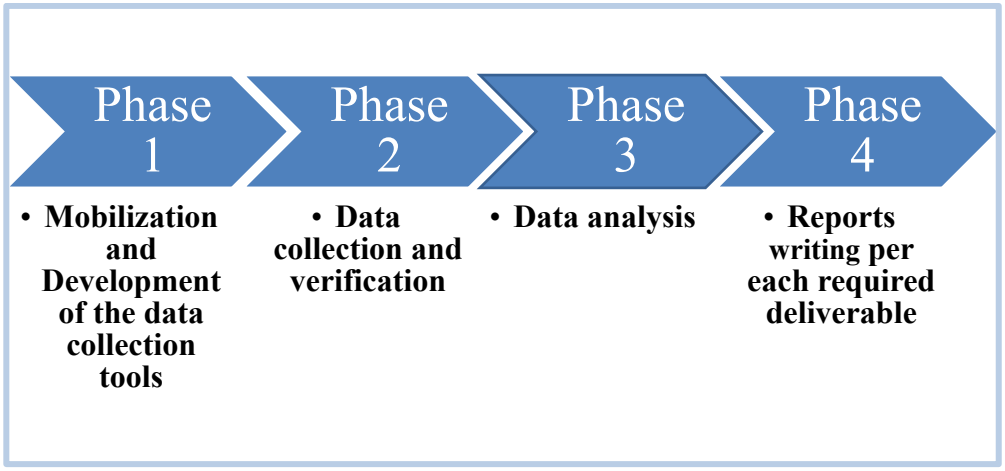

Figure 3-1 Methodology of the project

3.1 Field Visits

3.1.1 West Bank Field Visits

To understand the current status of composting and to meet with stakeholders, six field visits were conducted in different locations in the West Bank as shown in Figure 3-2.

In Danaba (East of Tulkarm), the researchers have visited the agricultural cooperative which was used to produce high quality compost for more than 15 years. Mr. Taleb Abu Hani who was the director of the composting facility and a large-scale farmer was interviewed. He explained the benefits of using compost for vegetable farming, and how most of the farmers in the area are convinced with the importance and benefits of using compost in their fields. He also explained how a farmer can produce his own compost with a minimum effort and low technology (Figure 3-3).

The second field visit was to the town of Burqin (Southwest of Jenin), which is an important agricultural center in the northern part of the West Bank (Figure 3-4). The researchers met with Mr. Ayman Shalamesh (the municipality manager) and Eng. Ahmad Qasrawi (the municipality Engineer). They stated that the municipality is in the process of establishing a composting facility that will produce 2,000 tons of compost annually. The input to the facility will be organic municipal waste, wasted vegetables and fruits from Qabatia central market, manure from local farmers, and agricultural waste.

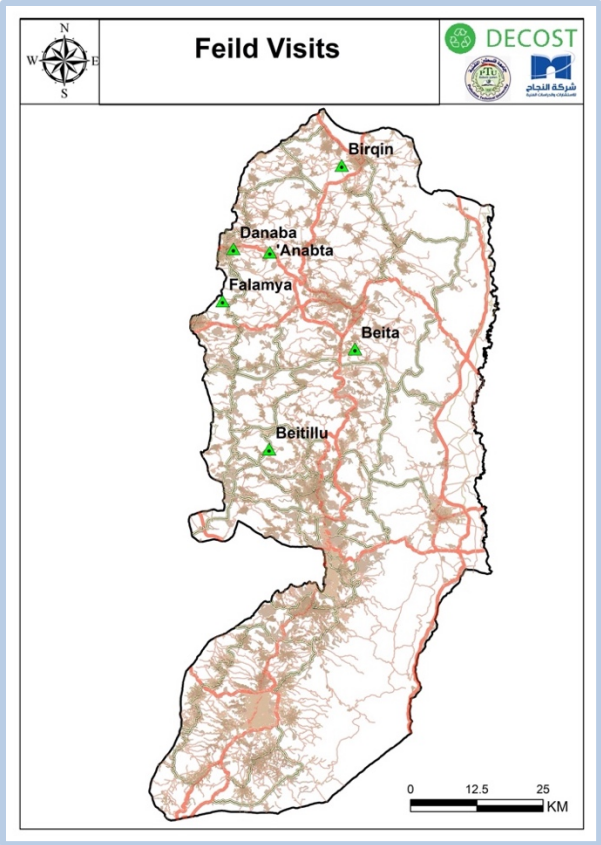

Figure 3-2 Location of the field visits

Figure 3-3 photographs from Danaba field visit (the field visit was on 28/9/2021)

Figure 3-4 photographs from Burqin field visit (the field visit was on 6/10/2021)

The third field visit was to Bietillu, which is a town northwest of Ramallah. The researchers have met with Mr. Nasr Raduwan (the head of the village council) and Eng. Hamza Shinnawi (an Agricultural Engineer). Eng. Hamza is running the composting facility, and he produces high quality compost used by farmers throughout the West Bank, especially Qalqilya. He sells the 25 L bag for 8 ILS ($2.5). Figure 3-5 shows Pictures from the composting facility in Bietillu.

Figure 3-5 photographs from Bietillu field visit (the field visit was on 9/10/2021)

The fourth field visit was to Falamya, which is a town northeast of Qalqilya famous with fruit farming especially avocado, citrus and guava (Figure 3-6). The researchers met with Mr. Bassam Abu-Daher (A fruit farmer). He stated that most of the farmers are using chemical fertilizers or Israeli compost, due to the shortage of good quality Palestinian compost in the market.

Figure 3-6 photographs from Falamya field visit (the field visit was on 15/10/2021)

The fifth field visit was to Bieta fruit and vegetable market (East of Nablus) (Figure 3-7_. The researchers have met with Eng. Fahad Abu Amer (the municipality manager), who explained that they have to process 60 ton/week of waste just from the fruit and vegetable market. They are in the process of establishing their own composting facility to serve Bieta and the neighboring communities.

Figure 3-7 photographs from Beita fruits and vegetables market (the field visit was on 5/10/2021)

The final field visit was to Anabta, a town east of Tulkarm. Where the researchers met with Eng. Murad Abdelhaleem (Anabta Municipality) and Eng. Ruba Hannoun (Decost Project). Also households in which home composters have been provided by the DECOST projects were visited. The researchers noticed that the experiment was more successful in the households with larger families that have agricultural activities around the house (Figure 3-8).

Figure 3-8 photographs from Anabta Field visit (the field visit was on 9/11/2021)

3.1.2 Jordan Field Visits

At present, Jordan has several factories (plants) to produce treated livestock manure using aerobic composting method. All these plants are located in the Al-Mafraq governorate East North of Amman City where the main animal production activities located. The manure treatment plants tend to be close to the animal production areas to reduce the transportation costs of the inputs. Plants are varying in the livestock mixture they are producing based on the availability of the different type of manure near their location. Some factories are using a mixture of cattle, sheep and chicken manure, others using only cattle d manure or cattle and sheep manure. The factories got the fresh manure through contractors. The contractors own Trucks and Backhoe Loader and make the deal with animal productions farms to clean their barns regularly according to Ministry of Environment regulation. Accordingly, the disposal of the fresh manure become the responsibility of the contractor who has to make the deals with the manure treatment plants. The price of the input fresh manure varies based on the season of the year. In summer it is cheaper.

The location of the treated manure factories is close to Mafraq agricultural area in the high lands but it is far away from the Jordan Valley (200-250 Km) where the main agricultural production area in Jordan. Accordingly, the transportation cost of the treated manure to the Jordan Valley is consider high and raise the price.

The following treated manure production plants were visited for market information:

1- Al-Hosainate Organic Fertilizer Plant: Produces 5000 Ton/year over an area of 10 donums. The manure is mixed of Cattle (60%) and Chicken (40%) manure. The conversion percentage is 50% from fresh (untreated) to mature (treated) manure. They own turner machine. Selling prices at factory ground ranges between JOD 26/Ton (36.7$/ton) for loose quantities, JOD 29/Ton (40.1$ / ton) for 100 L package quantities and JOD 50/Ton (70.5$/ton) for 50 L crushed and branded packages. Responsible person Eng. Khalid Abu Kaff.

Figure 3-9 Photographs for Al-Hosainate Organic Fertilizer Plant site visit

2- Al-Barq Organic Fertilizer Factory: Produces 35,000 to 45,000 Ton/year over an area of 100 donums. 75% of the produced quantity is sold The manure is only Cattle (100%) according Swiss IMO standards requirements. Its fertilizers are certified by Swiss IMO, American NOP and Japanese JAS. It is the only factory that has Hot Dryer Machine for advanced treatment. The conversion percentage is 70% from fresh (untreated) to mature (treated) manure. Selling prices at factory ground is JOD 1 (1.41 $) for 30L bag and JOD 1.65 (2.33 $) for 60L bags. Responsible person Eng. Tareq.

Figure 3-10 Al-Barq factory site visit

3- International Fertilizers Technology Corporation: Production capacity is 10,000 to 20,000 Ton/year. Produces 4,000 Ton/year over an area of 11 donums. The manure is Cattle and Sheep. The conversion percentage is 50% (w/w) from fresh (untreated) to mature (treated) manure. Selling prices at factory ground ranges between JOD 40/Ton (65.4 $/Ton) for - oose quantities, JOD 50/Ton (70.5 $/Ton) for 50 Kg bags and JOD 50-60/Ton (70.5 - 84.6 $/Ton) for 25 Kg bags. Responsible person Eng. Mohammad Al-Bess.

Figure 3-11 IFTC factory site visit

4- Fruit Trees and Ornamental Plants Nurseries: The visited nurseries are using the treated manure by mixing it with the clay soil to improve soil characteristics and weight. These Nurseries are considered as marketing windows for the backed treated organic manure to the households' customers who also use this treated organic manure for house gardens trees and ornamentals. The selling price of the treated manure ranges between JOD 1 to 1.25 (1.41 – 1.76 $) for 50 L bags and JOD 1.90 (2.68 $) for 95 L bags.

