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TITLE:

Quality of organic domestic waste (compost) available in the Palestinian local market and farmers' acceptance of its use: a case study from Hebron district in Palestine

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جودة النفايات المنزلية العضوية (الدبال) المتوفرة في السوق الفلسطينية المحلية ومدى تقبل المزارعين لاستخدامها : حالة دراسية لمحافظة الخليل في فلسطين

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Dedication

This work is cordially dedicated to the souls of my parents who devoted their life to their sons, and I would like to dedicate my thesis to my big family for their love, endless support and encouragement, I would like to Dedicate this work especially to the Immaculate spirit of my mother for her moral support and undying love because without it, I do not think I would have been able to accomplish anything.

I will not forget the great effort of my supervisor Prof. Dr. Issam A. Al-Khatib who has been a great source of inspiration and motivation.

Finally, this thesis is dedicated to all those who believe in the truth, justice, and freedom.

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Special thanks to those who assisted me to collect the data "individuals and institutions". Special thanks to all Palestinian National Agricultural Research Center (NARC) staff for their cooperation and help.

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Many thanks to all of my friends, colleagues and everyone assisted me to achieve this research.

Abstract

This study has been carried out to investigate the quality of organic domestic waste (compost) available in the West Bank local market and farmers' acceptance of its use in Hebron district in Palestine. In Hebron district, there are about 530,632 dunums of agricultural land, planted with crops, vegetables and olive trees. Hebron district was selected for this study because of its large agricultural area which requires large quantities of compost, in addition to the environmental problems in this area related to solid waste which causes air, water and soil pollution.

A questionnaire was used as a tool for data collection from farmers, as 321 questionnaires were analyzed. Compost samples were analyzed in the laboratory of the Palestinian National Agricultural Research Center (NARC), Qabatiya - Jenin. The quality of compost was checked for some of the physical and chemical parameters (pH, EC, C/N, OM, TN, TC, TP and the concentrations of Cl, Ca, Mg, Na).

The surveyed sample distribution was analyzed based on different socio-economic variables. 90% of the surveyed sample was living in urban areas, 54% of respondents live in a house where the number of members in the household is (5-8) members, 82% of respondents were living in independent house, and 67% of respondents have a monthly income in the range of 1501-3000NIS.

Regarding the trends of farmers, 97% believe the need to improve Solid Waste Management (SWM), 51% believe that source separation is needed for improving SWM, 80.7% believe that recycling should be the mean for disposing SW. The highest percentage of respondents (54%) who have higher education, believe that compost is better than chemical fertilizer because it produces healthy food without chemicals compared with other levels of education.

There was also a statistically significant relationship ($p < 0.05$) between the type of household and the believe that compost is better than chemical fertilizer because it contains useful substances. The highest percentage of farmers who live in independent houses (36 %) believed in that. Regarding the type of crop, it is found that the highest percentage (95%) of farmers who believe that compost is better than chemical fertilizers farmers was those who grow vegetables in their farms.

Fourteen compost samples were tested to verify the physical and chemical quality of compost. Out of the 14 tested samples, only two of them exceeded the recommended range of pH which is between 6.9 and 8.3. The content of organic matter in six compost samples was greater than the lowest critical threshold level of 30%. As an indication for maturity, the C/N ratio of 18.6 indicates a maturate compost in all samples. The EC was well beyond the recommended one indicating high concentration of salts that may affect the biological activity. Ten of the tested compost samples contained adequate amounts of TN and all of the tested compost samples contained sufficient amounts of available NO_3-N. The concentration of available PO_4-P was found to be quite low in the all tested compost samples. Only two compost samples contained sufficient amounts of calcium required for plant growth, but concentration of calcium for twelve samples was found to be quite low and below the lower threshold level 0.08% dw. Eight of the tested compost samples contained the typical range concentrations of magnesium, however in six samples have been contain magnesium below the lower threshold level (0.02% dw). The average of the C/ N ratio for the compost samples was calculated to be 9.99%, which is below the recommended limit of 25 stipulated by the EPA. So monitoring of the feedstock and the composting process should be carried out in order to achieve a stable compost with its parameters within the recommended limits.

الملخص

أجريت هذه الدراسة من اجل الكشف والتحقق من جودة سماد النفايات العضوية المحلية المنزلية (الدبال) المتوفرة في السوق المحلي في الضفة الغربية ومدى تقبل المزارعين لاستخدامه في محافظة الخليل.

في محافظة الخليل، هناك حوالي 530632 دونم من الأراضي الزراعية، المزروعة بالمحاصيل والخضار وأشجار الزيتون. تم اختيار محافظة الخليل لهذه الدراسة نظرا لمساحتها الزراعية الكبيرة التي تتطلب كميات كبيرة من السماد، بالإضافة إلى المشاكل البيئية المتعلقة بجمع النفايات والتخلص منها وأثارها السلبية وما تسببه من تلوث الهواء والماء والتربة وتأثيرها على صحة الإنسان وبالتالي التغلب على هذه المشاكل. كما تهدف هذه الدراسة الى تقليل كمية النفايات الواجب طمرها والتخلص منها، وتعزيز إعادة التدوير وحماية الإنسان والبيئة من مخاطر التلوث، والحد من الاستخدام المفرط للأسمدة وإيجاد فرص عمل جديدة.

تم استخدام الاستبانة كأداة لجمع البيانات من المزارعين، كما تم تحليل 321 استبانة. وقد تم اجراء تحليل لعينات السماد في مختبر المركز الوطني الفلسطيني للبحوث الزراعية (NARC)،قباطية - جنين. تم فحص نوعية السماد من خلال المعلمات الفيزيائية والكيميائية (درجة الحموضة، والموصلية الكهربائية، , نسبة النيتروجين الى الكربون، المادة العضوية، النيتروجين الكلي، الفسفور، البوتاسيوم وتركيزات الكلور، الكالسيوم، والمغنيسيوم، الصوديوم).

تم تحليل العينات الموزعة التي شملتها الدراسة على أساس متغيرات اجتماعية واقتصادية مختلفة. 90٪ من العينة التي شملتها الدراسة كانوا يعيشون في المناطق الحضرية، ويعيش 54٪ من المشاركين في منزل حيث عدد الأفراد في المنزل أقل من خمسة، 82٪ من المشاركين كانوا يعيشون في منزل مستقل، و 67٪ من المشاركين لديهم الدخل الشهري في حدود 1501-3000 شيكل.

اظهرت الدراسة ان 97% يرون الحاجة لتطوير نظام ادارة النفايات الصلبة، 51% يرون ان فصل النفايات عند المصدر ضروري لتطوير نظام ادارة النفايات، 80.7% يعتقدون ان اعادة التدوير هو الطريقة الجيدة للتخلص من النفايات الصلبة. تم تحليل البيانات وايجاد العلاقات بين توجهات وممارسات المزارعين والعوامل الديموغرافية. هنالك 54% من العينة ممن يحملون شهادة اعلى من التوجيهي، يؤمنون بان الكمبوست افضل من السماد الكيماوي. هنالك علاقة احصائية بين مستوى التعليم وعدم استخدام الكمبوست للشعور بانه غير ضروري حيث كانت اعلى نسبة 16% عندما مستوى التعليم اعدادي.

كان هناك أيضا وجود علاقة ذات دلالة إحصائية ($P < 0.05$) بين نوع الأسرة والاعتقاد أن الكمبوست هو أفضل من الأسمدة الكيماوية لأنه يحتوي على مواد مفيدة. حيث كانت أعلى نسبة حصلنا عليها من المزارعين الذين يعيشون في منزل مستقل (36٪) يعتقدون ذلك. وفيما يتعلق في نوع من المحاصيل في المزرعة، وجدت أعلى نسبة (95٪) من المزارعين الذين يعتقدون بأن الكمبوست هو أفضل من الأسمدة الكيماوية وأولئك المزارعين هم الذين يزرعون الخضروات في مزارعهم.

تم تجميع مجموعة من عينات الكمبوست التجاري والبعض من الأنواع المتوفرة لدى المزارعين والتي يقومون باستخدامها في حقولهم حيث شملت على 14 عينة من إنتاج فلسطيني وإسرائيلي.

نتيجة الفحوصات اظهرت ان عينتين كانت خارج المدى المقبول لدرجة الحموضة 6.9-8.3، المحتوى من المادة العضوي لجميع العينات تجاوز الحد الادنى (30%) . عشرة من العينات كانت تحوي كميات كافية من النيتروجين، وجميع العينات تحوي كميات كافية من النيتروجين المتوفر على شكلNO_3-N.اظهرت نتائج تحليل

نسبة الكربون الى النيتروجين ان النسبة 18.6 مما يدل ان الكمبوست ناضج كفاية. المحتوى من الفوسفور المتوفر على شكل PO_4-P كان قليلا في جميع العينات. عينتان فقط كانت تحوي كميات كافية من الكالسيوم بينما تركيز الكالسيوم في العينات الاثنتي عشر الاخرى كان قليلا واقل من 0.08% من الوزن الجاف. ثمانية من العينات كانت تحوي كميات كافية من المغنيسيوم (اكثر من 0.02 % من الوزن الجاف) . متوسط نسبة الكربون للنيتروجين كانت 9.99% والذي اقل من النسبة المثالية 25%. تم حساب متوسط نسبة النيتروجين الى الكربون لعينات الكمبوست لتكون 9.99٪، وهو أقل من الحد الموصى بها 25% المنصوص عليها من قبل وكالة حماية البيئة.

يتوجب مراقبة المواد الداخلة في انتاج الكمبوست وكذلك العملية برمتها للتأكد من ان المؤشرات أعلاه تقع ضمن النسب الموصى بها.

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ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie
ANOVA	Analysis of variance
ARIJ	Applied Research Institute Jerusalem
BSI	British Standards Institution
C/N	Carbon / Nitrogen Ratio
CCME	Canadian Council of Ministers of the Environment
CCQC	California Compost Quality Council
CEC	Commission for Environmental Cooperation
CIAS	Center for Integrated Agricultural Systems
DEFRA	Department for Environment, Food and Rural Affairs
DM	Dry Matter
DW	Dry Weight
EC	European Commission
EEC	European Economic Community
EPA	Environmental Protection Agency
EUR	EURO
IGES	Institute for Global Environmental Strategies
LOI	Limiting Oxygen Index
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NDI	Nitrogen Drawdown Index
NARC	National Agricultural Research Center
NGOs	Non-Governmental Organizations
OM	Organic Matter
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCR	Polymerase Chain Reaction
RDF	Resource Description Framework
SPSS	Statistical Package for the Social Sciences
SW	Solid Waste
TKN	Total Kjeldahl nitrogen
TN	Total nitrogen
TOC	Total Organic carbon
US	United States
VOC	Volatile Organic Compounds
VS	Volatile Solids
WD	Working Document
WHC	Water Holding Capacity'

Chapter One

Introduction

1.1 Introduction

Solid waste is a byproduct of human activities that is unavoidable, and a noticeable increase in waste quantity and complexity is continuously observed as a result of improving living standards, urbanization, and economic development (Rathi, 2005; AIT, 2004). A troubling issue of Municipality Waste (MW) in developing countries is rapidly growing, as there is a significant increase in the quantity of Solid Waste (SW) generated as a result of fast increase in the population and change in the people's lifestyle due to accelerated urbanization (AIT, 2004; Sida, 2006).

The rapid growth in population and industrialization has led also to environmental deterioration and pulled down sustainable development in the developing world (Rathi, 2005). Accordingly, developing countries raise the level of concern to improve municipal solid waste management (MSWM) practices in order to protect public and environmental health (AIT, 2004). However, municipalities of the developing countries are incapable of handling the increase in the waste quantities that cause waste accumulation in streets and public areas. So that there is an urgent requirement to build a sustainable SWMS that needs sustainability in social, economical, financial, institutional and environmental aspects (Rathi, 2005).

A threat to sustainability of the world and its urban communities is bad management and handling of domestic solid waste. Moreover, this domestic waste is considered a wealth that can be used and utilized as an economic resource, failure to invest in this resource is considered as a missed opportunity for economic and community development. Failure to investigate local trends, behavior, preferences, and knowledge will lead to unsuccessful innovations in SW management.

To develop MSWM strategies, most industrialized nations adopted Waste Management (WM) hierarchy (incineration and land-filling, recovery of materials, minimization /prevention) (Sakai et al., 1996).
Many factors determine the option that a given country uses, including population density, topography, infrastructure and transportation, environmental considerations and social factors, and economic condition (Sakai et al., 1996).

1.2 Trends in the treatment of MSW

The Landfill Directive, more formally Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, is a European Union directive issued by the European Union to be implemented by its Member States by 16 July 2001 (EC ,2007).

The Directive's overall aim is "to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from the landfilling of waste, during the whole life-cycle of the landfill". This legislation also has important implications for waste handling and waste disposal (EC, 2007).
The Landfill Directive5 has imposed regulations for the sake of reducing the amount of organic waste entering landfills as follows:

• Less than three quarters by 2006
• Less than half by 2009 and
• Less than on third by 1 2016

The objectives of this policy are reducing pollution to environment coming from the biodegradable portion, utilization of the rich fertilizer in agriculture and increasing the service lifetime of the landfill (EC, 2007).

There are different rankings of the countries in following these regulations. In order to enhance the application of this policy The Landfill Directive asks the states that are member to launch implementation strategy on the national level aiming at reducing biodegradable MSW that is disposed to landfill. In 2005 the European Commission reviewed the strategies (national) submitted by Denmark, Germany, France, Greece Italy, Netherland, Luxembourg, Sweden and Portugal, Wales, England, Scotland, Ireland, Gibraltar, Austria, Belgium. The document illustrates different methodologies that give different objectives of composting exist between these different strategies. In the following paragraphs, illustration is given how three of these strategies differ from each other (Paulin and O'Malley, 2008).

Austria for example has imposed regulation requiring separation of the biodegradable portion of the MSW from other wastes. This imposition has raised the biodegradable quantity collected in 1989 from several tones to half million tons in 2001 out of the total biodegradable portion which was 2.7 million tones. This was accompanied by regulations specifying the quality for composts produced from the biodegradable portion, and the quality of the source material to be used in compost production, and the methodology of producing and marketing these composts (EC, 2008). Nowadays Austria has100% fulfilling the required landfill directive objectives.

Denmark is another example that fulfilled the directive objective, however in a different way. In the past, in 2000 all the waste was to be sent for incineration. Nowadays, less than ten percent of the biodegradable portion goes to landfills (EC, 2008).

Italy had chosen a different strategy which delayed its fulfillment of the directive objective. In 2014 Italy achieved the target of 2006. In 2002 about 8.3 million tons of biodegradable SW were shifted from going to landfills by (EC, 2014):

• Collecting biodegradable separately (3.8 million tons),

• Treatment of the biodegradable portion mechanically (5.6 million tons of unseparated SW where the expected organic portion was 3.1 million tons) and

• Incineration (2.7 million tons of SW, biodegradable portion of it was 1.5 million tons) (Pauline and O'Malley, 2008).

1.3 Compost and the handling of MSW

Municipal solid waste is composed from waste from different sources like houses, clinics, commercial establishments and entities, some small scale workshops, and other sources like street garbage. The MSW components differ from locality to another and also among each locality and it also varies from time to time. The common factor between the MSW is that it contains a considerable portion of biological matter as an average, the organic waste (kitchen and garden) form one third to on half of the MSW. This portion of MSW is called bio-waste or putrescible waste. Wastes that come from kitchen are mostly composed from food wastes, and on the average it has the same amount of organic matter coming from kitchen, with some variations between rural and urban areas. Paper and non-synthetic textile are considered part of the biological matter as shown in Fig 1-1.

Waste composition is influenced by factors such as culture, economic development, climate, and energy sources; composition impacts how often waste is collected and how it is disposed (EC, 2007).

In the municipalities' solid waste stream, waste is broadly classified into organic and inorganic. Waste composition is categorized as organic, paper, plastic, glass, metals, and 'other.' These categories can be further refined, however, these six categories are usually sufficient for general solid waste planning purposes. Figure 1.1 describes the different types of waste *(EC, 2007).*

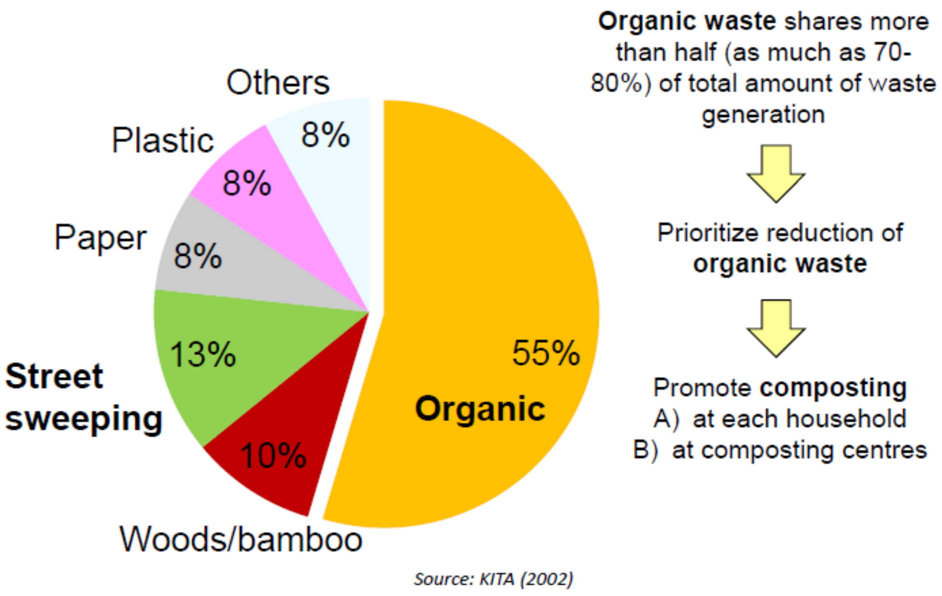

Fig. 1.1: Waste Composition in Surabaya (Maeda, 2013).

It is well known that biological waste is biodegradable under aerobically or anaerobic conditions (with or without oxygen respectively). The only exception of that is lignin (wood material), that degrades only under aerobic conditions and does not degrade under anaerobic conditions. Degradation speed differs from material to material depending on its physical structure and some other factors like pH, moisture, temperature. The other alternative for degrading the biological matter is incineration or burning *(EC, 2007).*

Other alternatives for treating the biological portion of municipal solid waste:

- **Landfill**

In old days all the municipal solid waste was mixed together without any separation and loaded to landfill. Nowadays, a requirement of the landfill directive is to reduce the biological portion of the MSW to less than one third. This is for preservation of environment and for controlling the leachate, landfill gas and also for reducing the settlement of the landfill*(EC, 2007).*

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- **Incineration of MSW**

The incineration of SW will reduce its quantity to be backfilled and change it into an inorganic inert material. In combustion, organic carbon is changed into CO2 and water

by oxidization that is launched to the air in the stack gas. The most common type of incinerators is the large ones, with no separation before combustion. Recent incinerators utilized heat to generate electricity. The energy value of different types of SW vary from one type to another, ranges from null for wet putrescible waste to more than thirty GJ/tone for specific types of plastics (Smith et al., 2001). If the putrescible waste is very wet it will come through the waste streams, so fuel will be added to make sure that there is sufficient high temperature for combusting these wet wastes.
One of the alternatives is processing the SW for producing RDF (refuse derived fuel). Pre-process will make sure that recyclable SW is taken out from the combustible portion, also organic wet matter like garden waste and food are removed for further treatment. The combustible portion will be incinerated directly or combusted, such as cement kilns or power plants that uses coal (Smith et al., 2001).

Most recently new technologies were evolved such as gasification. In these technologies the organic material are broken down into a mixture of liquid or/ and gaseous product which is utilized as secondary fuel. The Directive of Waste Incineration main objective is to alleviate or prevent adverse impacts on the environment because of incineration and co-incineration of waste. Particularly, the Directive should minimize pollution as a result of the emissions that are going to pollute soil, air, ground and surface water and groundwater, and by this decrease risks that are posed to human health. These objectives will be drawn by making sure of good condition for operation, technical requirement, and making sure that threshold limit values for emission are not exceeded (Smith et al., 2001).

- **Mechanical biological treatment**

In this type of treatment, the municipal solid waste will be sorted mechanically into a biodegradable portion and a rejected portion, that is sorted out and metals are extracted for recycling. The remaining residue of the rejected portion is taken away to landfill, and utilized there as cover material or simply will go for incineration (EC, 2007).

The biodegradable portion will be aerobically digested or composted. The residue after composition will have a reduced volume when land-filled, and less tendency of producing leachate and gas in the landfill with a good compactable characteristic. This material is best used for restoration of land, but it will not be suitable for horticulture or agriculture(Smith et al., 2001).

1.4 Goal and Objectives of study:

The main goal of this study is to assess the quality of organic domestic waste compost and farmers' acceptance of its use in Hebron district in Palestine.

The following objectives are to be satisfied in order to achieve the main goal:

1) Assessment of the physical and chemical quality of compost materials available in the West Bank of Palestine.

2) Investigate attitude, cognition and acceptability of farmers in Hebron district towards using the compost as an alternative to the chemical fertilizers

Chapter Two

Literature Review

2.1Compost

Compost is a stable organic material that is decomposed aerobically. Most of it is organic matter and is considered biological active substance, and varies in texture. Compost usually has brownish dark color appearing and smelling earthy. Compost is manufactured through decomposing the originally organic materials through breaking down and transforming the organic substances into different organic material that is called humus. This process is carried out by very tiny aerobic organisms (Pauline, 2008).

The organic matter of waste or wastewater can be characterized by the following approximate chemical composition: $C_{18}H_{19}O_9N$. This average elemental composition was calculated on the basis of formulae for carbohydrates, fats and proteins.

The general aerobic biological transformation of solid waste can be described by means of the following equation:

Bacteria resistant
Organic+ O_2+ nutrients -------> new cells + organic+CO_2+H_2O+ NH_3 + SO_4^{2-}+..+ heat
Matter

If the solid waste organic matter is represented as CaHbOcNd, biosynthesis of new cells and production of sulphate and phosphate is not taken into account and the composition of the resistant organic matter is represented as CwHxOyNz, then the amount of oxygen required (on molar basis) for the aerobic stabilization of the organic fraction of MSW can be estimated by the following equation:

$$CaHbOcNd + 0.5(n \cdot y + 2s + r - c)O_2 \rightarrow nCwHxOyNz + sCO_2 + rH_2O + (d - nz)NH_3$$

where $r = 0.5\cdot[b - n\cdot z - 3\cdot(d - n\cdot z)]$, $s = a - n\cdot w$, n = moles of organic matter in the output/moles of organic matter in the input.

The terms CaHbOcNd and CwHxOyNz represent the empirical elemental composition of the organic material at the beginning and at the end of the process, respectively (Bizukojc and Ledakowicz, 2003).

During aerobic degradation the oxygen present during burial of refuse is consumed with the available organic waste serving as the source of aerobic microbial activity. Oxygen serves two different functions during degradation: a terminal electron acceptor of electrons released during oxidation of organic carbon and a reactant in the attack on substrate molecules (Bizukojc and Ledakowicz, 2003).

Although aerobes initiate the overall degradation process, they play a minor role in refuse decomposition and landfill gas production as a whole. The aerobic or initial adjustment phase normally lasts only a few days, depending on other refuse conditions such as moisture content. After oxygen depletion, roughly 98% of the soluble sugars remain. Landfill gas composition during this phase is nearly 100% carbon dioxide (Bizukojc and Ledakowicz, 2003).

Two important factors of the landfill ecosystem are generated during this phase: heat and moisture. Aerobic decomposition generates heat with a possible temperature rise of 10 to 20 deg C above ambient temperature. Such heat generation is important in providing the temperature range to maintain anaerobic digestion. The addition of moisture is also crucial in providing the proper environmental conditions for the anaerobic bacteria to carry out further degradation of organic material (Bizukojc and Ledakowicz, 2003).

Many of the necessary features of good quality soil are attributed to compost, like capability of holding moisture and plant nutrients that make the soil of very good quality. As it is known, main constituent of compost is organic material, with a suitable ratio of carbon to nitrogen. It is to address that the important factor in manufacturing compost is to control the oxygen, temperature, and moisture level within the optimized levels (Paulin and O’Malley, 2008).

We should learn from nature, how to keep our universe clean and develop in a healthy way. Nature decomposes all unwanted materials and substances like dead animals, tree leaves and dead trees and branches, using its soldier that is composed of millions of very small organisms. These organisms will spend their time decomposing these organic substances into a more soil- healthy compound that retains all nutrients and moisture required for a smooth growth of plants. We should use this technology in getting rid of all unwanted material like organic garbage, our garden residues, and any other organic source in manufacturing compost in order to enrich our soil and increase its productivity and keep our universe clean. All that we need for this clean health universe is small area to produce and manufacture the compost, the unwanted garbage, and some of our time and effort (EPA, 2009).

Composting is defined as a process in which a biological disintegration takes place under aerobic / or anaerobic environment with control on input, output and on the process as a whole (CIAS, 2002). Five parameters are to be controlled which are oxygen, moisture, carbon to nitrogen (C/N) ratio, temperature, and pH. During this action, biological waste is transformed into humic materials that are called compost (CIAS, 2002).