Figure 3-12 Nurseries site visit

3.2 Focus Groups

3.2.1 Focus Groups – West Bank

In addition to collecting relevant data from various sources, in this project qualitative data obtained from focus groups for farmers and households is utilized. For the West Bank, 4 focus groups were held with participation of farmers (representing various types of farming), households (representing different types of households), and university students (representing potential future consumers of organic products). Figure 3-13 shows the town that the participants come from and the sector they represent. Figure 3-14 shows the distribution of the governorates that the participants came from. Appendix A shows examples of the questions that were asked in the focus groups.

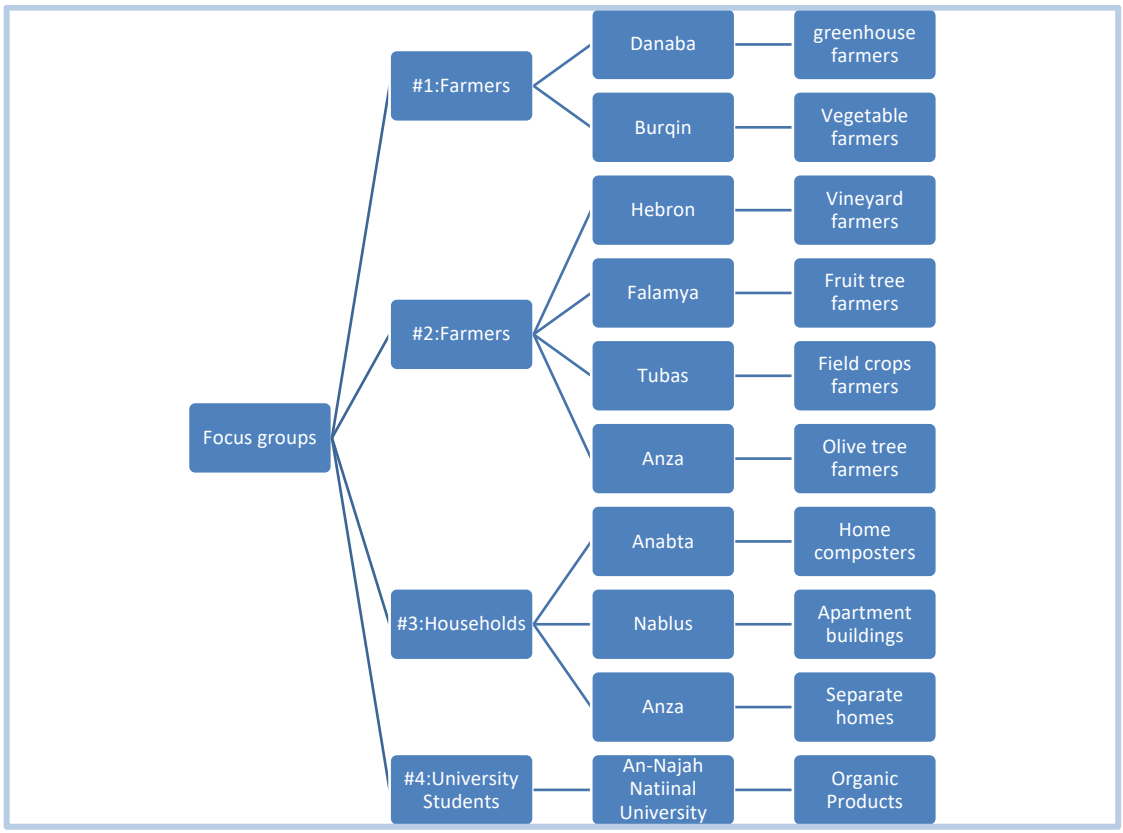

Figure 3-13 Distribution of focus group participants among towns and sectors

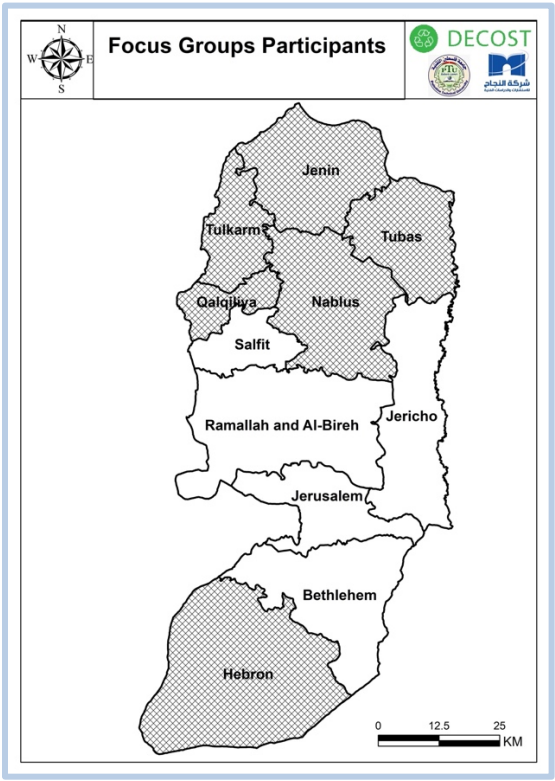

Figure 3-14 Distribution of focus group participants among West Bank governorates

In the two farmer focus groups, a lengthy and in-depth discussion was held about the uses of compost and the extent of their awareness and knowledge of compost, its advantages and the extent to which it relates to the types of agriculture they grow.

The first focus group included farmers from Hebron, Falamya, Tubas, and Anza specialized in various types of farming (vineyards, fruits, field crops, and olive trees). The discussions helped the farmers to correct some misconceptions they had about the composting process. Furthermore, the participants agreed that the main advantages of compost are: its ability to add nutrients to the soil and enhance its characteristics without adding unwanted weeds; its affordable price; and its ease of application.

The meeting concluded by presenting the following recommendations:

1. Improving the quality of the product's packaging by making it dry to facilitate distribution.
2. Periodically testing the chemical composition of compost in labs
3. Customizing compost product to be more compatible with different types of agricultural products.

The second focus group included farmers from Buqin and Danaba specialized in vegetable farming (protected and non-protected). Some farmers stated that there is a difficulty in using compost in rainfed field crops and in areas where rainfall is less than the natural annual rates. Furthermore, the participants agreed that the main advantages of compost are: its ability to enhance the soil structure and its moisture content; not harming the roots because it is already decomposed; it is ecofriendly; it is an alternative to Israeli products; and its ease of application.

The meeting concluded by presenting the following recommendations:

1. Locating the composting facility far from the population.
2. Establishing new facilities to increase its quantities and availability on a larger scale.
3. Periodically testing and controlling the manufacturing process to guarantee a good quality.
4. Produce it in the form of granules to facilitate the use of agricultural machinery in adding it with seedlings or seeds in the furrow.

In the third focus group, housewives from Nablus, Anza, and Anabta representing three household segments (Apartment buildings, separate homes, and households with home composters) participated. The discussions focused on the possibility of sorting household waste at home, and what do they know about organic fertilizers and agriculture in general. At the beginning, the participants were informed about the extent of solid waste problem globally and locally, and the benefits of composting. As for the extent of readiness to work on separating waste at home, all the attendees expressed their willingness to separate, as they unanimously agreed that the separation process is possible. Awareness programs should be done to raise awareness of its importance, especially among young people. They also emphasized the importance of providing separate garbage cans in the neighborhoods, and the necessary composting equipment for people living in separate homes with home gardens who are willing to compost. Figure--- shows selected photographs from the focus groups.

The fourth focus group included 22 students from An-Najah National University in Nablus. They were asked about their previous knowledge about organic products, their perception about its health and environmental benefits, and their willingness to pay more for these products. Less than half of the students knew about organic products. But when they knew about it, the vast majority believed it is healthier and more environmentally friendly. Only 3 out of 22 stated that they would pay more to buy organic products.

Figure 3-15 selected photographs from the focus groups.

3.2.2 Focus Groups – Jordan

Two meetings were conducted with big holdings and small holdings farmers with different cropping pattern in two different areas in Jordan; The first meeting was with farmers from Ghor Al-Safi area (Jordan Valley- South of Dead Sea) where the area is dominated with open field vegetables (tomato, onion, garlic...etc.), plastic houses vegetables (cucumber and beans) and Banana trees. The second meeting was with farmers from Subeihy area (Salt Governorate – close to Middle Jordan Valley agricultural area) where rain fed olive trees, vegetable (protected) farmer and citrus trees farmer attended the meeting.

The first impression comes to the farmers' mind when asking about compost is the livestock manure. Although they have heard about the recycling of organic waste as a compost but their main idea that such compost is produced on a small scale and for house gardens use only, but for farms the livestock manure is more practical to be used due to the big quantities required for their farms.

Most farmers depend on the use of organic fertilizer, mainly untreated livestock manure, and chemical fertilizers. In spite that all farmers are aware that the treated organic fertilizer is better than the untreated organic fertilizer in many aspects, but they tend to use the untreated manure because they believe it is cheaper than the treated ones especially that they need big quantities for their farms, also they can get the untreated manure directly from the livestock farms closer to their places, while the treated manure required that they buy it from factories (plants) located far away from their farms and they need to pay more for transportation. Also, some farmers have incorrect information that the untreated manure contains more nutrients in its liquid portion than the treated manure that lost its nutrients due to treatment.

As a summary, farmers mentioned the strengths and weaknesses by using the treated, untreated manure and chemical fertilizers as shown in Table.