Compost will have many economical advantages (Otten, 2001; Hoornweg et al., 2000), however it may have adverse effect on environment like odors and leach ate, and implications related to financing (Kwon, 2005).

Composting is also defined as sanitization and stabilization of the organic material to produce the solid particulate substance Compost is the output of the operation of decomposition of biodegradable substances under controlled and monitored environment that are mainly aerobic and make it possible to provide suitable temperature for thermophilic organisms as a result of heat which is produced biologically (EC, 2014).

Biodegradable waste change into compost by controlling the bioactivity which is an alternative to landfill and combustion of MSW. Old, MSW is first pre-treated with anaerobic process first and then aerobic curing steps are utilized (Silva et al. 2007). In the process of compost generation, many types of fungi, bacteria and yeasts disintegrate the MSW to stable products that are like soil in appearance and rich in organic matter, in addition to carbon dioxide, microbial biomass, and energy (de Bertoldi et al. 1983).

The composting entities for aerobic treatment of waste constitute of a preliminary procedure, in which removal of contaminants and other inorganic matter takes place using screening. The organic SW will remain in composting tunnels, aerated piles, static piles, or windrows for many days. Periodic aeration of compost material should be carried out, as disintegration of biological waste will take place, and this will be done, either mechanically or by open floor systems that generate forced aeration. Further to this active process two to three months are required as a curing period for the bio-waste to change into mature and to be stabilized as compost, to be utilized in, soil reclamation, agriculture, gardening, landscaping (Silva et al., 2007).

Main objective of composting of MSW is to reduce the load on the landfills and combustion. However, compost is a marketable material, and in case of effective process that generates good quality compost it may have an acceptance and economic return as shown in Fig 1.2 (Lasaridi et al. 2006).

But, compost product is considered a sub-product, and in no way should be considered as the main target, which is diversion of parts of MSW away from landfills. In order to produce compost of very good quality, source-separation of biological waste at origin should be carried out and improved. The provision for composting process should be developed with the aim of improving the quality of the final product (Silva et al., 2007).

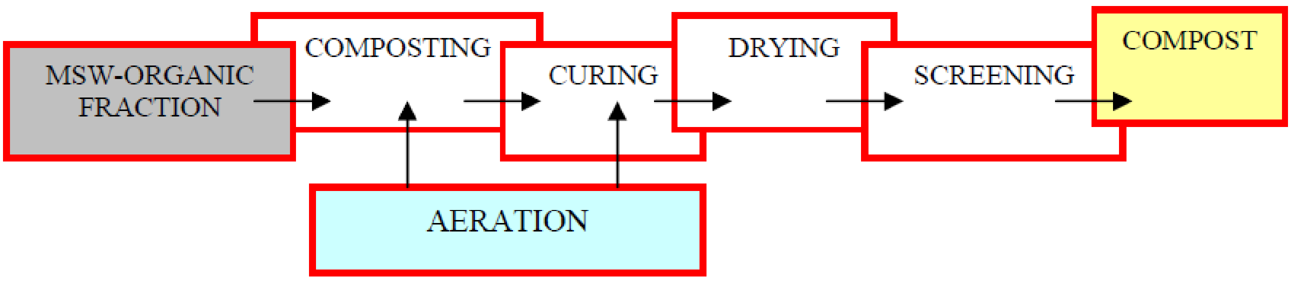

Fig2.1: Steps involved in the aerobic composting process (Jovičić et al, 2006).

Any further microbial decomposition occurs only very slowly. Figure 2.1 provides the overall steps involved in the aerobic composting of the organic fraction of MSW.

Composting requires attention about factors that affect the process, to carbon and nitrogen ratios, moisture content, oxygen availability, maintenance of favorable temperatures. Altogether compost creating time is determined by composition of waste but primarily by type of applied process (Jovičić et al, 2006).

The actual compost process can be established in a number of environments, from simple outdoor piles to sophisticated reaction vessels with controlled temperature, airflow, and humidity (Jovičić et al, 2006).

From agricultural point of view, classification of the compost will be in accordance to time of application (Paulin and O'Malley, 2008).

2.2 Advantages of compost

There is clear advantage of using compost on soil both on quality of the organic material in the soil and on quantity of that organic material. Also it has a good effect in increasing the stability of the carbon levels in soil (Paulin and O'Malley, 2008).

Compost may replace mineral fertilizer, especially for phosphate and potassium. However, for nitrogen, this is not the case as it will not be available to plant quickly, if it originates from compost. To figure out, only less than 2% of the nitrogen contained in the compost is taken annually. Utilizing compost will decrease the quantity of mineral fertilizer, that its production has many environmental implications. Main implications are phosphate extraction and emissions that increase greenhouse gas (energy related emissions and N_2O). If compost was used for long time, reduction of mineral fertilizer will be achieved and thus reduction of nitrate leaching is accomplished. Usually, the run-off of the nutrient into surface water and ground is negligible (EC, 2001).

Other advantage of compost is increasing organic matter in soil by the humus which is generated from compost, and also increase storage capacity of the biomass carbon contained in compost for a long period. This carbon is impounded from the surrounding air, and by this it decrease global warming. More advantages on environment are (EC, 2001):

• Reducing soil erosion

• Controlling plant diseases and reducing the need for using pesticides

• Improving water retention, and thus the need for irrigation is reduced which leads to less flooding

• Using fuel will be less as soil structure is improved leading to lower use of agricultural machinery.

Using compost to replace peat in growing media, will result in less global warming as degradation of peat is faster when exposed to oxygen and release of CO_2 will be more (EC, 2001).

2.3Soil and compost incorporation

The main trick of making good compost is by degrading the carbon in the raw materials of the compost. This can be achieved by grinding the components so they will be exposed more to the microorganisms that execute the decomposing. Turning over the material is the important factor that results in good compost that is best degraded. Design of good turning system is important as much as suitable grinding the materials. This will result in good compost that is close to the soil structure from texture and characteristics. Adding some clay to this compost will enhance more its properties. It is good to bear in mind that woody materials will take more time to degrade than other organic material. So good grinding of woody material is a requirement of good compost as soil quality factors will be affected as shown in Fig 2-2 (Paulin and O'Malley, 2008).

The use of woody components in making the compost requires screening of these woody elements with a 100 opening sieve, by this increasing the exposed area of the material to the bacterial activity. The fear is that some of the un-decomposed material will be in the compost and thus it will be mixed with the soil. Degrading process will continue in the field be degrading these fractions that has not finished degrading. This will be done by bacteria that will need nitrogen. So there will be a competition on the nitrogen between the plants and the bacteria and thus productivity of the field will go down (Paulin and O'Malley, 2008).

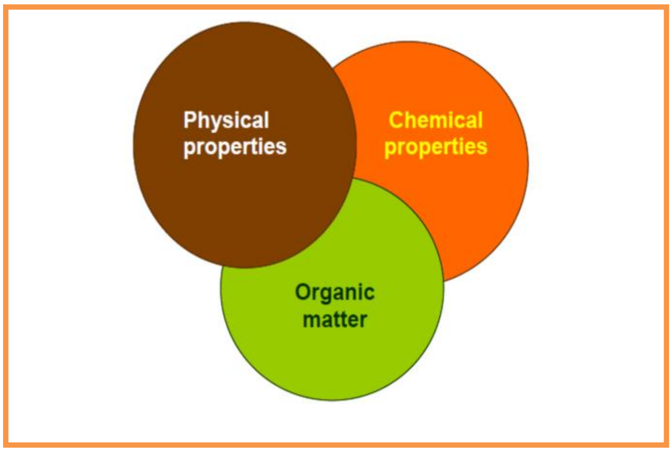

Fig. 2.2: Three aspects of soil quality (Paulin and O'Malley, 2008).

Some of the main aspects in classifying soil are physical properties, chemical properties, and soil organic matter. Soil organic matter is very important as it will affect both physical and chemical properties and it can improve soil and plant production and result in:

- Improved performance of crop and its quality
- Better nutrient and efficiency of irrigation will be improved
- Compaction will be reduced and infiltration will increase.
- leaching of nutrient will decrease and capacity of holding nutrients will increase.
- The need for pesticides will decrease.

Better soil characteristics will be achieved through more active soil from biological point of view. The physical properties like the drainage, less compacted soil, erosion, and moisture holding characteristic will be improved. Fertility will also go up and considered to be improved (Paulin and O'Malley, 2008).

It is too being addressed that the most important component of soil is its organic carbon content. The soil food web which is the different types and large amounts of organisms will work on decomposition of the organic compounds in the soil. These organisms work to complete the circle of organic compounds by returning them back to soil. Different types of organic compounds are generated through this process. These products range from simple sugar that works as power source for the biological actions to more complicated compounds that attribute structure to soil like cellulose. One of the products is the humic matter that contributes in providing the soil with many advantages like stabilization of its carbon content. To achieve that, systematic addition of organic substances should be carried out. So, one of the advantages of compost is be providing soil with humic material which will stabilize carbon levels in soil (Paulin and O’Malley, 2008). Organic matter in compost ranges from 30-70% (US Composting Council, 2003) and it should not be less than 30% (Herity, 2003).

It is to mention that carbon to phosphorus of>300: 1lowers solubility of phosphor but this of course will depend on the decomposition rate. Large amounts of organic material will not allow phosphorus to be mobilized into the organic material through the biological action which will lead to less phosphorus solubility. On the other hand, disintegration of organic substances when carbon to phosphorus is lower than 200:1 will lead to releasing soluble Phosphorus. The on ground release/ retention is affected by the existing conditions, and the soluble phosphorus that is generated from organic substances disintegration is not going to leach from soils in case it is absorbed by the plant or getting tight to soil through adsorption. So, either the phosphorus is released through disintegration or it is absorbed by soil particles (Harrison, 2011).

Soil structure will be improved through increasing the organic fraction of soil, and many other characteristics will be improved like water-holding capacity, infiltration of water, compaction of combats, and aeration of soil. In case of sand, organic material will improve holding capacity of nutrients, combined with increasing nitrogen level that can be utilized in providing nitrogen for the plants. Another privilege of organic material is resisting acidification that is considered a bad side effect of using fertilizers. The accompanying biological activity will decrease pests and diseases (Paulin and O’Malley, 2008).

Nitrogen is an important element for plant growth and development. Mineralization is the release of nitrogen to be used by plants, and is considered one of the decomposition products. Using the compost will help in giving the plants the required dosage of nitrogen, and at the same time in keeping this nitrogen (nitrate) away from polluting ground-water. Fertilizer, if used will aid in increasing the level of nitrogen in groundwater and thus causing pollution. Thus damage of soil will be reduced, groundwater is less polluted by nitrogen and compost will sustain existing soil and water resources (Paulin and O'Malley, 2008).

To conclude, utilizing compost will:

• decrease cost of production and improve performance of crop through:

- Improving yield products, both the quality and storage time
- Reducing the quantity of fertilizer to be used and more effective utilization of pesticides and fertilizers, also soil fumigants
- Irrigation is utilized in a more efficient way
- Crop will have more resistance to diseases and pests.

• Soil quality will be improved by:

- Levels of organic matter will be improved and organic cycles are optimized
- Plants will have more water
- Nutrient availableness and nutrient-holding capacity will be much better
- Improving structure of soil
- Reducing pests and pathogens of soil-borne plant.

This includes determination of all materials containing carbon by laboratory testing of compost. It is known that carbon content decreases during composting, so this is an indirect estimation of organic carbon. The usual procedure for estimating OM is described below (CCQC, 2001).

Organic matter is represented by volatile solids (VS) which is the combustible portion which is lost during ignition as OM or VS. OM can be calculated by a total-carbon analysis which is represented by TOC. Alternatively, carbon can be found from organic matter as it is approximately 54% of volatile solids. The typical OM content is a function of the age of compost, intended use, and its nitrogen content. The organic matter test is the basis for finding out C: N ratio (Woods End Research Laboratory, 2005).

2.4Composting process production and stages

Compost is made from a wide variety of materials, under desired conditions (temperature, moisture, oxygen). Compost processing may be indoor or outdoor, or in closed vessels. There should be a control on:

• C: N ratio should be within 25 to 35:1

• Oxygen level should be adequate

• Moisture content should be between 40 and 60%

• Temperatures should be within the limits 55 - 65°C.

In 2000, approximately 14% of compost production in the world was used in landfills, 43% in agriculture, 8% in landscaping, and 4% in horticulture, 14% in and for their restoration, 13% in private gardens (SV and A, 2005).

Composting process consists of three stages which are preprocessing, processing and post-processing. The preprocessing stage involves removing undesirable material and sorting and shredding to typical particle size. The processing stage has two phases: which are the composting phase and the curing phase. In this stage weight of feedstock reduces because of disintegration of some of the organic material. In the curing phase compost changes into a stable biological material, in which microorganisms are active at lower level than in the actual composting. Within this stage of curing, aeration should be carried out and less heat is generated and the compost begins to cool, which is an indication of decrease in the microbial activity. Fig 2.3 shows the composting and transition of microorganisms and the associated change in temperature (United States Environmental Protection Agency, 1994).

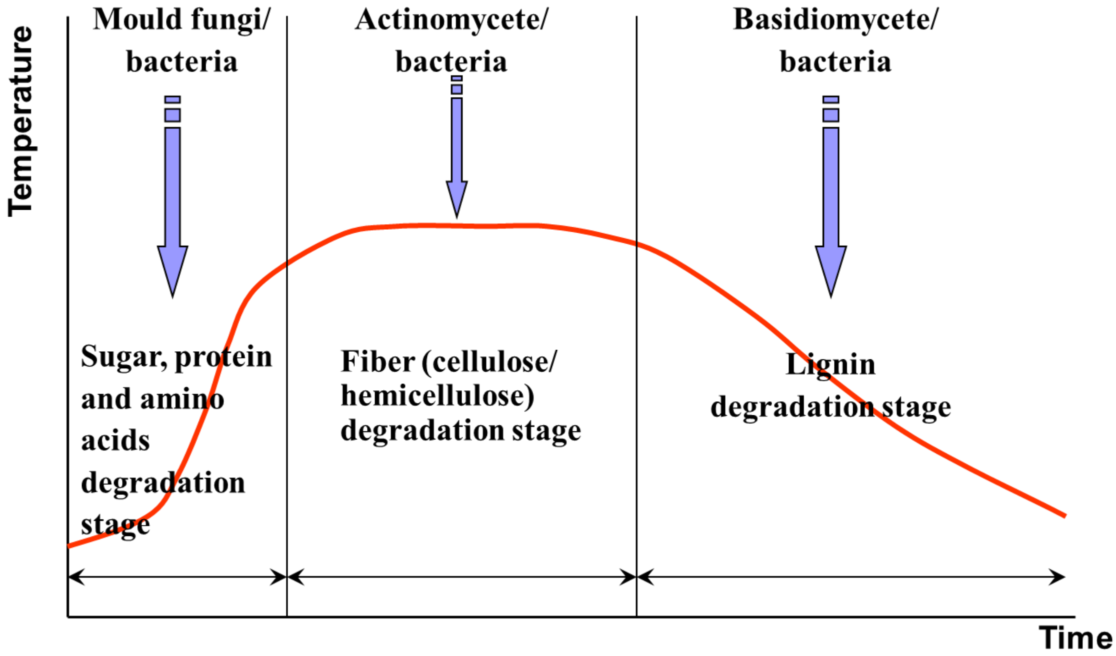

Fig. 2.3: Composting and transition of microorganisms (Maeda, 2013).

The post-processing stage is optional but may be required to ensure compliance with customer needs. Example of what can be done in this stage is: (United States Environmental Protection Agency, 1994)

- Ensuring complete stabilization by analyzing compost;
- Determining nutrient level and testing compost for pathogenic or chemical pollutants;
- Removing unwanted material; and
- Reducing compost size, screening, and sorting by size, and blending it with other materials.

Compost procedures may be carried out into different ways as follows: vermin-composting, anaerobic processing, in-vessel composting, aerated static pile, turned windrow, and passive pile. Variation among these methods is in the air supply method, turning/ mixing the material, temperature control, and the time required for composting (ARIJ, 2005).

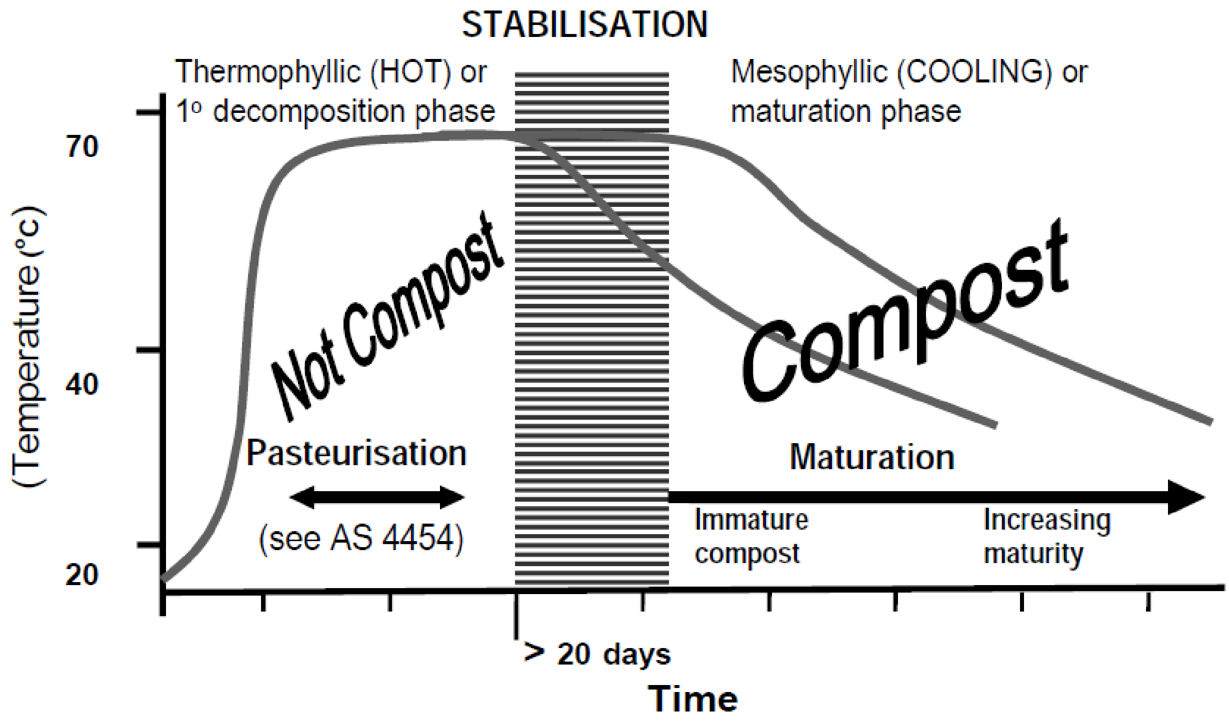

Fig. 2.4: Temperature changes during in-vessel and static pile composting process (Paulin, 2008).

In the first stage, fungi disintegrate cellulose and other complex molecules, raising the temperature to around 65 C disrupting weed seeds and harmful organisms. In the second stage, the fungi disappear, and bacteria disintegrate the organic matter into humus. Only half of the mass remains as, the other half are released as water, Co_2, and heat, and this mass occupies only one third of the initial volume. Fig 2.4 shows the temperature changes during in-vessel and static pile composting process (Schneider et al., 2001).

The pH of the compost changes during the process from 7 to 6 and may go down to 4.5 before it goes up to 8 and then goes down to 7 gradually with time (EPA, 1995). Raising the pH of the final compost will be achieved by treating with lime (up to 9.0), or hydrated lime or ash (up to 11.0). Optimum pH of compost is (6.0 – 7.5) but if pH goes above 8.4 it should be controlled as it becomes harmful to plants, and is associated with odor and ammonia loss (Woods End Research Laboratory, 2005).

Storage time should be minimized as much as possible. As activity of microorganisms depend on moisture content, so enable compost to dry enough is an important issue for good storage. Appropriate moisture content of 30% is typical for accepted storage conditions (EPA, 1995).

Other factors that are important are timing of application of compost, application rates, and placement, which may affect the results. If compost is not maturating enough, it may cause problems with establishment (EPA, 1995).

Efficient use of compost requires repeated and regular use. As microbial population and organic matter increase in soil; decrease will be achieved in irrigation, fertilizer, and pesticide use (EPA, 1995).

Some quality parameters are presented in table 2.1, which indicate proposed use of compost in accordance to its quality.

Table 2.1: Suggested quality factors for using compost in horticulture (Paulin and O'Malley, 2008).

Factor	**Soil incorporation**		**Surface mulch**
	Vegetables and annual crops	Orchard, vineyard and perennial crop establishment	Orchards, vineyards and perennial crops
C:N ratio	<17	<20	Not as critical, prefer <35 to minimize N competition
NDI (Nitrogen Drawdown Index)	>0.6	>0.5	Not critical, prefer >0.3 to minimize N competition
Electrical conductivity (mS/m)	<60.0	<80.0	<80.0
pH	6.5–7.5	6.0–8.0	6.0–8.0
Moisture content (% dry matter	) >35	>35	>35

Total nitrogen (mg/kg)	>1.5	>1.0	Not critical, prefer>0.7
Soluble nitrogen (mg/kg)	>100	>100	Not critical
Nitrate: ammonium ratio	>0.14	>0.14	Not critical
Toxicity %	>60	>60	>30
Application rate, suggested typical rang	15-30 m3 /ha	25-75 m3 /ha trenched into planting rows	50-75 mm depth to 15-25% of land centered on the row

Unlike the aerobic composting, anaerobic digestion is carried out without oxygen. In this process the organic products are disintegrated in a closed controlled container for 15 to 20 days composting, biological wastes can also be decomposed in controlled processes in the absence of oxygen. The important feature is that it is carried in a very tight vessel, so outside air is not allowed to interfere in the degradation process and thus all the degrading process is carried out without oxygen. One important product of this process is methane gas which is called biogas and has different uses starting with utilization in electricity production and ending with use for cooking. This biogas can be used also for heating the process of decomposition and thus maintaining the required temperature between 30 to 65 degrees C Another important product is the digestate which is a residue like sludge and is usually dewatered and treated in order to get the material stabilized and then will be utilized for soil improvement as it is rich with organic matter and considered to be a very good fertilizer The other by product is the liquid portion which is returned back into the closed vessel to enrich the anaerobic process and the residue of it could be utilized as a liquid fertilizer. If the quality of the liquid portion is not suitable it can be discarded to sewerage network. The main input of anaerobic digestion is putrescible portion of MSW accompanied with some plants residues in case of using the digestive as a fertilizer (Paulin and O’Malley, 2008).

2.5 Health and environment impacts of composting

Composting has different impacts on environment and health that are affected by the input materials, the technology used, level of monitoring and control, and other factors. (Eunomia, 2000)

- **Emissions to air**

The compost processes will result in gaseous emissions to air such as water vapour, carbon dioxide (CO2), volatile organic compounds (VOC), small quantity of ammonia (NH3), bio-aerosols (mycotoxinsn, endotoxins, actinomycetes, bacteria, fungi). As there is no guarantee of 100% aerobic condition, some methane (CH_4) emissions will be there. Additionally, composting will cause vigorous odors (EC, 2007).

In the closed process of compost production, for the sake of reduction of emissions, bio-filter is utilized. This will decrease the emissions of certain VOC, particulates, aerosols, ammonia, and odors. Conversely, other emissions will be launched from bio-filter, particularly new VOC and N_2O. The methane and nitrogen dioxide emissions are related to climate change effects and carbon dioxide are regarded climate-neutral as it originates from biomass. Other emissions are related to some health and nuisance effects on the inhabitants. Labors working in a compost entity are exposed to, and may inhale, some gaseous emissions. Effects will differ from person to person as some will be as thematic and individuals with impaired immune will adversely have side effects because of being exposed to bio-aerosols. Mitigation measures should be taken to protect close residents and workers of the compost plant. Unfortunately, there is a shortage of data regarding air emission quantity and absence of information on emissions at the time of storing biological substances (ADEME, 2005 and DEFRA, 2004).

- **Leachate**

Methodology of treating leachate differs from plant to another. Some plants treat the leachate or directly discharge to sewerage network; others recirculate leachate. As a result of evaporation during the composting process, and usually composting needs water. In good controlled composting systems, environmental impacts are considered negligible. But, there is lack of data on the quantities and components of leachate generated which takes into account the variation in of composting plants (EC, 2014).

- **Soil-related**

The addition of compost to soil will change its biological, physical, and chemical, characteristics. The factors that may be affected are: structure, density, content and availability of nutrients required for plants, ion exchange capacity, pH, the organic matter in the soil, buffering capacity, chelating ability, biological activity, water management. Composts will be part of the organic material in soil which is called humus, and will affect soil properties on the short as well as on the long run. Unfortunately, methods in which compost change soil characteristics are not modeled and complicated and very difficult to understand; but, it is agreed that soil fertility is positively affected by compost on both short and long run (EC, 2014).