Table 3-1 the strengths and weaknesses by using the treated, untreated manure and chemical fertilizers

Untreated Manure		Treated Manure		Chemical Fertilizers	
Strength	**Weaknesses**	**Strength**	**Weaknesses**	**Strength**	**Weaknesses**
Availability	Weeds	Higher productivity	Higher cost	Quick action	High cost
Cheaper	Burning plants	Environmental friendly; flies and odor	Far distances	Easy to use and store	Unstable prices
Closer	Insects	Not Harmful		Higher nutrients	Soil salinity
	Bad Odor	Easy to use and store			

When explained the importance of compost on the environment and the possibility to produce it in large scale for commercial purposes, farmers accepted the idea of using a large industrial scale of municipal organic wastes compost if:

1. The municipalities participated in collecting the sorted organic wastes
2. The cost of compost is the same as the cost of the treated livestock manure
3. The composting facility (plant) is close to their farms to minimize transportation cost
4. They are ready to cooperate with the plant through collecting their farm wastes, if the plant provides subsidized price for cooperated farmers

The third focus group meeting was held with the household's women; the meeting was very informative because some of the women participated in trainings about the production of small scale composting units. Most of women are aware of high quantities of organic wastes produced in the houses and that this is an environmental friendly solution to deal with such huge quantities. Women in rural areas mentioned that they are practicing the waste sorting in their houses because they use the kitchen wastes to feed their houses' livestock (sheep, goats and chicken) then they use the livestock wastes (manure) as fertilizers and soil amendments for the house trees. They also agree to participate in their municipals initiatives to separate the organic wastes in order to establish a large scale composting facility if that participation will be reflected as services to their towns. The problem was with women living in apartments in cities who complained that the small places in their houses do not enable separating organic from inorganic solid wastes, in addition to the lack of motivation to do so. To convince women living in apartments in big cities to participate in organic wastes sorting initiatives, there was a suggestion for financial compensation that can be paid through reducing the fixed fees collected by municipalities for collecting residential waste (Greater Amman Municipality, fixed JOD 20 (28.2$) per household per year plus JOD 0.005 per KWh (For >200 KWh per month) as fees for collecting and dumping residential wastes, while all other municipalities fixed JOD 24, 15, and 8 (33.85, 21.15, 11.28 $) per household per year depending on municipality class [13]). There was a good suggestion; to involve building guards in this activity through financial incentives if they participate in this initiative, this could be a good entry to organic solid waste separation in big cities. 30% of the interviewed women prefer small scale compost facilities; an individual household composter, while the majority (70%) prefer a large scale composting facilities for commercial purposes under the supervision of the municipalities.

Figure 3-16 Selected Photographs from the different Focus Groups in Jordan

Figure 3-17 Photographs from agricultural fields in Jordan

4 Marketing Strategy

The compost marketing strategy is based on the following:

4.1 Market segmentation

Market segmentation, which results in the classification of compost users into the following:

1. **Vegetable growers** in each governorate, most of which are concentrated in the northern governorates of the West Bank:
   - **a**. Protected and irrigated vegetables.
   - **b**. Open and irrigated vegetables.
   - **c**. Uncovered vegetables.
2. **Field crops cultivation** farmers by governorate and type of crop.

3. **Trees:**
   - **a**. Fruit (citrus + guava.... etc.) in addition to grapes, mainly in the Hebron area.
   - **b**. Olives according to the governorate.

Work on modifying the proportions of compost components according to the type of soil and type of crop to work on producing compost with the components and proportions involved in the manufacturing process, such as leafy vegetables, you may need compost components that are high in nitrogen, using vegetable residues.

On the other hand, marketing will make the compost occupies a special place in the mind of the consumer compared to other types, whether local or Israeli, organic or chemical in terms of effectiveness and efficiency, in terms of price and side effects of using chemical fertilizers.

4.2 Competition

There are many direct and indirect competitors in the Palestinian market, and they are:

1. Compost factories in the West Bank: there are about twelve compost factories, some of them are active and others are seasonal, for example in Beitello, Al-Jalama, Jericho, Thanaba, Dura and others.
2. There are projects under construction in Beita and in Burqin.
3. Israeli fertilizer companies.
4. Foreign fertilizers.
5. Foreign compost.
6. Animal manure that is not fermented.

The quantities of chemical and organic fertilizers entered from Israel or imported are shown in Appendix B

4.3 The marketing mix for the proposed compost project:

4.3.1 The product:

1. As mentioned earlier, an examination of the soil to be planted must be done,
2. If the farmer has decided the type of vegetables, crop, vegetables or even the type of trees that he intends to plant, then from the soil examination it becomes clear what should be added to the soil and what is commensurate with the intended type of cultivation. Since the farmer has not decided on the type of cultivation he intends to

cultivate, the examination of the soil helps him in deciding what suites his land and what elements are available in it.

3. What he should cultivate in both cases, the compost plant can make mixtures in certain proportions commensurate with those needs of the soil or with those needed by the plant intended to be planted.
4. The Palestinian product of compost must be in different forms to suit the farmers' uses. Some of them prefer to be in the form of granules to be used through mechanical farming machines, and some of them want it to be soft, crushed and sifted so that there are no impurities in it.
5. It must be dry so that it can be used and spread easily.
6. It should be odorless.
7. It must be packed in different sizes.
8. It must appear on the packaging the ingredients fit inside the package, and if possible, put a picture of the plants on the cover to facilitate identification.
9. All the ingredients and instructions must be written on the cover, these give information on how to use them and the quantity recommended to be used, for a plant, a tree or an area of land.

4.3.2 The price:

1. The pricing method of the compost product can be "cost +" pricing. All costs are calculated for the production and marketing of the compost product, and then the amount of the intended profit is added to achieve the intended goals.
2. The second method of pricing is setting the price on the basis of the perceived value method, which requires marketing efforts in order to place the product and its quality as a mental image in the mind of the farmer (called positioning). It is also possible to imitate competing products either equal or less, if the farmer thinks that our product is comparable to the competing product, but this option is not favored, because the mental image of the farmers is that the Israeli product is of higher quality than the Palestinian product, even if the truth shows otherwise.
3. Other pricing policies can also be used, such as a discount on the quantity purchased.
4. A price discount to farmers who pay cash when purchasing.
5. A discount can also be offered to farmers who are loyal to the use of the project compost, for each year of use, provided that the discount rate should not exceed a certain percentage.
6. It is possible to use low prices at the beginning and then gradually raise prices in order to encourage farmers in the beginning to use the products of the project, and here it must be emphasized that the level of product quality is high.

4.3.3 Place (Distribution)

The following distribution methods can be used:

1. Direct distribution from the compost factory to farmers without the use of intermediaries, especially if the volume of orders is large, whether the factory delivers the orders to the farmers or the farmers submit to the factory to purchase the necessary quantities.
2. Using a long distribution method, i.e., selling to wholesalers, who in turn sell to retailers.
3. Agricultural associations can be used as sales points for compost to sell to members of those associations.
4. Nurseries can be used for distribution when farmers buy their seedlings from these nurseries. As shown in Table 4-1 There are 136 nurseries in the West Bank distributed among:

Table 4-1 Type and number of nurseries in the West Bank

Region	Vegetables	Gardening Trees	Ornamental Plants	Forests Trees
North of West Bank	33	39	3	2
Central West Bank	3	3	0	1
Southern West Bank	3	7	1	1
Total	**39**	**49**	**4**	**4**

Source: PCBS, 2019

4.3.4 Promotion

Various means and programs can be used to promote the compost product, taking into account the target sectors, their educational level and the most efficient means of persuading them.

1. The most convincing way for farmers is to make observations in every area where there are large numbers of farmers and different types of crops.
2. It is also possible to make experiments and observations for each farmer by using compost on part of the cultivated areas of each farmer.
3. Conducting workshops for farmers in each region to familiarize farmers with compost, its benefits and uses.
4. Creating awareness brochures to introduce compost.
5. Using various social media outlets to deliver targeted messages and product reminders.
6. Targeting farmers of all kinds, including olives, gardening trees, and not only promoting vegetable farmers.

4.4 Evaluating each market segment:

The following criteria is used in evaluating each market segment who are or will be using compost in different agricultural types:

1. **Segment size:** The number of farmers or the number and size of agricultural holdings.
2. **Segment growth:** The extent of the growth of each sector, because some sectors may have a fixed size and some are growing, and the growth rate, by showing the statistics over the years, and some of them are regressing.
3. **Segment attractiveness**: The attractiveness is judged through the relevant figures in terms of the volume of the use of compost, users' numbers, the quantity of their use, the frequency of use, their ability to pay (purchasing power), or the extent to which this sector is free of competitors or their concentration in a particular area, these are all indications of the attractiveness of the sector.
4. **Project resources**: Here the needs of each sector are measured along with the extent of the capabilities of the compost project and its ability to produce and market the type or types of compost for this sector or other sectors.
5. **Project objectives:** The Company's objectives are used as a criterion for judging each of the market sectors and the extent to which the project objectives can be achieved by serving any of the sectors that can be served through the production and marketing of compost.

4.4.1 Expected Demand for compost in the West Bank

The sectors expected to be served, and then the size of each sector, the size of its needs, and the type (components) of compost for each type.

A. **Vegetables**

1. Leafy vegetables (parsley, spinach, molokhia, mint... etc.)
2. Non-leafy vegetables (cucumber, tomatoes… etc.)
3. Cauliflower, pepper, zucchini... etc.

B. Field crops:

The areas planted once per year, wheat, barley, beans...etc.

C. Trees:

1. Olives: their number in each governorate and the rate of what each tree needs and when it is added in each season or any month
2. Grapes: the areas planted or the number of trees, the rate of what each tree needs, when to add it, and what is the composition.
3. Citrus: the areas planted or the number of trees and the rate of what each tree needs, when to add it and what is the composition.
4. Guava: the areas planted or the number of trees and the rate of what each tree needs, when to add it and what is the composition.

Table 4-2 shows the annual need for compost for each of the West Bank governorates based on the areas planted with field crops, vegetables and various horticultural trees. Figure 4-1 shows the distribution of agricultural areas and agricultural sectors in West Bank governorates.