Meanwhile, utilization of compost as soil improver or an organic fertilizer has different environmental effects. When compost is added to soil, the chemical components of the composts are conveyed to the soil. One of the adverse impacts is that to consider organic pollutants and heavy metals. Usually, heavy metals contents in compost are controlled and studied compost utilization. Input materials entering the process will determine these portions. The adverse effect of heavy metals is their toxicity to plants and their harmful effect on humans if passed through the food chain. The destiny of the heavy metals in soil varies from one site to another and is affected by some parameters like crop nature, and pH of the soil. It is to address that continuous adding of compost to land will increase the heavy metals concentrations in soil, however assessing this in terms of environmental effects is not conveniently handled among researchers. Some issues to be studied in this regard are leachability of heavy metals into groundwater, background concentrations of these metals, consequences of the increase in the uptake of heavy metals by plants that enter into the food chain. Nickel, zink and copper are important for plant growth as trace elements with a controlled quantity (EC, 2014).

Hygienically, the application of compost may induce some risks, as biological wastes include some types of pathogens that may be viruses, bacteria, parasites, fungi, and prions. Many factors affect the quantity of these pathogens like the original components, storage conditions, handling, and initial treatment of the waste. If measures are not taken to prevent these pathogens during the processing, then the compost may contain these pathogens with higher quantity. These pathogens may lead to infection of humans, animals, and plants causing serious health problem. Particularly, attention should be paid for production of vegetables that do not need cooking, salads and grazing. To overcome this risk, sorting of raw material before composting process should be carried out, taking away the nappies, and ensuring proper system of sanitation is carried out by subjecting the input materials to a temperature-time profile killing all pathogens (EC, 2007).

Care should be drawn also to concentration of the pollutant as well as its load. High concentrations may affect labor health in growing media. Also, safety considerations are important for example a piece of glass may cause injuries (EC, 2007).

2.6 Quality of compost

- **Compost quality standards for land application**

Main parameter affecting compost quality is input materials. The WD in its 2nd draft published specifications for input material (EC, 2001). Accordingly, only compost originating from MSW that is source separated and containing only animal waste and vegetable is allowed (CEC, 2006).

Other standards, for the process of composting which objective is to make sure of ensure compost sanitization, are published also as shown table 2.2.

Table 2.2: Standards for composting process to ensure compost sanitization (EC, 2001; BSI, 2005).

	Composting Process	**Temperature (°c)**	**Moisture (w/w)**	**Time (weeks)**	**Mixing/turning**
EC 2001	Windrow	≥ 55	n.a.	2	5
	Windrow	≥ 65	n.a.	1	2
	In-vessel	≥ 60	n.a.	n.a.	n.a.
BSI 2005	n.a.	≥ 65	≥ 50 %	1	≥ 2

There are also standards specifying the maximum content of physical, organic and physical pollutants, weeds, and pathogens for bio-waste treatment, for the polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) only; their limits have to be according to Sewage Sludge Directive (86/278/EEC). Generally, organic contaminants should have low values in compost originated form source separated MSW, thus no need for setting limits for organic pollutants in European countries (Hogg et al., 2002).

Limits for the physical contaminants are to be less than 5% of the weight of compost when sieving with mesh size > 2 mm. These impurities include plastic, glass, metal. Stones > 5mm should be less than 5% of compost weight (EC, 2001). This percentage should not be more than 8% for stones >4 mm (BSI, 2005).

There are other standards specifying number of weed seeds, plant, and compost maturity, and compost nutrient related properties (CEC, 2006).

In general there are many different standards for compost quality according to country and development and progress in their using compost. But most of countries begin publishing routine guidelines. It is to address that these specifications are not enforced by law as some of them are voluntary (Brinton,2000).

Comparison between standards of compost in different countries reveals that Europe has make steps forward than other countries in the world. This is because of the political will in Europe to address this issue as very serious, in addition to scientific capabilities that are present in Europe regarding testing compost (Brinton, 2000).

Compost is not classified as fertilizer as it does not contain sufficient amounts of potassium, nitrogen, and phosphorus, although it contains other plant nutrients that increase the fertility of soil (Diaz at al., 1993:103).

- **The objectives of Guidelines for Compost Quality are to:**

• Protect environment and public health;

• Ensure that compost product is of high quality by encouraging source separation;

• Ensure that compost quality and standards are consistent and similar in all parts of the country;

• Utilizing the experience of technology and industry when practicing the guidelines, so that the national guidelines make use of new development in science and technology;

• Reduce the use of untreated organic wastes; and,

• Increase confidence of consumer by product that is consistent in accordance to quality standards (CCME, 2005).

- **Compost Product Guidelines**

Four parameters govern the guidelines for compost product that are related to safety issue: Maturity, pathogens, foreign matter, and trace elements.

Objective of the final use of the compost product is important for imposing the quality standard. Important limits are the total nitrogen, C: N ratio, available nitrogen. Element contents in conventional compost of waste are presented in table 2.3.

Table 2.3: Element contents in conventional compost of waste concern (Rothenberger et al., 2006).

Elements	Concentration (%)
Organic matter (OM)	35-40
Nitrogen (N)	1.0 – 2.0
Phosphorus (P)	0.4 – 4.0
Potassium (K)	0.5 – 2.6
Ph	7.8
Moisture content	25-55%
pH	5.5-8.5
EC	Less than 5.0 ds/m
C/N ratio	10-40
Heavy metal	Cu less 300ppm Zn less 900 ppm

The parameters that affect the quality of compost product depend on the rate of composting process and depend on the chemical and physical factors. Temperature is an important factor that determines the success of composting process. Particle size and moisture content are physical characteristics that influence the rate of the composting process. Other factors include the shape and size of the system that influence the rate and type of aeration as well as the trend of the compost to keep or lose the energy which is generated (Rothenberger et al., 2006).

- **Temperature**

Temperature of the compost during the process depends on moisture content of the pile its size, C/N ratio, and aeration, and C/N ratio (Australian Alps Best Practice, 2000).

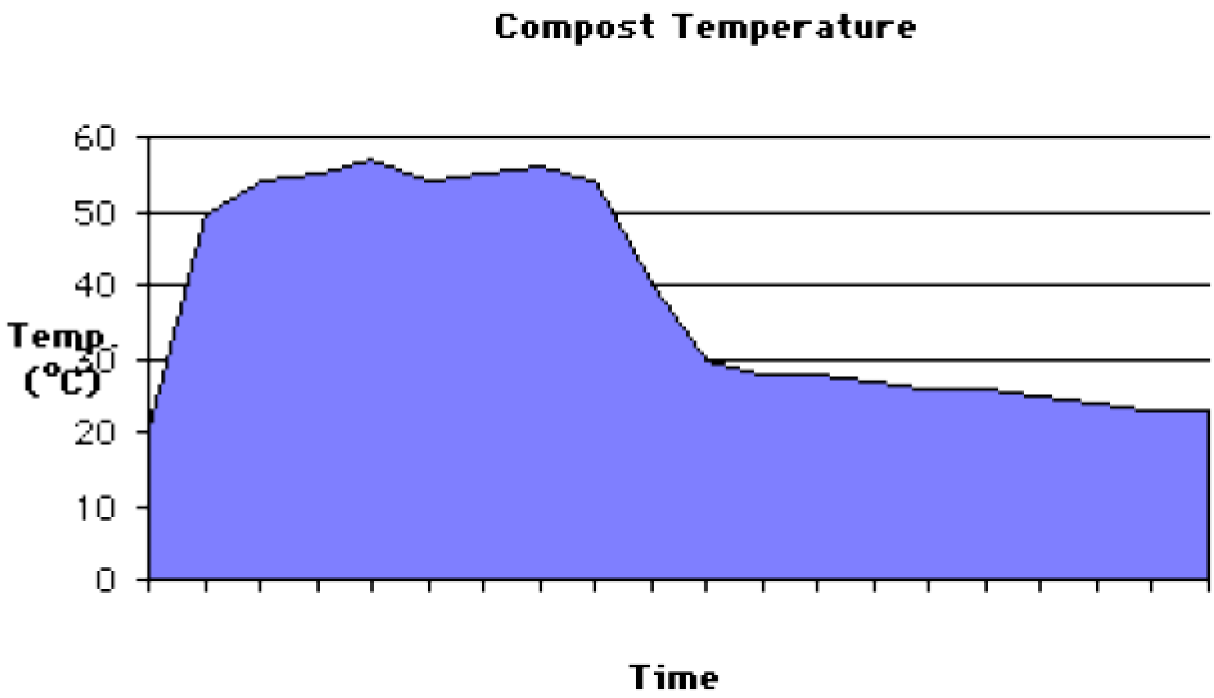

Fig 2.5: Compost temperature

Changes in temperature of the compost pile change with time as shoe Decomposition shown in Fig2-5 reaching its amplitude between 40-60°C, for several weeks or months. And this stage is called thermophilic phase (Khatib et al., 2010).

The importance of the heat amplitude is for destroying fly larvae, pathogens, and weed seeds. it is also important that temperature does not exceed 60-65°C C as at this temperature most microorganisms could not survive, so aeration and turning of the pile is needed (Trautmann et al., 2000).

- **Particle Size**

Particle size should be small enough so as microbial activity takes place on the surface of Microbial activity generally occurs on the surface of the particles, so increasing surface area will increase the decomposition process. He particle size should not be too small so as to allow enough circulation of air that includes oxygen which is necessary for the process of disintegration (Holmer, 2002).

- **Aeration**

Percentage of oxygen in pile should be kept between 15-20% as in the natural air. F this percentage falls below 5%, anaerobic decomposition takes place, and thus bad odours are produces. Good aeration can be achieved through turning, aeration pipes, drilling air holes, or forced air flow (Holmer, 2002).

- **Moisture content**

Best water holding capacity (WHC) of the feedstock is 80-85% of the saturated WHC, but it depends on other factors like the organic matter content *(Woods End Research Laboratory, 2005)*. High water contents may increase leachate and potential of anaerobic digestion. Usually, there is a need to add water to keep the ideal water content *(Woods End Research Laboratory, 2005).*

- **Oxygen**

Oxygen is necessary to guarantee aerobic process in which microorganisms use it to oxidize carbon for energy (Holmer et.al, 1997).

Optimum oxygen concentration is greater than 10% but if it goes down to 5% then anaerobic process starts (Dickson et al., 1991).

- **Nitrogen: total-Kjeldahl-N, organic-N, ammonium, nitrate, nitrite:**

Compost to be considered fertilizer should have TN more than 1%, dry weight, the ideal range is 1-3%, as over 3% will be ammoniac and immaturate (Barker, 1997).

Maturate compost, will have organic nitrogen, and large amounts of NO_3. Ammonium nitrogen will volatile as NH_3 vapor and lost and if it exceeds 15% of TN, it is regarded high loss *(Woods End Research Laboratory, 2005)*.

Total nitrogen consists from organic nitrogen ad inorganic nitrogen (ammonium-, nitrite-, and nitrate-N).

Kjeldahl Nitrogen (Wet Combustion) is the test for finding organic- plus ammonium-N in the sample. When the nitrate-/nitrite-N portion is large, then a modification of the Kjeldahl method will be the reduction step that changes the nitrite- and nitrate-N into ammonium. The resulting will be the total N content that will be used to find out the C: N ratio *(CCQC, 2001)*.

The most available form of nitrogen to plants is NO_3. Environment Agency (2000) classified the compost to be utilized in agriculture according to its NO_3-N content as shown in table 2.4.

Table2.4: Interpretation of available Nitrogen as NO_3-N in compost (Environment Agency, 2000).

Interpretation	**NO_3-N (mg/L)**
Deficient	0-15
Low	16-25
Satisfactory for seedling and nursery stock	26-50
Satisfactory for pot plants and bedding plants	51-80
Satisfactory for tomatoes, cucumbers and carnations	81-130
	131-300
Unnecessarily high for all crops	201-300
Excessive	Over 300

- **Carbon: Nitrogen Ratio**:

The C: N ratio is an indication of the rate of disintegration of the compost and may be considered for testing maturity (Anon, 1998). The EPA states that the C: N ratio of compost must be less than 25 (Herity, 2003). If C: N was lower than 30, N may be more than required causing the excess to l be lost as ammonia gas, which causes bad odors. If C:N ratio was higher, this implies that there is no enough N for ideal conditions for the growth of the microorganisms causing the compos to stay cool and disintegration may continue at a slower rate(Dickson et al.,1991).

Usually composting process can be regarded finished when a C: N of 17 or less is reached *(*Woods End Research Laboratory, 2005*)*.

If the total C: N is lower than 20:1, ammonia will be given off by the microorganisms generating odor. The C: N was in the range 40:1, the microorganisms will slow till the extra Carbon is oxidized. Normally, C and N should be supplied in the appropriate ratio to ensure nutrients are available to the microorganisms (Schneider et al., 2001).

The (C: N) ratio should be less than 25 so as to be considered acceptable B *(CCQC, 2001)*.

2.7Categories of compost

According to use of com[post product, two categories were developed for foreign sharp material and trace element concentrations category A for unrestricted use and category B for restricted use *(CCME, 2005)*.