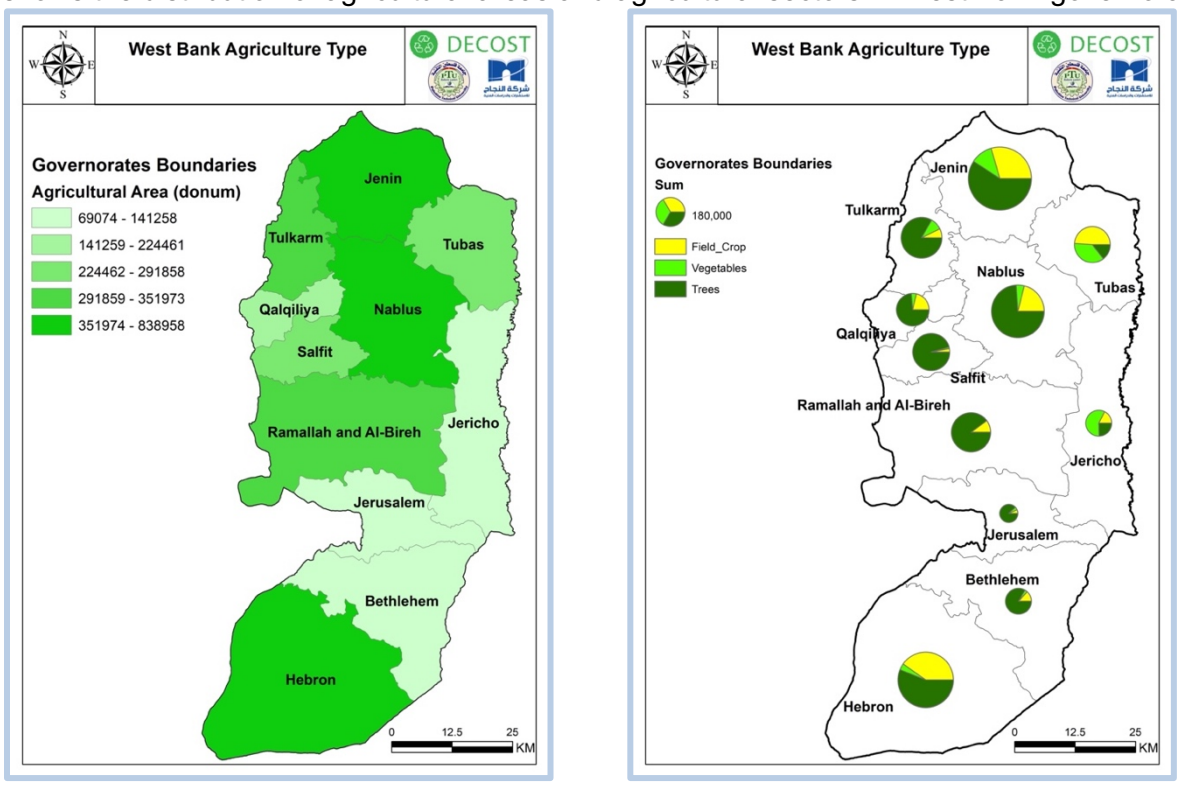

Figure 4-1 Agricultural area and agricultural sectors in West Bank governorates (source: Ministry of Agriculture 2021)

Table 4-2 The annual potential demand of compost for each of the West Bank governorates

Governorate	Areas (donums)			Compost needs (ton/year)			
	Field crops	Vegetables	Trees	Field crops [a]	Vegetables [b]	Trees [c]	Total
Hebron	26,1526	24,751	36,4699	26,1526	24,751	109,410	**395,687**
Bethlehem	18,640	4,565	117,734	18,640	4,565	35,320	**58,525**
Ramallah	32,529	1,897	288,422	32,529	15,897	86,527	**134,953**
Nablus	123,203	29,039	432,566	123,203	29,039	129,770	**282,012**
Salfit	8,375	3,629	279,854	8,375	3,629	83,956	**95,960**
Tulkarm	25,368	33,571	293,034	25,368	33,571	87,910	**146,849**
Qalqiliya	47,968	11,546	164,947	47,968	11,564	49,484	**109,016**
Jenin	247,787	94,374	496,797	247,787	94,374	149,039	**491,200**
Tubas	133,308	99,456	39,400	133,308	99,456	11,820	**244,584**
Jericho	24,545	81,992	34,721	24,545	81,992	10,416	**116,953**
Jerusalem	4,456	3,713	60,905	4,456	3,713	18,259	**26,428**
Total	**92,7700**	**402,533**	**2,538,403**	**927,705**	**402,551**	**771,911**	**2,102,167**

[a] 1 ton of compost per each dunum of field crops
[b] 0.5 tons of compost per each dunum of vegetables twice a year
[c] 15 KG for each tree (average of 20 trees per dunum)
Source of data: Ministry of Agriculture 2021

4.4.2 Expected Supply of Raw Materials

The potential sources of organic matter that can be composted are:

A. **Municipal organic waste:** the average solid waste generation in the West Bank is 0.9 kg per capita per day, with annual growth rate of 4%. The percentage of organic waste is 60%. Tables 4-3 and 4-4 show the population and organic waste projections in the West Bank governorates, while Figure 4-2 shows the trends in the period 2021 to 2026.
B. **Agricultural waste:** this sector includes waste from vegetable farming, trees pruning, poultry manure, and dairy farm manure. Field crops residues were excluded because the Palestinian farmer uses them to feed the animals he owns or sells to farmers to feed farm animals. The remnants of the pruning of grapes in Hebron were calculated, as the area planted with grapes in Hebron is estimated at about 45,000 dunum (pcbs), and that each dunum, on average, includes about 25 trees, and the remnants of the vines on average are estimated at about 15 kilograms. The manure of grazing animals was excluded as well due to its collection difficulty. Table 4-5 summarizes the expected amount of organic waste from all sources in the West Bank governorates.

Table 4-3 Population expectations in the West Bank governorates 2021-2026

Governorate	2021	2022	2023	2024	2025	2026
Hebron	782,227	802,172	822,435	842,969	863,797	884,830
Bethlehem	234,802	239,740	244,704	249,689	254,657	259,616
Ramallah and Albireh	355,202	362,602	370,030	377,465	384,903	392,363
Nablus	415,606	423,572	431,584	439,631	447,695	455,752
Salfit	82,099	84,000	85,920	87,861	89,822	91,794
Tulkarm	198,856	202,401	205,946	209,505	213,049	216,586
Qalqiliya	121,671	124,332	127,025	129,745	132,481	135,233
Jenin	338,919	345,875	352,875	359,934	366,989	374,041
Tubas	65,915	67,340	68,779	70,225	71,682	73,143
Jericho	53,317	54,289	55,268	56,256	57,248	58,243
Total	**2,648,614**	**2,706,323**	**2,764,566**	**2,823,280**	**2,882,323**	**2,941,601**

* Jerusalem was excluded from the calculations because MSW is currently managed by Israelis
Source: PCBS 2019

Table 4-4 Expected organic municipal waste generation (ton/year) in the West Bank governorates 2021-2026

Governorate	2021	2022	2023	2024	2025	2026
Hebron	154,177	164,432	175,331	186,886	199,200	212,359
Bethlehem	46,279	49,143	52,167	55,359	58,719	62,257
Ramallah and Albireh	70,010	74,328	78,884	83,688	88,751	94,090
Nablus	81,916	86,825	92,007	97,471	103,229	109,290
Salfit	16,182	17,219	18,317	19,480	20,711	22,012
Tulkarm	39,195	41,489	43,904	46,449	49,125	51,938
Qalqiliya	23,981	25,486	27,080	28,766	30,547	32,429
Jenin	66,801	70,899	75,227	79,801	84,620	89,696
Tubas	12,992	13,804	14,663	15,570	16,528	17,540
Jericho	10,509	11,128	11,782	12,473	13,200	13,967
Total	**522,042**	**554,753**	**589,361**	**625,942**	**664,630**	**705,578**

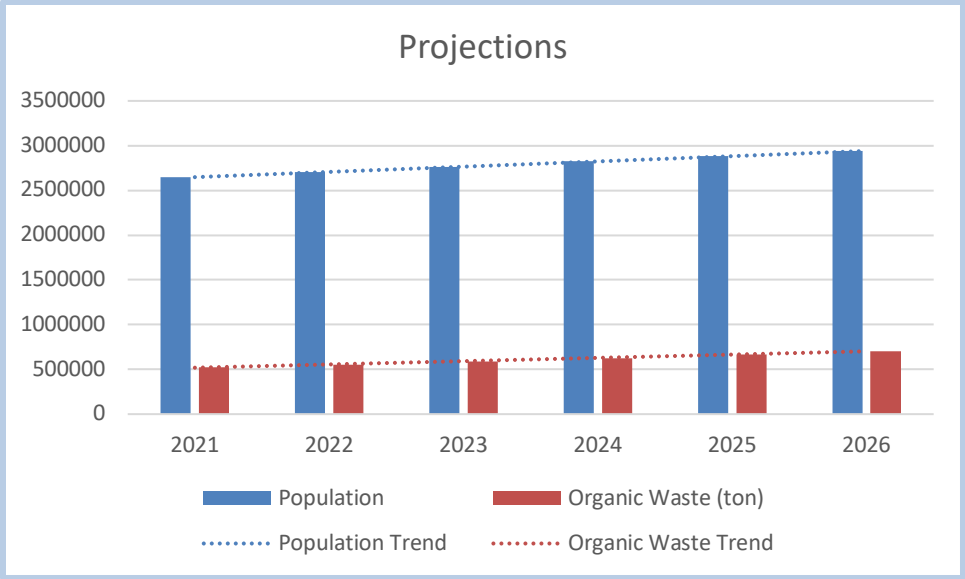

Figure 4-2 Projections of population and organic waste generation in the West Bank 2021-2026

Table 4-5 Organic wastes from different sources in the West Bank governorates

Governorate	Organic Wastes (ton/year)				
	Municipal	Poultry	Vegetables	Trees	Total
Hebron	256,962	18,139	1,931	16,875	**293,907**
Bethlehem	77,133	3,527	1,979	---	**82,639**
Ramallah and Albireh	116,684	16,598	15,897	---	**149,179**
Jerusalem	---	3,996	---	---	**3,996**
Nablus	136,527	3,784	29,039	---	**169,350**
Salfit	26,970	848	3,629	---	**31,447**
Qulqiliya	65,324	6,286	11,546	---	**83,156**
Tulkarim	39,969	4,154	33,571	---	**77,694**
Jenin	111,335	10,803	94,374	---	**216,512**
Tubas	21,654	764	133,308	---	**155,726**
Jericho	17,515	3,771	81,992	---	**103,278**
Total	**870,073**	**72,670**	**407,266**	**16,875**	**1,366,884**

* In addition to the above waste, 178,677 ton/year of dairy farm manure can be added (from 40,794 heads of cows in the West Bank)

Source of data: Ministry of Agriculture 2021

4.4.3 Expected Supply and Demand for Compost in Jordan

Main Indicators in Jordan:

Cultivated Area:

The total cultivated area reached 1,937 thousand donums in 2020 compared to 2,212 thousand donums in 2019 with a decrease of 12.4%. The irrigated area formed 42% ofthe total cultivated area in 2020 as compared to 36% in 2019. The fruit trees area reached 805.6 thousand donums in 2020, while in 2019 the area was 796.6 thousand donums. The increase in the area of the trees was 1.1% for the year 2020 compared to the year 2019. The field crops area reached 786.8 thousand donums in the year 2020 compared to 1082.1 thousand donums in the year 2019 with a 37.5% decrease. It is worth mentioning that the field crops area varies based on the rainy season when farmers expect higher rain, they expand the plantation of field crops while in dry years this area shrinks substantially. The vegetable area reached 344.7 thousand donums in 2020 compared to 334.1 thousand donums in 2019, with an increase of 3%.

Table 4-6 Total cultivated area in Jordan based on crop type in donums (2008-2020)

Year	Field Crops	Vegetables	Fruit Trees	Total
2008	1,076,323	418,703	818,853	2,313,879
2009	1,007,550	411,794	822,563	2,241,907
2010	1,285,568	480,806	827,128	2,593,502
2011	1,129,038	428,623	850,049	2,407,710
2012	1,155,230	449,051	858,647	2,462,928
2013	1,277,997	495,439	835,998	2,609,434
2014	1,385,500	508,687	845,258	2,739,445
2015	1,314,065	487,729	864,171	2,665,965
2016	1,354,860	505,792	867,045	2,727,697
2017	736,732	376,959	780,634	1,894,325
2018	963,049	374,889	787,563	2,125,501
2019	1,082,084	334,130	796,632	2,212,846
2020	786,834	344,696	805,590	1,937,120

Source: Department of statistics/ agricultural statistics publications

Table 4-7 Total irrigated and rain fed areas in Jordan based on crop type in donums (2008-2020)

Year	Irrigated Areas				Rain Fed Areas			
	Field Crops	Veget.	Fruit Trees	Total	Field Crops	Veget.	Fruit Trees	Total
2008	87,242	402,057	439,065	928,364	989,081	16,646	379,787	1,385,514
2009	116,834	388,680	442,681	948,195	890,716	23,114	379,882	1,293,712
2010	128,625	448,851	447,246	1,024,722	1,156,943	31,956	379,882	1,568,781
2011	87,549	407,195	469,751	964,495	1,041,489	21,432	380,298	1,443,219
2012	84,109	400,018	472,412	956,539	1,071,121	49,033	386,235	1,506,389
2013	111,133	472,353	450,946	1,034,432	1,166,863	23,086	385,051	1,575,000
2014	114,405	478,436	457,631	1,050,472	1,271,095	30,251	387,627	1,688,973
2015	96,825	461,433	476,544	1,034,802	1,217,240	26,296	387,627	1,631,163
2016	112,034	474,139	479,418	1,065,591	1,242,826	31,654	387,627	1,662,107
2017	76,842	369,762	417,945	864,549	659,890	7,196	362,689	1,029,775
2018	74,880	344,168	424,618	843,666	888,169	30,721	362,945	1,281,835
2019	68,970	300,657	430,938	800,565	1,013,114	33,473	365,694	1,412,281
2020	60,100	313,734	439,390	813,224	726,734	30,962	366,200	1,123,896

Source: Department of statistics/ agricultural statistics publications 2017-2020

Imported Chemical Fertilizers:

Table 4-8 Imported Chemical Fertilizers by Type During 2001-2019 (1000 Ton)

Year	Nitrogenous	Phosphate	Potash	Other Fertilizers
2001	41.4	0.3	0.9	7.9
2002	37.6	0.9	2	8.7
2003	42.4	0.4	0.7	10.5
2004	35.3	0.4	0.5	11.5
2005	47.8	0.4	0.5	13
2006	32.4	0	0.4	13.2
2007	40.3	0.2	0.2	17
2008	38.4	0	0.3	11.5
2009	38	0.5	0.4	13.8
2010	41.9	0.5	1.1	20.5
2011	33.3	0.2	0	23.8
2012	36.2	0	0.4	28.5
2013	31.6	0	3.9	26.5
2014	48	0	3.8	20.4
2015	54	0	5.3	23.9
2016	71	0.1	4.3	21.4
2017	53	0.5	4	19.7
2018	51	0.3	4.5	17.1
2019	52.7	0	8.4	23.7

Source: Department of statistics/ external Trade Statistics 2019

Animal and Manure Production

Table 4-9 Number of Sheep, Goats and Cattles in Jordan (2009-2019)

Year	Sheep	Goats	Cattle
2009	2,070,940	919,740	64,520
2010	2,175,690	751,730	65,540
2011	2,264,600	752,230	67,600
2012	233,980	791,980	68,510
2013	2,311,149	836,473	69,738
2014	2,680,261	857,729	69,408
2015	2,596,446	860,217	73,600
2016	3,198,925	977,755	74,742
2017	3,063,123	722,666	75,689
2018	3,060,321	742,172	76,406
2019	3,008,837	764,466	77,616

Source: Department of statistics/ agricultural statistics publications 2019

Table 4-10 Number of Sheep, Goats and Cattle by Governorate as in 1/11/2020

Governorate	Cattle	Goats	Sheep
Amman	10,185	87,027	580,173
Balqa	2,433	66,136	141,539
Zarqa	33,056	86,686	314,645
Madaba	2,017	37,720	161,322
Irbid	12,736	54,465	251,032
Mafraq	13,720	67,540	789,526
Jarash	2,138	30,491	20,287
Ajlun	1,314	31,342	15,552
karak	133	84,985	334,610
Tafiela	40	23,429	98,820
Ma'an	116	92,424	235,690
Aqaba	0	100,507	59,089
Total	**77,888**	**762,752**	**3,002,285**

Source: Department of statistics/ Jordan in Figures 2020

Table 4-11 Organic manure production amount (M.T), and Price (JOD) by livestock type in Jordan (M.T), 2019

Livestock type	Goats and Sheep	Cattles	Chicken (Broiler farms)	Chicken (Layer farms)	Chicken (Parent stock farms)	Total/ Average
Production	93,636	63,005	166,851	8,652	8,850	340,994
Total price	888,450	477,220	1,472,090	95,470	92,440	3,025,670
Unit Price	9.5	7.6	8.8	11.0	10.4	8.87

Source: Department of statistics/ agricultural statistics publications 2019

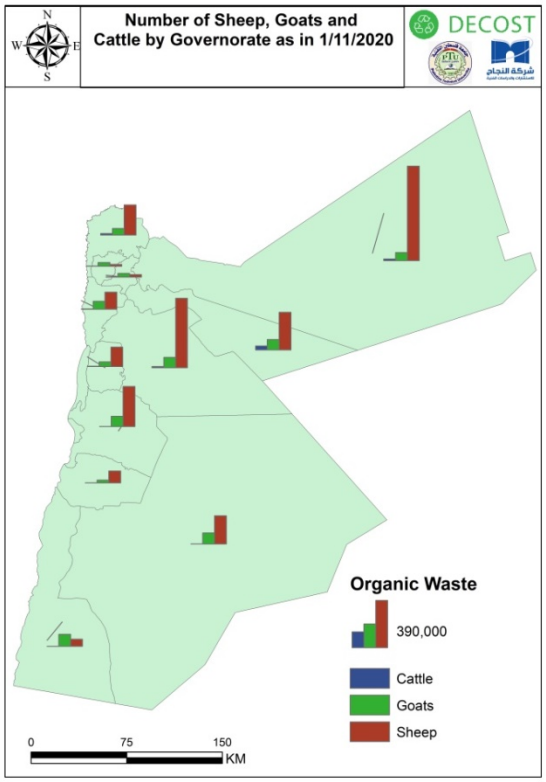

Figure 4-3 Distribution of farm animals in Jordan governorates

Jordanian Markets for Compost

Composting is the term used for the decomposition process that occurs naturally in the environment, in the presence of atmospheric oxygen. The technical process of composting is essentially a controlled and accelerated version of the natural process. Compost is used as a soil amendment and as fertilizer for plants. Its application provides nutrients to the soil, and it contributes to moisture retention, and improves soil structure and texture. Using compost made from recycling, such as organic wastes, is considered environmentally sustainable. Compost can be produced on a small scale, for example, an individual household, or on a large industrial scale for market purposes.

The growing industrialization, increasing urbanization and high population growth rate have led to a rapid increase in solid waste generation in the country which put increasing pressure on waste management infrastructure. Around 2 million tons of municipal waste is generated in Jordan each year with most of it diverted to unsanitary landfills and dumpsites. Improper solid waste disposal is leading to public health risks, adverse environmental impacts as well as socio-economic problems.

The total MSW generation has steadily increased from 1.5 million tons per year in 2000 to about 2.6 million tons per year in 2015 and is expected to reach up to 6.0 million tons by 2039 [11]. Future projections show the waste volume increasing by 3-5% annually [12], and, as the country continues to urbanize, municipal waste generation will continue to grow from the 2012 average rate of 0.9 kg/cap/day [13]. In 2015, the average rate of SW generation was estimated at 0.99 kg/cap/day in the urban areas and 0.87 kg/cap/day in the rural areas, while the MSW collection coverage was estimated at 90% and 70% for urban and rural areas, respectively [14]. Waste composition varies across the country, but in municipalities, it is in general, 50% organic, 16% plastics, and 15% paper [15].