Category A is for compost which may be used in any application, like horticultural operations, residential gardens, agricultural lands, the nursery industry, and others.

In order to achieve category A standards for trace elements, there should be use of MSW that are source separated, pulp and paper mill, and municipal bio-solids, or manure *(CCME, 2005)*.

In case of presence of foreign sharp material or high trace elements, then compost category is B which has a restricted use. Compost category B requires additional control as it fails to meet all the criteria for the unrestricted use and only achieved the criteria of category B. In case compost fails to meet the criteria for category B it should be appropriately disposed *(CCME, 2005)*.

Quality of compost is the main factor that ensures consumer satisfaction, and in turn permanent request of the product. If compost was of low quality such as having foreign matter like sharps or glass, it will cause complains from farmers as they will be injured. In addition to that, low quality compost may contain toxic compounds, invisible contaminants, and heavy metals that will affect the consumers and farmers and cause pollution of groundwater. Other criteria of classification depends weather visible and invisible as shown in table 2.5 (CCME, 2005).

Table 2.5: Quality criteria for compost (Rouse et al., 2008).

Visible criteria: **Customers can assess**	**Invisible criteria:** **Customers cannot assess**
▪ Colour ▪ Smell ▪ Visible foreign matter (wires, plastic, glass) ▪ Degree of maturity assessed by ▪ Colour and smell	▪ Nutrient content (NPK) ▪ Degree of maturity in terms of chemical constituents ▪ Suitability for plants (salt content, pH) ▪ Weed seeds inactivation ▪ Existence of pathogens ▪ Heavy metal content

It will be useful if an external party took the responsibility of testing compost product. This may increase consumer confidence and satisfaction regarding quality. Any compost should meet the national or international standards relating to heavy metals, pathogens, and toxic chemical, as they are measures of safety more than quality (Rouse et al., 2008).

A successful example of quality assurance in a developing country is the case of Dhaka, Bangladesh. There, they know the importance of consistent high quality compost product. After producing their finished compost, they sell it to MAP Agro that owns compost grinding and cleaning machinery. In this plant, any glass shards are reduced to harmless powder, in addition to separating metal and removing polythene by an air sorter. Although this process costs more effort, money and time, farmers consider it vital because it protects human safety. In order to control heavy metal levels, careful selection of raw material for composting was carried out *(Ali, 2004).*

2.8Minerals in the compost

- Phosphorus, Potassium, Calcium, Magnesium, Sodium, Chloride, Sulfate:

Table2.6: Concentration of the rest of the elements, and the favorite value of each (Qadomi, 2014).

Favorites Value	Test Name
0.08-1.49 % dw	CaO% content
0.02-0.49 % dw	MgO % content
Less than 0.45 % dw	Na% content
Less than 0.17 % dw	Cl% content

Table 2.6 shows the favorite values of minerals as total form, for k and Na about 80% of the total is available, while for P and Ca and Mg the available ranges from 25% to 75%. Considering 50% of the total P, Ca, and Mg available will be a good approximation (Woods End Research Laboratory*, 2005.)*

Phosphorus

The form of available phosphorus is PO_4-P in units of mg/L. Usual range of total phosphorus is between0.4 - 1.1%, dry wt. For green waste and biowaste the ideal range of available P 50-120 mg/L (Herity,2003).

Potassium

Available form of K is K_2O, and its percentage depends on the feedstock and the composting process (Barker, 1997). The percentage of Potassium in compost is low because of its high solubility and thus goes into the leachate (Fricke and Vogymann, 1994). BordnaMona (2003) recorded that the ideal content of total potassium (TP) in green-waste and bio-waste ranges from 0.6-1.7%, dry wt, while the ideal content of available potassium ranges between 620-2280 mg/L, fresh wt (Herity,2003).Researches show that potassium in compost is more efficient than that in fertilizer by 20%.

Compost is beneficial for container production of crops where the calcium content in beat is low (Herity, 2003).

Magnesium

Magnesium is totally available in compost and this may compensate magnesium sulfate (Paulin et al, 2008). It is known that it has a basic nature and it will counteract the acidity of soil when it is available as carbonates, hydroxides, and oxides which will increase the pH of soil. Table 2.7 presents the concentration of essential elements (Fricke and Vogtmann, 1994).

Table2.7: The concentration of the essential elements (Qadomi, 2014).

Preferred values	**Test Name**
More than 0.5% dw	P2O5 Content
More than 0.1% dw	K2O Content
More than 1.0% dw	Total nitrogen content
25-35 %	Organic carbon content
20-150 ppm	NO_3-N
Less than 1% of foreign matter (no plastic, glass or metal) of total air –dried sample by mass	Impurities

Electrical conductivity is a mean for measuring the dissolved salts in compost. Most element contributing to salinity are VOA, ammonia, sulfate, nitrate, chloride, potassium, and sodium. Low values are indication of shortage in minerals, but large values indicate high percentage of soluble minerals which may affect bioactivity or adversely affect soil in case it was applied in high quantities. The units of conductivity in the report are the traditional mmhos/cm, which is equivalent to dS/m(Woods End Research Laboratory, 2005).

2.9 Marketing Compost

Cost of production of compost depends on many factors like local condition, type of feedstock and may range between 5EUR -60EUR per ton (Eunomia, 2000).

There is a need to improve the view of citizens toward compost, in order to market it, as many factors play a role in the unwillingness of citizens to utilize it, among them are:

- lack of knowledge and awareness on when and how to use compost;
- Extra expectations from compost that leads to overestimation of its efficiency compared to chemical fertilizers ;
- Unsuccessful previous experiences in utilizing compost;
- The intention of most farmers to get fast results ;
- Comparison with other chemical fertilizers, as they are low cost such as manure;
- high transportation cost because it is usually produced far distances away;
- Lack of policies and regulations that encourage its utilization.

Production cost includes spreading, distribution, processing, and raw materials.

There should be quality standards and guidelines showing and facilitating purchase of compost that is appropriate to the intended use (Paulin, 2008.)

India is a typical case of a country that considers use of compost old fashion and encourages the use of chemical fertilizer*(Ali, 2004).*

Chapter Three

Study area and compost horizons in Palestine

3.1 Study Aria

Hebron city is considered one of the oldest cities in the world. Many other towns and villages fall within Hebron district. Hebron is the largest city in the southern area of West Bank, and it is 36 km south from Jerusalem. It is bordered by Bethlehem from north, and by the green line from the other directions as shown in Fig 3.1. According to PCBS and the population were 389,014 in 1997. This population is approximately distributed as one third residing in Hebron city, one third in other villages and towns and the other third is living in rural areas, and a small portion 3% living in refugee camps (ARIJ,2000).

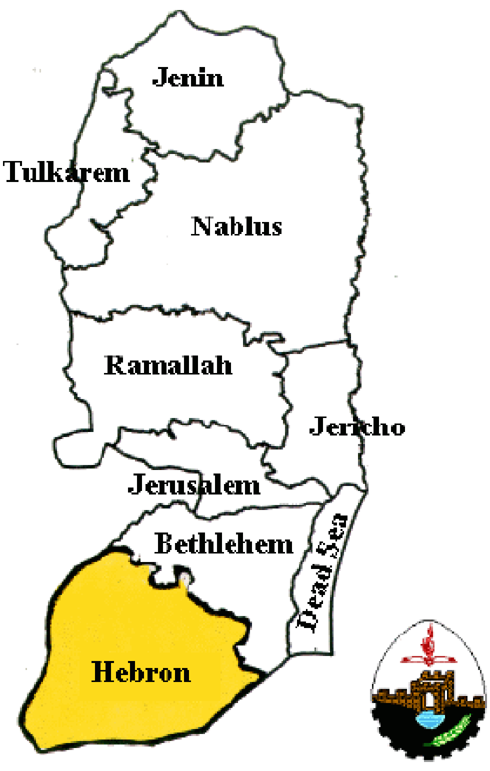

Fig. 3.1: Map showing location of Hebron District (ARIJ, 2000).

The number of inhabitants in mid-2010 in Hebron was 600,364 citizens of whom 306,185 males and 294 179 female population, it can be seen that the number of population increased by 55.9% of the total population of the province in 1997. The population density reached in mid-2009 in the province 582.7 persons /km ².Distribution of inhabitants in according to locality urban and year are presented in table 3.1(PCBS, 2010).

Table3.1: Localities in Hebron Governorate, Estimates, 2007-2016 (PCBS, 2013).

Locality Name	Years									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Urban Total	**464,102**	**479,674**	**495,728**	**512,290**	**529,401**	**547,110**	**565,271**	**583,867**	**602,864**	**622,220**
Rural Total	**65,521**	**67,720**	**69,986**	**72,325**	**74,740**	**77,240**	**79,804**	**82,430**	**85,112**	**87,844**
Camps Total	**14,268**	**14,747**	**15,240**	**15,749**	**16,275**	**16,820**	**17,378**	**17,950**	**18,534**	**19,129**
Total Hebron Gov.	**543,891**	**562,141**	**580,955**	**600,364**	**620,417**	**641,170**	**662,454**	**684,246**	**706,509**	**729,193**

The cultural and physical geography of the district has a lot of variations, for example height above mean sea level changes from 1,011 m in Halhul into only one hundred meter in the eastern areas. Most citizens of the district are living in areas that are under 1000 m and over 600 m from sea level. These changes in level impose changes in climate that changes from arid in the southern parts to semi-arid. The mean monthly temperature differs from 22 c in summer to 7.5 to 10 C in the winter (ARIJ, 2000).

Manufacturing and agriculture marketing form the skeleton of Hebron economy. Presence of many and different industries make Hebron leader of the West Bank in terms of industrialization (ARIJ, 2000).

The main industries in Hebron include stone and aggregate quarrying, production of leather products, tanning of leather and, production of hand-blown distinctive blue glass, stone and marble cutting, cultivation (in the west areas). Most agriculture depends on rainfall and not irrigation. Fruit production constitutes a major sector, as Hebron is classified as the second on the West Bank level in fruit production. The main fruit products are grape, as approximately 68% of total national grape product comes from Hebron District (ARIJ, 2000).

According to 1993 accords of Oslo, Hebron was divided into three zones:

• "Zone A" where the Palestinian Authority is responsible for civil functions and internal security, and this is the city of Hebron;

• "Zone B" where the Palestinian Authority is responsible for civil functions, and these include Palestinian built-up areas, camps, populated villages;

• "Zone C" where Israelian Authorities are responsible for civil functions as well as internal security, and this include other areas in the district (ARIJ, 2000).

Fig 3.2 shows the division of Hebron in accordance with controlling authority.

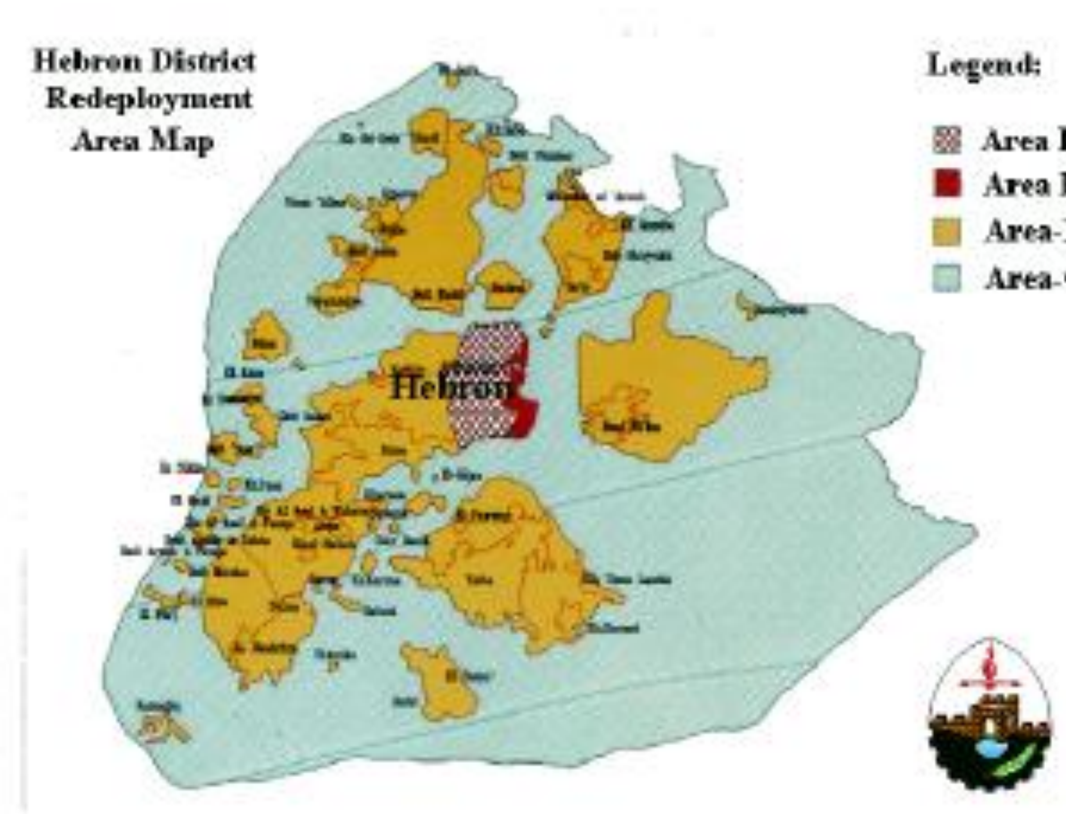

Fig.3.2:Map illustrating division of Hebron into three areas (ARIJ,2000).