A total of 21-landfill sites are available in Jordan with a total area of 756 hectares [16]. Seven of them are closed landfills. The only landfill in Jordan that meets international best

practices is the Al Ghabawi landfill [17]. 85% of the generated MSW is landfilled and 10 percent is recycled, with the remaining percentage being open-dumped [16].

The Waste sector in Jordan is governed by several national authorities and defined primarily by the solid waste management activities undertaken by municipalities and by the MOLA, as well as the MoEnv [15]. Waste separation at the source is not practiced at a large scale in Jordan and mixed waste is collected and dumped without any treatment. In their assessment study, Ikhlayel, et. al., (2016) found that waste separation at the source, if applied, would potentially increase the recycling rate by up to 25 percent compared with recycling without waste separation at the source [16].

In May 2015 a new National Strategy for MSWM was launched in Jordan to enhance the overall MSWM system including short, mid, and long term planning frameworks and implementation actions, infrastructure and investments, as well as the institutional setting at the national level. The National MSWM Strategy recommends mitigating the informal waste-picking of MSW through integration into the MSWM system including the establishment of partnerships between the public and the private sectors. The strategy motivates the public to participate in safe MSWM practices by increasing public awareness and education in MSWM related issues [14]. According to the national solid waste master strategy issued, average values of the organic solid waste generation according to the urbanization index are as follows:

Table 4-12 average values of the organic solid waste generation according to the urbanization index

Urbanization Index	0-50%	50-75%	75-100%
Food waste (organic)	65	57	50
Governorates	Mafraq, Tafileh	Jarash, Madaba, Balqa, Ma'an, Karak	Amman, Irbid, Ajloun, Zarqa, Aqaba

Population and Organic Waste Generation

Table 4-13 Population forecast per governorate in Jordan (2020-2026)

Governorate	2020	2021	2022	2023	2024	2025	2026
Amman	4,536,500	4,644,239	4,749,861	4,855,483	4,961,105	5,066,727	5,172,349
Balqa	556,600	575,001	588,078	601,155	614,232	627,309	640,386
Zarqa	1,545,100	1,581,253	1,617,215	1,653,176	1,689,138	1,725,100	1,761,062
Madaba	214,100	221,154	226,184	231,213	236,243	241,273	246,302
Irbid	2,003,800	2,045,677	2,092,201	2,138,725	2,185,249	2,231,772	2,278,296
Mafraq	622,500	641,347	655,933	670,519	685,105	699,691	714,277
Jarash	268,300	276,443	282,730	289,017	295,304	301,591	307,878
Ajlun	199,400	199,039	203,565	208,092	212,619	217,145	221,672
Karak	358,400	364,905	373,203	381,502	389,801	398,100	406,399
Tafiela	109,000	110,577	113,092	115,607	118,122	120,636	123,151
Maan	179,300	187,981	192,256	196,531	200,807	205,082	209,357
Aqaba	213,000	221,154	226,184	231,213	236,243	241,273	246,302
Total	**10,806,000**	**11,068,770**	**11,320,502**	**11,572,234**	**11,823,967**	**12,075,699**	**12,327,431**

**Calculated based on the excel forecast from Population Estimate 2016-2020 and population % of each governorate from the department of statistics/ Department of Population and Social Statistics.*

Table 4-14 Expected solid waste generation per governorate in Jordan, 2020-2026 (Ton)

Governorate	2020	2021	2022	2023	2024	2025	2026
Amman	1,911,351	1,956,745	2,001,246	2,045,747	2,090,249	2,134,750	2,179,252
Balqa	203,635	210,367	215,151	219,935	224,720	229,504	234,288
Zarqa	308,409	315,626	322,804	329,982	337,160	344,338	351,516
Madaba	8,989	9,285	9,496	9,707	9,918	10,130	10,341
Irbid	321,553	328,273	335,739	343,204	350,670	358,136	365,602
Mafraq	296,411	305,385	312,330	319,276	326,221	333,166	340,111
Jarash	88,870	91,567	93,650	95,732	97,815	99,897	101,980
Ajlun	108,958	108,760	111,234	113,707	116,181	118,654	121,128
Karak	112,405	114,445	117,048	119,651	122,254	124,856	127,459
Tafiela	776,58	78,782	80,573	82,365	84,157	85,949	87,740
Maan	57,508	60,293	61,664	63,035	64,406	65,777	67,149
Aqaba	20,809	21,605	22,097	22,588	23,079	23,571	24,062
Total	**3,516,556**	**3,601,132**	**3,683,031**	**3,764,930**	**3,846,829**	**3,928,728**	**4,010,627**

*Calculated from the 2019 solid waste generation as the base year and the forecasted population.
Source: Department of statistics/ Jordan in Figures 2020

Table 4-15 Expected Organic Waste generation per Governorate in Jordan, 2020-2026 (Ton)

Governorate	2020	2021	2022	2023	2024	2025	2026
Amman	955,676	978,372	1,000,623	1,022,874	1,045,124	1,067,375	1,089,626
Balqa	116,072	119,909	122,636	125,363	128,090	130,817	133,544
Zarqa	154,205	157,813	161,402	164,991	168,580	172,169	175,758
Madaba	5,124	5,292	5,413	5,533	5,654	5,774	5,894
Irbid	160,776	164,136	167,869	171,602	175,335	179,068	182,801
Mafraq	192,667	198,500	203,015	207,529	212,044	216,558	221,072
Jarash	50,656	52,193	53,380	54,567	55,754	56,941	58,128
Ajlun	54,479	54,380	55,617	56,854	58,090	59,327	60,564
Karak	64,071	65,234	66,717	68,201	69,685	71,168	72,652
Tafiela	50,478	51,208	52,373	53,537	54,702	55,867	57,031
Ma'an	32,780	34,367	35,148	35,930	36,711	37,493	38,275
Aqaba	10,404	10,803	11,048	11,294	11,540	11,785	12,031

*Calculated based on the organic waste generation according to urbanization index

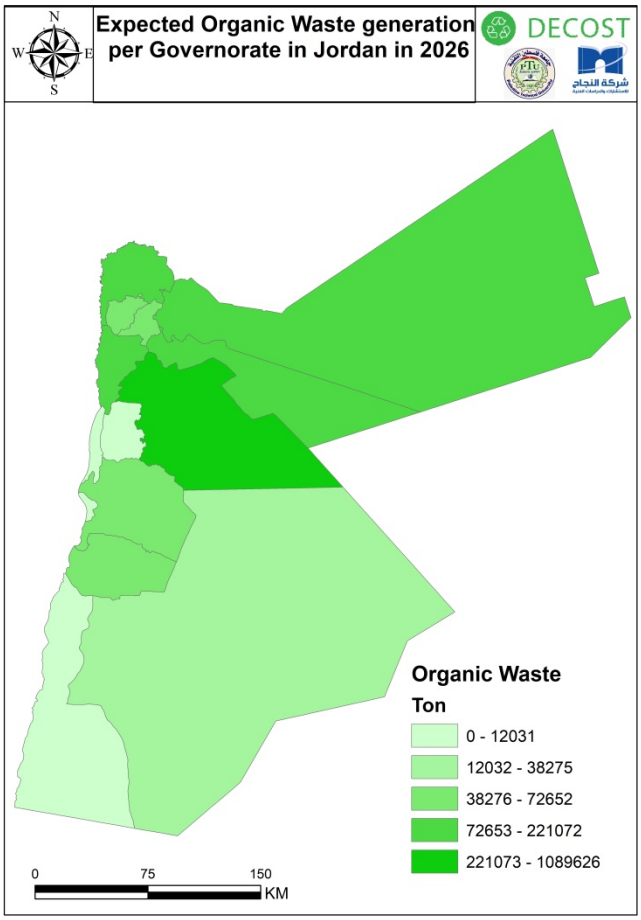

Figure 4-4 Expected organic waste generation per governorate in Jordan in 2026

4.5 Factors affecting compost market

The key factors that affect the compost market dynamics are:

1. The population growth, and as a result the rapid increase in organic waste generation.
2. The growth of livestock and poultry sectors, and as a result the rapid increase in manure amounts.
3. The large amounts of agricultural waste generated every season.
4. The large areas of cultivated lands and the increasing demand of fertilizers.

4.6 Drivers and challenges of the compost market

The main compost market drivers can be summarized as:

1. The recent increase in the chemical fertilizer prices and the competitive price of compost.
2. The benefits of using compost instead of chemical fertilizers, in terms of soil restoration, and water conservation.
3. The environmental benefits of composting.
4. The revenue that could be generated from composting projects.

The main challenges facing compost market can be summarized as:

1. Lack of awareness among farmers and homeowners.

2. The fact that chemical fertilizers give nutrients immediately, and compost takes longer time to benefit the crops.

4.7 Business risks to the compost market

The business risks and threats to the compost market can summarized as:

1. The generated compost product is only about 20% of organic municipal solid waste, and about 50% of animal manure.
2. The cost of collecting organic municipal solid waste is relatively high, and the revenue is relatively low.
3. Organic municipal solid waste, even if separated at the source, could include detergents. This could inhibit the composting process.
4. The competition with chemical fertilizers and animal manure

4.8 Trends in compost market

The emerging trends in the compost market show that there is an increasing demand for compost products. This demand is mainly due to the following reasons:

1. The competitive price of compost compared with chemical fertilizers.
2. The increasing awareness about the environmental benefits of using compost.
3. The large potential market for compost in the study area in terms of tens of millions of trees and large areas planted with vegetables and field crops

4.9 The current status of compost market

In the West Bank, there are initiatives to produce compost mainly by farmers cooperatives supported by non-governmental organizations. For example, Danaba farmers' cooperative used to produce high quality compost for more than 15 years. Farmers from different governorates used to buy their product. Unfortunately, they stopped their production two years ago due to administrative problems. This is the case of the other initiatives, except the case of Beitillu in which a young entrepreneur rented the composting facility that had been stopped and turned it into a private business. He currently sells high quality compost products into different governorates, but he mainly relies on poultry manure as raw material for composting.