The Population of the Hebron district is increasing rapidly from year to year. As mentioned earlier, the estimated population is 250,000 for year 1992. The population of the Hebron city is 120,000 and the populations of the Hebron villages are 130,000 (ARIJ, 2000).

Governorate area is 997 km ² in 2008, or about 17.6% of the total land area of the West Bank (PCBS, 2010)**.**

3.2 Climate

The data show that more or less the average temperature is the same for all the places which have a moderate temperature in the summer (20-30°c) and the winter temperature is low. Yatta has a highest average temperature and Halhul has the lowest temperature due to the height with respect to sea level (ARIJ,2000).

The average rainfall is 588 mm, with extremes of 1027 mm as the largest and 200 mm as the least. As we go to the south and east, rainfall quantity decreases Rainfall in the Halhul and Beet Ommar is high around 650 mm where in Yatta is comparatively low around 350 mm. The average annual rainfall in the Hebron city areas and Dura village are almost same which is about 500 mills (ARIJ, 2000).

There are two types of climate in Hebron, the first Mediterranean climate: which prevails most areas of the province, which is characterized as Mater relatively warm winters and hot, dry summers, and the second desert climate: The prevailing eastern slopes of Mount Hebron and the coast of the Dead Sea, which is characterized by a warm winter and high temperatures and drought in the summer (PCBS, 2010).

3.3 Infrastructure and environment:

Hebron district suffers from water scarcity, either the lack of rainfall that falls on the territory of the province, especially the southern and eastern, or lack of artesian well. In addition to the Israeli control of the aquariums which aggravates the problem. The deficit of water in the province in 2010 was 18.3 million cubic meters while it was 64.3 million cubic meters in the West Bank, excluding the city of Jerusalem. About forty populated sites don't have water networks and rely on water wells, or they are obliged to buy water*. The amount of water, which the population were obliged to buy in 2010, was estimated by 8.5 million $(PCBS, 2010).

- **Solid waste:**

Collection of solid waste responsibility:

According to study in 2008, collection of solid waste was carried out by the local councils in 41 localities, the international relief agency was responsible for this service in 5 localities, and 3 localities did not specify the party responsible for the waste collection, while 43 lacks this service. With regard to frequency of waste collection, it has been shown that 19 localities collect waste on a daily basis, and 14 collect waste once a week, and 11, collect waste more than once a week, and 5 localities are collecting once every two weeks or more, and 44 localities acquired special vehicle for waste collection, one use a tractor and 4 of the localities use other means. Distribution of dumps in Hebron is presented in table 3.2(PCBS, 2010).

Table3.2: Distribution of dumps in Hebron Governorate,2008(PCBS, 2010).

Item	**Number**
Number of dumps	14
Ownership of Dump:	
Local Authority	5
Governmental	1
Rented	6
Other	2
Year of Establishment of the dump:	
Before 1993	1
After 1993	13

There are more than 35 localities that don't have any solid waste collection. The solid waste dumping site which is located in the east of Yatta causes a healthy nuisance and pollutes the air. The bad economic conditions prompt more than100 scavengers to extract the buried copper and iron from the solid waste and convey it to residential areas where they burn the plastic material that covers it to sell it (PCPC, 2010).

3.4 Reality and the use of compost in Palestine

The results of the agricultural census in 2010 revealed that 64.9% of the farmers in the Palestinian territories are using organic fertilizers, and 34.8% are using chemical fertilizers, in addition to the 49.7% of the total who are using agricultural pesticides (MoA, 2011).

Israel worked for many years, especially with the start of the second intifada, on preventing and restricting the import of all kinds of fertilizers, whether organic or chemical except under stiff regulations and under many complications for a variety of reasons. This led to the damage to agriculture and decrease in production, degradation of farmland, as a result of the high prices of fertilizers. This in turn led to increased amounts of fertilizer smuggled and adulterated that do not match the specifications (MoA, 2011).

Accordingly, the Ministry of Agriculture invited businessmen and investors, and agricultural associations to invest in the production of organic fertilizers and marketing these products in the Palestinian market, so as to compensate for the shortage in quantities of the fertilizer (MoA, 2011).

The Ministry of Agriculture worked hard on spreading the culture of using the national product alternative to importing from Israel, as it is good quality compared to the imported fertilizers which have high price and sometimes anonymous and adulterated with low quality (MoA, 2011).

Currently, there are units or some factories that produce compost in Palestine, five factories distributed as follows: one in Tulkarem - Thinnaba, one in Hebron - Dura, and three in Jericho and the Jordan Valley as shown in Fig 3.3. There are two units in the northern part of Jordan Valley and it is expected to open the other during the next two years (MoA, 2011).

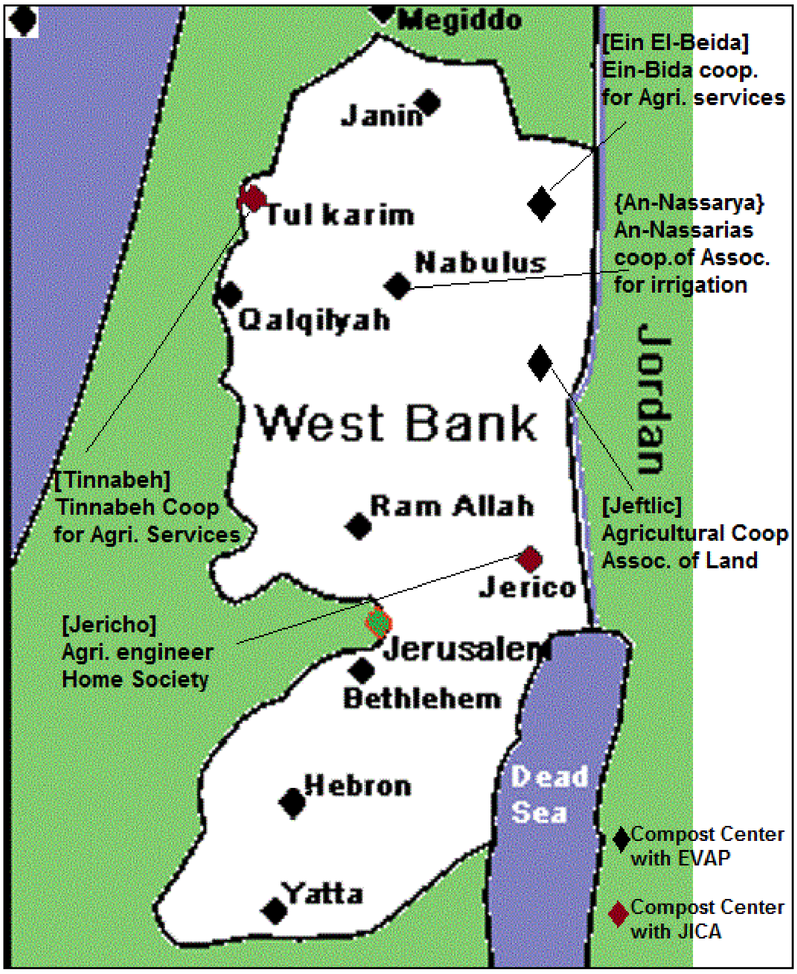

Fig. 3.3: Compost Center in the West Bank (EVAP and JICA, 2013)

The Ministry of Agriculture to issue a set of regulations and acts concerning the organization of the fertilizer sector, these include the following decisions:

The need to obtain prior authorization from the Ministry of Agriculture to import fertilizer from Israel, similar to issuing permits to import from other countries.

The need for Palestinian import companies to obtain on the import agency production manufacturers (PSI, 2011).

Need to have a card statement in Arabic stating all relevant information needed for the use of fertilizer and the technical instructions in addition to the original manufacturer language. Also, its role is issuing technical approvals to import fertilizer, for the companies that import fertilizers, from Israel or from the rest of the world.

The final draft of the compost specification is the specification of the Palestinian - organic fertilizers MF609-2001 and this standard include on many articles and definitions covering supply, and other important issues and specification (PSI, 2011).

Packing and storing compost is an important issue. Provide compost in bulk form or being packaged in containers or bags in a strong, airy, resistant storage and transportation. Storing compost should be in dry stores and so appropriate ventilated and proper storage methods should be ensured (PSI, 2011).

For marketing, compost must be placed in sacks with a label specifying (PSI, 2011).

- Product name and trademark, if any.
- Name of the manufacturer, importer and address.
- Production date (month and year) or manufacturer.
- The phrase "not to eat", those words are printed in a different color.
- Basic raw material for organic fertilizer, and the relative quantities.
- The target and the nature of the work of the compost.
- Weight or volume of compost (kg / l).
- Characteristics of organic fertilizer, as detailed in the specification.
- Determine the electrical conductivity of the product and the amount used for each donum based on Table 3.3 and 3.4.

Table 3.3: Organic fertilizer use for coverage or burial by soil at a depth of up to 5 cm (PSI, 2011).

electrical conductivity (dS / m)	**The maximum size of the manure (m3/dunum)**	
	Sensitive crops from salinity	**Crops resistant to salinity**
0.0 – 0.2	No identification	No identification
0.2 – 0.4	15	60
0.4 – 0.8	8	32
0.8 – 1.6	4	16
1.6 – 2.4	3	12
2.4 – 3.2	2	8
3.2– 4.0	1	4
More than 4.0	Prohibits the use of	Prohibits the use of
Note regarding the table: (A) 1 cubic meter of dunams = 1 liter per square meter		

Table 3.4: Use organic fertilizer for burial in the soil depth of 20 cm at least (PSI, 2011).

Electrical conductivity (ds/m)	**The maximum size of the manure (m3/dunum)**	
	Sensitive crops from salinity	**Crops resistant to salinity**
0.0-0.4	8	24
0.4-5	6	18
5.0 - 6.0	4	12
6.0 -7.0	2	6
More than 7.0	1	3
Note regarding the table: (A) 1 cubic meter of Dunums = 1 liter per square meter		

Chapter Four

Research Methodology

4.1 Introduction

This chapter reviews the approach used to investigate the research objectives, and discusses the methods of data collection, pilot scale, lab. analysis, questionnaire design, and the materials used through that.

4.2 Laboratory Analysis

4.2.1 Purpose

There are many developed tests for compost output product. These tests are important in order to ensure the compost product is safe and satisfies consumer demands. Protocols for sampling monitoring, and analyzing of materials are available within these testing methods of examiningthe compost to ensure product characterestics, and to prevent environment degradation.

Using standard protocols and methods for reporting, laboratory analysis sampling, and interpretation of test results may improve product in addition to open market horizons and improve quality of compost.Table4.1 shows the test methods used for samples testing in the laboratory and units used.

Table4.1: The methods used in the laboratory and units used(PSI, 2011).

Examination Name	Unit used	Test method
Moisture content	%	EPA 160.3
Electrical conductivity	dS/m	
Organic matter content	% of dry matter	EPA 160.4
Total nitrogen content	% of dry matter	EPA 351/353
Carbon – nitrogen Ratio		
Phosphorus content (P)	% of dry matter	EPA 365
Potassium content (K)	% of dry matter	EPA 3050/7610
Sodium content	% of dry matter	
pH		EPA 9045

4.2.2 Samples collection

The samples were taken randomly from compost available in the local market from the different sources including the the Israeli market; and used mainly in local farms and seedlings-producing farms which are promoted and sold to stores that sell agricultural requirments, and then samples were taken and analyzed in the laboratory of the Palestinian National Agricultural Research Center (NARC) Qabatiya - Jenin in accordance with the standard methods for the analysis of soil and plant and standard methods for analysis of solid compost.Laboratory analysis was carried out to determine the amount of nutrients in the compost and the poassible contaminants such as heavy metals.The tested parameters include pH, EC, and nutrient content (N, P, K), and humidity, organic matter, and the concentrations of Cl, Ca, Mg, Na,Total Nitrogen C/N Ratio. The results were compared with national standards in order to verify the quality of the finished compost.