The case in Jordan is similar to case of Beitillu. Private facilities that process livestock and poultry manure and distribute the processed product to farmers in different governorates.

5 Feasibility Study

In this section the feasibility study will be presented in two scenarios:

A. a composting facility in a selected location in the West Bank
B. a national company that runs 6 composting facilities in the West Bank

5.1 Feasibility Study of One Composting Facility

In this sub-section the feasibility study of a composting facility that processes 4,000 ton/year of organic waste (municipal+ agricultural+ manure) to produce 2,000 ton/year of compost will be presented. It should be noted that the presented costs may differ depending on the selected location of the composting facility.

Table 5-1 shows the individual cost of the civil works and equipment required by this composting facility, including the engineering, installation and contingencies costs. The estimated total investment cost for this facility is $210,100.

Table 5-1 Capital cost of the proposed compost facility

Civil Works	Units*Unit cost	Cost ($US)
Asphalt pad	2,000 m^2*$25	50,000
Shed (steel structure)	150 m^2*$100	15,000
Fencing, lighting, gate	200 m*$25	5,000
Construction		**70,000**
Contingencies	10%	7,000
Sub-Total Civil Works		**77,000**
Equipment		
Compost Turning Machine	2*$10,000	20,000
Shredder	2*$10,000	20,000
Grinding machine	2*$5,000	10,000
Conveyer	2*$6,000	12,000
Trommel Screen	2*$5,000	10,000
Packaging machine	2*$7,500	15,000
Scale	2*$2,000	4,000
Waste collection truck	1*$30,000	30,000
Equipment		**121,000**
Contingencies	10%	12,100
Sub-Total Equipment		**133,100**
Total Capital Cost		**210,100**

The main operating expenses of a composting plant are labor costs and variable costs, which includes maintenance and depreciation costs, energy, water and other materials consumed during the operation of the plant.

Table 5-2 shows the annual operating costs of the composting facility assuming that it is operating at full capacity, producing 2,000 tons of compost from organic waste. In this scenario, the total operational cost of the plant is $129,280 per year, which is equivalent to $64.64 per ton of compost produced.

Table 5-2 Operational cost of the proposed compost facility

Labor	Units*Unit cost	Cost ($US)
Supervisor (Part Time)	12*$800	9,600
Accountant (Part Time)	12*$200	2,400
Sales person (Full time)	12*$1000	12,000
Marketing person (Part time)	12*$500	6,000
Laborers (Part time)	3*12*300	10,800
Sub-Total labor costs		**40,800**
Variable operational costs		
Maintenance and depreciation of equipment	3%*$133,100	4,000
Electricity	500kwh/m*12*$0.25	1,500
Fresh water	$10m^3$*12*$1.5	180
Fuel (for composting equipment)	12*$400	4,800
Fuel (for waste collection)	12*$1,500	18,000
Cost for inputs (for waste separation)	3*12*$500	18,000
Insurance	1*$1,000	1,000
Land rent	1*$1,000	1,000
Printed bags for compost	100,000*$0.3	30,000
Miscellaneous	1*10,000	10,000
Sub-Total variable operational costs		**88,480**
Total Operational Cost		**129,280**

As for revenue, the 17 kg (25 liter) compost bags will be priced at $2.38 (7.5 ILS). As shown in Table 5-3 This will add up to an annual revenue of **$280,119**, and annual profit **of $150,839**.

Table 5-3 Total Revenue and profit of the proposed compost facility

production (KG/yr)	Total Cost ($US/yr)	Cost per 17 kg bag ($US/bag)	Profit Margin	Price per bag ($US/bag)	Number of bags produced	Total Revenue (US$/yr)	Annual profit (US$/yr)
2,000,000	129,280	1.099	117 %	2.38	117,650	280,119	150,839

5.2 Feasibility Study of a National Company with Six Composting Facilities

In this sub-section the feasibility study of a national company that runs 6 composting facilities will be presented. Each composting facility processes 4,000 ton/year of organic waste (municipal+ agricultural+ manure) to produce 2,000 ton/year of compost.

To select the locations of the facilities, the West Bank is divided into six regions to reduce the cost of transportation of raw materials and end product. Table 5-4 shows the proposed regions and the expected supply of raw materials and expected demand for compost in each region.

Table 5-4 Expected supply and demand in the suggested regions

Region	Expected supply of raw material (ton/year)	Expected Demand for compost (ton/year)
Hebron– Bethlehem	361,546	454,212
Ramallah and Albireh – Jerusalem	153,175	161,381
Nablus – Salfit	200,797	377,972
Qalqilia – Tulkarm	102,058	255,865
Jenin – Tubas	372,238	735,784
Jericho	103,278	116,953

Table 5-5 shows the capital cost of the six composting facilities. The estimated total investment cost is $1,260,600.

Table 5-5 Capital cost of the proposed National company with 6 composting facilities

	Units*Unit cost	Cost ($US)
Capital cost of the composting facilities (see table 6-1)	6*210,100	1,260,600

The operating expenses include the overhead costs of the company, in addition to the operating costs of each composting facility (labor, maintenance, depreciation, energy, water and other materials consumed during the operation of the plant).

Table 6-6 shows the annual operating costs of the national company including the composting facilities. In this scenario, the total operational cost of the company plant is $737,280 per year, which is equivalent to $61.44 per ton of compost produced.

Table 5-6 Operational cost of the proposed National company

Labor – Headquarter	**Units*Unit cost**	**Cost ($US)**
General manager (Full Time)	12*$2000	24,000
Secretary (Full time)	12*$700	8,400
Accountant (Full time)	12*$800	9,600
Sales person (Full time)	12*$1,000	12,000
Marketing person (Full time)	12*$1,000	12,000
Sub-Total		**66,000**
Labor – composting facilities	**Units*Unit cost**	**Cost ($US)**
Supervisor (Part Time)	6*12*$800	57,600
Laborers (Part time)	6*3*12*300	64,800
Sub-Total		**122,400**
Variable operational costs		
Variable operational costs – headquarter	12*$1,500	18,000
Variable operational costs – composting facilities	6*$88,480	530,880
Sub-Total		**548,880**
Total Operational Cost		**737,280**

As for revenue, the 17 kg (25 liter) compost bags will be priced at $2.38 (7.5 ILS). As shown in Table 5-7. This will add up to an annual revenue of **$1,680,000**, and annual profit **of $942,720**.

Table 5-7 Total Revenue and profit of the proposed national company

production (KG/yr)	Total Cost ($US/yr)	Cost per 17 kg bag ($US/bag)	Profit Margin	Price per bag ($US/bag)	Number of bags produced	Total Revenue (US$/yr)	Annual profit (US$/yr)
12,000,000	737,280	1.044	128 %	2.38	705,882	1,680,000	942,720

5.3 Feasibility Study of Home Composting

In this section, the feasibility study of home composting (300L) in a typical Palestinian household will be presented. The assumption here is that these units are suitable for separate homes in rural areas. According to PCBS, 2018, the number of households in rural areas is 140,613 with an average size of 5.1 capita per household.
The annual organic waste generation expected from the household can be calculated as:

5.1 (capita)*0.9 (kg of solid waste /capita/day)*0.6(percentage of organic waste)*0.25 (percentage of organic waste after composting) * 365 (days/year)= 251 kg

The value of the generated compost annually can be estimated as:

251 (kg) / 17(kg/bag) * 2.38 ($/bag) = 35.14 $/year

The cost of the home composting unit is $412 and its estimated life expectancy is 10 years with estimated maintenance cost of $10/year

Total cost over 10 years: 412+10*10= $512
Total revenue over 10 years: 10*35.14= $351.4

These numbers show that it is not financially feasible for the household to install a house composter.

On the other hand, the savings in solid waste management (SWM) cost over 10 years can be estimated as:
5.1 (capita)*0.9 (kg of solid waste /capita/day)*0.6(percentage of organic waste)
* 365 (days/year) *10 (years)* 0.04 (cost of SWM/Kg) = $402

The average household pays $5/month for SWM. It is feasible for the SWM provider to offer households to choose one of the following options:

1. Reduce the SWM fees by 50%
2. Providing 70% of the cost of home composters

The above options are only feasible if the households commit to home composting. This commitment can be increased by raising awareness and periodic supervision.

5.4 Feasibility study of community composting

Community composting is an option in which municipalities collect organic waste from households, restaurants, vegetable markets, and street trees pruning in a centralized composting facility. The produced compost can be used to fertilize public parks and street trees or can be distributed to citizens with reasonable cost. In this section we will present the feasibility study of

home composting in a typical town (in this case Anabta, Palestine). The assumption in case is that all generated organic waste is collected and processed in the community composting facility. The capital cost of the composting facility is equal to the total cost from Table 5-1, which is $210,100. In 2022, the estimated population of Anabta is 8,753 and the expected amount of organic waste from households is 1,725 ton/year. The expected amount of organic waste from restaurants, vegetable markets, and street trees pruning can be estimated as 1,825 ton/year (5 ton/day). The cost of separation and collection of municipal organic waste can be estimated as $53250/year ($15/ton). On the other hand, the cost of collection and landfilling is estimated at $45/ton, which result in savings of $30/ton. Table 5-8 shows the annual operating costs of the composting facility assuming that it is operating at full capacity, processing 3,350 tons of organic waste from households, restaurants, vegetable markets, and street trees pruning. In this scenario, the total operational cost of the plant is $112,630 per year, which is equivalent to $126.97 per ton of compost produced.

Table 5-8 Operational cost of the proposed comunity composting facility

Labor	**Units*Unit cost**	**Cost ($US)**
Supervisor (Part Time)	12*$800	9,600
Laborers (Part time)	3*12*$300	10,800
Sub-Total labor costs		**20,400**
Variable operational costs		
Maintenance and depreciation of equipment	3%*$133,100	4,000
Electricity	500kwh/m*12*$0.25	1,500
Fresh water	$10m^3$*12*$1.5	180
Fuel (for composting equipment)	12*$400	4,800
Cost for inputs (for waste separation and collection)	(1725+1825)*$15	53,250
Insurance	1*$1,000	1,000
Land rent	1*$1,000	1,000
Printed bags for compost	55,000*$0.3	16,500
Miscellaneous	1*10,000	10,000
Sub-Total variable operational costs		**92,230**
Total Operational Cost		**112,630**

The expected amount of compost produced from the municipal organic is only about 0.25 of the input due its high moisture content. As a result, in the case of Anabta the expected compost production is only 887 ton/year. As for revenue, the 17 kg (25 liter) compost bags are valued at $2.38 (7.5 ILS). As shown in Table 5-9 This will add up to annual revenue of **$124,179**. If we take into account the savings resulting composting over landfilling ($30/ton), the expected annual profit will be **$118,049**.

Table 5-9 Total Revenue and profit of the proposed community compost facility

production (KG/yr)	**Total Cost ($US/yr)**	**Cost per 17 kg bag ($US/bag)**	**Price per bag ($US/bag)**	**Number of bags produced**	**Total Revenue (US$/yr)**	**Savings over landfilling (US$/yr)**	**Annual profit (US$/yr)**
887,000	112,630	2.16	2.38	52,176	124,179	106,500	118,049

5.5 Conclusions and Recommendations

5.6 Conclusion

The raw materials needed as inputs for compost production, namely municipal, agricultural and livestock waste are available in abundance in all governorates. The compost production project may incur the costs of transporting it from its sources (agricultural holdings) to the site of the compost production project, which are clarified in the tables in this study. The municipal organic waste separation and transportation cost can be incurred by municipalities and local authorities (which are lower than the costs of landfilling and/or incineration).

With regard to the outputs of the compost production project, the statistics show (according to the tables attached to this study) the areas planted with various types of agriculture in each governorate, whether the areas in dunums and the number of times they are planted annually or the number and types of trees, as was shown the need in each governorate for the required quantities of compost annually both according to the type of cultivation and according to the type and age of trees.

Home composting in rural areas could be feasible to homeowners only if the municipality co-fund the home composter or if the municipal solid waste management fees were reduced by 50%. Community composting could also be profitable for municipalities if most of the organic waste from households, restaurants, vegetable markets, and street trees pruning is collected and process in a centralized composting facility.

This industry is promising in light of the steady rise in the prices of chemical fertilizers and raising awareness of the harms of continuing to use it among farmers and consumers to obtain organic agricultural products alike.

5.7 Recommendations

1. Awareness programs should be conducted for farmers and observations should be made to convince farmers of the benefits of using compost.
2. Awareness programs should be conducted for citizens to encourage separation practices in household level.
3. It is recommended to establish compost production stations in a decentralized manner (a joint station for every two neighboring governorates) in order to reduce transportation costs for both raw materials and transportation costs for the manufactured material.
4. It is recommended to establish a central company that supervises the various compost production plants in different governorates in order to manage the entire process.
5. It is recommended to produce compost with high quality standards and to preserve the mental image of it among farmers.
6. It is recommended to conduct experiments and observations with farmers with large holdings, as most smallholder farmers follow the example of large holding farmers.
7. Do not use low prices because farmers associate the price with the quality level in their minds.
8. It is recommended to increase awareness about organic farming as a crucial market for compost and to produce healthier and environmentally friendly farming froducts.
9. In rural areas, we recommend the MSW service providers to co-fund the home composters or reduce the MSW fees by 50% for households that commit to home composting.
10. For communities in which home composting is not practical, community composting could be a profitable option.

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Appendix A: Focus Groups Questions

- Today's topic is organic fertilizer or compost
- What are your feelings about compost?
- What do you really know about this product?
- What do you want to know about compost?
- How did you hear about compost the first time?
- What are the words or phrases that comes to your mind when you think about compost?
- How do you rate your knowledge about this product?
- When and how do you use this product?
- What trademark do you connect with this product?
- What are the trends that you see happening in this industry?
- When searching about this product what company or trademark that comes first to your mind?
- Who do you think the biggest competitor to our products and why?
- In what aspects we succeed where the others fail and vice versa?
- What are the changes do you recommend we do on our products to give us competitive edge?
- What are the specific problems you faced when using this product?
- How important are these problems and the pain you have with this product?
- What is the reason for this problem?
- How do you expect the manufacturer to deal with this problem?
- What excuse do you give to our sales representative if you don't want to buy the products and he was pressuring you to buy it?
- What's the thing holding you from using our products?
- What's the thing that will make you more likely to buy and use this product even if you are already a user?
- What are the features and information that our marketing does not cover and you want to know more about?
- What are the main shortcomings in our product?
- What are the main positive aspects of this product?
- What are the positive experiences or outcomes you got from using this product?
- What will affect you or motivate you to choose this product and not the competitive?
- What is the favorite aspect you have from our products and why?
- What are the values and basic believes that you believe in and leads you to buy this project product and not the competitor?
- if you can choose One feature to this product to get rid of, what would it be and why?
- if you can choose one feature of this product to improve, what would it be and why?
- if you can add another feature to our product, what would it be and why?
- what are the features you think it's better in our product compared to the competitor?
- What are the features that make this product more beneficial in your daily life?
- What are the factors that affect you to buy this product?
- how your opinion has changed about this product in the past three years?
- how did your use of the product change in the last three years?
- what are your expectations to buy a product like this?
- do you expect to buy this product again or use it more in the next year and why and why not?
- Is there a different product you think will replace this product? if the answer is yes what next?
- how much are you willing to pay for this product per liter per kilo per cubic meter and why?

- you said that it's possible to choose/not to choose our product over the competitors, why?
- how would you explain the reason for decrees/increase of your usage of this product the past three years?
- please tell us why you have these limited expectations when you buy this product?
- you mentioned a competitor product (Israeli) what about a competitor product from Palestine or a different country?
- Among all the competitor companies mentioned which company would you use if you have to choose a product from a different company? And why?
- will deferred payment be significant for you or will it affect your decision making from where would you buy?
- do you know about tea of compost?
- What are you planning to use it and why?
- Do you know how much wastes are produced at your house daily?
- Are you aware of the environmental impact of producing huge amount of wastes in the neighborhoods of the dumping sites?
- Do you know that your house organic solid wastes could be recycled and used as fertilizers or soil conditioners for agriculture?
- Do you use organic fertilizers or compost in your house for your ornamentals or garden trees?
- Do you think that the organic fertilizers (compost) is cheaper or more expensive than inorganic fertilizers? Which is more convenient to be used by farmers?
- What Characteristics you prefer in the organic fertilizers; color, smell, texture, water content? Would you rank them based in your preference?
- Do you hear about organic products (vegetables and fruits)? Which ones you prefer for your consumption?
- In your house garbage, do you separate the organic wastes from other wastes like cans and papers or not? Why?
- If you are given different containers and asked to separate the food wastes from other waste would you be willing to do so? Why?
- Do you think that the wastes separation inside the house is a feasible practice or people will find it useless or impractical? Why?
- Would you participate in a campaign to raise the awareness on the importance of using organic fertilizers in agriculture? Why?
- Would you participate in a campaign to raise the awareness on the importance of recycling the municipal solid wastes to fertilizers? Why?
- Are you familiar with organic products?
- Do you believe that organic products are healthier?
- Do you believe that organic products are better for the environment?
- Are you willing to pay more for organic products?

Appendix B: Quantities of Chemical Fertilizers Used in the West Bank in 2019

Table B-1 Imported Fertilizers from Israel in 2019 (Source: Ministry of Agriculture)

Name of Fertilizer	Quantity (m3)	Quantity (Ton)
Abetek	1.000	
Ammonia NH3		1000.000
Ammonium Sulfate 21%		1300.000
Coco Peat Blocks		30.000
D.C.P. 11-22-0		500.000
Gatit 11-6-22		6.600
Gatit 13-13-13		6.600
Ilit 5-3-8 +3% ME	1.864	
Ilit 6-6-6 +3% ME	1.864	
Ilit 7-3-7 +3% ME	7.184	
Koratin ME	10.000	200.000
Koratin Mn	10.000	
lekasen0-60-20		25.000
MicroGat	0.750	
NPK 11-8-20		225.000
NPK 11-8-22		25.000
NPK 13-13-13		85.000
NPK 20-1-0		60.000
NPK 28-1-0	18.000	
NPK 5-3-8		60.000
NPK 6-2-10		60.000
NPK 6-2-8		60.000
NPK 6-3-9		60.000
NPK 7-0-7		60.000
Peak 0-32-52		25.000
Peak 0-54-32		50.000
Peatmoss	1.000	
Phosphoric Acid	16.750	500.000
Potassium sulfate		200.000
Shafir 5-3-8 +3% ME	27.504	
Shafir 6-6-6 +3% ME	8.640	60.000
Shafir 7-3-7 +3% ME	84.912	
Super Phosphate (SSP)		1300.000
Super Phosphate (TSP)		1300.000
TUV 28-0-2	6.912	
Artificial soil	1064.200	255.000
Compost		1500.000
Sum	**2259.580**	**8953.200**

Table B-2 Imported Fertilizers (from sources other than Israel) in 2019 (Source: Ministry of Agriculture)

Name of Fertilizer	Quantity (m3)	Quantity (Ton)
Agraguard	0.408	
Agraroot	0.408	
Cuore	4.000	
DKP 0-33-42	7.020	
Fertiplus 4-3-3		42.000
Garbi	0.250	
Humic Acid 15 %	40.740	
Iper Flash Ca	11.712	
NPK 11-8-20 + TE		35.000
NPK 13-13-13		85.000
NPK 13-13-13 + TE		30.000
NPK 8-15-35 + 2.5 MgO		28.000
Talosint HortiPlus	1.008	
Tri Super Phosphate TSP		500.820
VIT-ORG	35.280	
Sum	**100.826**	**720.820**

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