Samples that have been tested and analyzed included fourteen different samples and were divided into: -

- Six samples of the Ministry of Agriculture - Jericho (Mothalath, Thinnaba, Qawasmeh, Nsarih, Jeftlek, Haifa),

- Two samples of Holland (Tubas, Aqaba).

- One sample factory Agri Plant - Dura.

- One sample from Palestinian Agricultural Relief Committees (PARC) - Jenin.

-One sample from Palestinian Agricultural Relief Committees (PARC) - Wadi Fukin.

- Three Israeli samples (Green Grass, Jenas, Israeli)

4.2.3 Test methods and general testing procedures

The following procedures are applied for all tests except for moisture and density tests and in accordance to standard testing details. The compost was dried in a well-ventilated oven in a temperature of (5 ± 65) degrees celsius for a period of at least 48 hours and then it was cooled by a Dezekitor and then it was weighed. Continuous drying in an oven was used to ensure that the difference between successive two weights is not greater than 0.1 grams, for each individual sample then spreading of the sample was done for further air drying in order to conduct the remaining tests (Qadomi, 2014).

- **Moisture content**

In order to conduct this test no drying of sample is carried out is explained in preceding paragraph. Fifty gram of compost is taken and screened with a sieve which opening is 5 mm with an accuracy of 0.1 g. Compost is then spread on container which weight is known, and the layer thickness should not exceed 1 cm. The container is kept in an oven at 105 ± 5 C for 24 hours and then it was cooled by a Dezekitor and then it was weighed. Continuous drying in an oven was used to ensure that the difference between successive two weights is not greater than 0.1 grams (Qadomi, 2014).

. Moisture content is calculated according to the following equation:

H% = 100*(W1 – W2) /W1

- **H%**= moisture content
- **W1= weight o**f compost before drying (g)
- **W2**= **weight o**f compost after drying (g)

  - **pH**

Distilled water is added to compost that passes the 5 mm openning sieve in a ratio of 1:10 but quantity of compost should not be less than 20 grams, and then stirring for 24 hours at a rotation speed of 125 rpm (Qadomi, 2014).

Then filtration through filter paper equivalent to Autaman 1was carried out for the sample.

The pH was read for the filtered solution on the ndevice for measuring acidity.

- **EC**

It was measured using the electrical conductivity of the Filtred solution, with a measuring accuracy of 0.05 Dsasameenz per meters (Qadomi, 2014).

- **Content of organic matter**

It was done by taking about - 20 grams of compost that has passed through a sieve size 5 slot / mm and dried out of water. First carefulweighing of 0.1 grams. crumbling compost was done and then levelled for a thickness less than 1 cm, on the basis of a known weight vine The vine was kept with compost in the oven at a temperature (5 ± 550) º C for a period of 6 hours at least. Then cooling was carried out through a Aldezictor then weighing was done in the organic matter content is calculated by the equation(Qadomi, 2014):

$\% F = O_1 - O_2 / O_1 * 100$

Of which:

The proportion of organic matter. = F%

Weight after drying compost to 105 º C (g) = O1

weight after drying compost to 550 º C (g) = O2

- **C/N Ratio**

This resembles the ratio between carbon and total nitrogen content and referred to as C/N ratio and is calculated according to the equation(Qadomi, 2014):

C / N

Of which:

- The total nitrogen content = N

- Organic matter content =% F

Calculated the carbon content of the organic matter content by the equation C = %

C = 0.58F%

- **Total nitrogen content**

This is done by taking about 1 gram of compost that has passed through a sieve size 5 slot / mm, and thetotal nitrogen content is determined by Keldhal method or any another equivelant method. In case of difference between different methods, the Keldhal method will be the governing one(Qadomi, 2014).

- **The content of phosphorus, potassium, sodium and heavy metals**

Compost is grinded finely and dried. Then 1.5 g are taken and accurately weighe with an accuracy of 1 mg. Then 18 ml of hydrochloric acid HCL with a specific weight of 1.16 are added to the), then 6ml of nitric acid HNO_3 with a specific weight 1.42 is added to the test tube(Qadomi, 2014).

Filtration is carried out by filter paper equivalent to Autaman 42, and then volume is completed to obtain100 ml(Qadomi, 2014).

Then Examination of the content of sodium, potassium, phosphorus and heavy metals are carried out using photometric device or in the Auto Abozorbishn Spictrofotomitr device and can also examine the content of sodium and potassium from your Votomitrlhba(Qadomi, 2014).

4.3 Questionnaire

The questionnaire was among farmers distributed in the study area; Hebron and its surroundings where the study was carried out.

The population under study consistedfrom farmers of Hebron district, and a random sample was selected. The sample size was 321 farmers

Data collection was done using questionnaire that was designed for this research. Socioeconomic factors as well as practices and trends regarding compost were included in this questionnaire.

The questionnaire included six independent variables:locality type, number of household, gender, type of house education level and Monthly income.

The questionnaire was in Arabic language to enable respondents to smoothly answer it. Interviews were carried out from door-todoor which target was farmers weather female or male. Surveys among compost users were conducted using the questionnaire that was distributed to those who are practising in the field of compost from Engn or vendors or others.

Statistical Package for Social Sciences (SPSS) was used in analyzing the data in addition to Excel Means and ranges were calculated (descriptive statistics) and relationships among different parameters was tessted using Chi square test.

4.3.1 Questionnaire for farmers

Questionnaire included the main questions:-

General Information:Type of locality Gender, LivingEducation, Area of cultivated land

What do you know about compost?

Are you using compost in agriculture? If yes, how often?

What is the price of compost?

Who is your compost supplier?

Do you face any problems with the use of compost? If yes, please explain?

If you don’t use compost, could you please explain why?

What types of fertilisers are you using? (Chemical fertilisers, manure, compost?)

What are the costs of the fertilisers used?

What is the best fertiliser to apply?

How much of which fertiliser do you need per year?

Have you ever produced compost? If yes, how?

What raw materials do you use in composting?

What plants do you cultivate?

Do you think the local market needs compost?

Chapter Five
Results and Discussion

5.1. Compost samples quality: Chemical analysis

The evaluation of compost quality has mainly been based on physicochemical properties. The most relevant physicochemical parameters of compost analyzed in the present study are shown in Table 5.1.

Compost quality testing is necessary to determine the quality of the compost in order to protect the environment and humans from any harmful substances it may contain to maintain the composting process and to verify compost attributes. Results of compost quality testing provide the basis for which recommendations can be made regarding suitable end uses for the product.
Most of the compost quality testing was carried out in Palestinian National Agricultural Research Center (NARC) Laboratories based in Qabatiya - Jenin. The main quality parameters analyzed determine the pH, EC, and nutrient content (N, P, K), and humidity, organic matter, and the concentrations of Cl, Ca, Mg, Na,Total Nitrogen C/N Ratio, in fourteen types of compost samples (Mothalath, Thinnaba, Qawasmeh, Nsarih, Jeftlek, Haifa, Tubas, Aqaba, Dura, PARC, WadiFukin, Green Grass, Gennass, Garden Bio).
Laboratory results showed that the concentration of elements varied considerably from type to other. The results were compared with national standards in order to verify that the compost is identical global and local specifications, and to verify of quality of the finished compost.

Table 5.1 shows the results of the lab analysis for the compost samples.

Table 5.1: Laboratory Analysis of Compost Sample.

	PH	EC /ms	Cl /ppm	Ca /ppm	Mg /ppm	PO4 /ppm	Na /ppm	K /ppm	OM %	NO_3 /ppm	T-N ppm	C/N %
West Bank												
1	7.1	15.8	351.5	30.3	9.7	240	2,600	4,440	27		23,000	
2	8.88	9.5	533	440	336	2,961.8	800	6,175	56.4	27.9	26,000	12.69
3	7.12	14.3	1,633	385	366	2,048.3	1,650	5,250	42.6	23.2	15,000	16.8
4	7.8	2.4	382.3	320	1344	1354.9	500	6,000	5.74	27	5,500	
5	7.25	10.12	665.5	160	336	1661.3	2,000	12,000	26.6	27.3	800	
6	8.1	7.7	3,479	6,000	96	32.8	750	1,250	32.3		20,000	9
7	7.8	7.2	3,195	400	72	32.5	220	635	27.8		14,000	11
Israel												
8	6.56	13.9	433	1,100	792	2,518.9	625	4,325	30.8	27.6	15,000	11.71
9	7.18	4.6	327	770	492	2,491.2	400	1,250	23.6	20.2	22,000	6.3
10	7.16	3.95	332.8	200	528	1633.6	600	18,000	32.1	27	3,640	
11	6.97	9.1	99.1	80	240	1737.5	2,000	8,000	31.36	26	17,150	
12	7.95	6.59	141.6	440	168	1406.4	1,200	4,000	21.9	26.5	4,200	
EVAP Farmers Group												
13	8.56	7	426	330	204	1,882.2	575	4,325	9.8	24.9	14,000	4
14	8.18	11.3	746	220	168	2,297.4	875	4,825	21.6	28.6	15,000	8.4

1) PARC **2)**Thinnaba**3)**Quasmeh**4)**WadiFukin**5)** Dura **6)** Tubas /Holand
7) Aqaba /Holand**8)**Mothalath(Israel)**9)** Haifa (Israel) **10)** Garden Bio (Israel)
11) Green Grass**12)**Gennass (Israel) **13)**An- Nasrih**14)**Jeftlek

pH: acceptable pH range is 6.05–7.5. If it reached 8.0 it should be lowered. This is done by reducing the ammonia volatilization and thus odours are reduced, which makes a favourable environment for microbial organisms.

In this study,pH values of the tested compost samples obtained from organic domestic waste (Thinnaba, Nasrih and jeftlek) presented the highest pH values, and sample from Thinnaba has the highest pH value whereas (Mothalath and Green Grass) showed the lowest pH (Table 3.1).The range of values for pH of the tested samples is between(6.56 - 8.88)where 6.56 represented the lowest value for the Mothalath sample, while 8.88 represented the highest value sample from Thinnaba.

In the present study, pH values were neutral in the composted samples (Quasmeh,Haifa,Garden Bio, Dura,Green Grass) and slightly alkaline in the samples from Thinnaba,An- Nasrih, Jeftlek,Tubas /Holand compost, whereas the Al-Mothalath compost was slightly acidic. Inert materials are those that do not contribute to compost activity and include metals, non biodegradable plastics, glass, stones, etc.

An important factor of the compost is its pH value as it may affect the soil pH and in turn have effect on effect on nutrients availability for the crops. A recommended range for acceptable pH is 6.9-8.3 as proposed by Bord na Mona (2003). Lowering pH should be carried out in case it exceeds the preceeding limits.

Some substances may be added to the compost in order to control the pH to be within the acceptable limits. Adding lime for example, will increase the pH, while adding sulfur will decrease it. Side effects of this addition may arise, making this adjusted compost suitable for some applications and unsuitable for others, and thus restricting its use.

Usually, controlling the pH in the process of composting is easy, and no attention is required in case good aeration is preserved throughout the process, however, there will be production of great amopunts of organic acids in the anaerobic disintegration case within a a stock. Lime, carbonates, ash, and other alkaline materials may act as a buffer and thus keeping the pH within the acceptable limits and preventing it from gouing very low. Addition of alkalinity is usually unnecessary in aerobic decomposition. Actually, it is more harmful as the loss of nitrogen that occurs when ammonia gas is released is greater when the alkalinity is high (high pH). For most organisms, the optimum pH is in the range of 6.5-7.5, so it is better to keep the pH within these limits. But, ascomposting process is a batchprocess, small deviations in the pH are usual.

Lowering the pH will help reducing volatilisation of ammonia and thus reducing odours (Woods End Research Laboratory, 2005).

The pH of Thinnaba and An- Nasrih compost it exceeds about pH range (Schneider et al., 2001). Lowering a high pH lowers ammonia volatilization and reduces odours, favouring a balanced microbial population.

Organic matter (OM): It is calculated by determining the difference in weight before and after combustion. There are no specific limits for the appropriate value, as it depends on many factors such as nitrogen content, age of the compost, the intended use of compost. In all cases it is advantageous to record the initial and the final organic matter values, as these records are valuable in detecting the extent of decomposition.

However, organic matter is necessary for improving some soil properties, such as water holding capacity and nutrient availability. Knowledge of OM content is vital for determining the physical characteristics of compost and its age. Organic matter content is also necessary for estimating the application rates of compost on some crops and for turf establishment. In these cases, test kits are provided to find out the best rates of OM for best results.

The OM contents were higher in Thinnaba sample (56%) in comparison with the other compost samples. In particular, the OM values of WadiFukin composts were the lowest values (5.74%) compared with other values.

Reference to US Composting Council (2003), the organic matter may range from 30-70%, just six samples were in this range. In view of the EPA waste-licensing system, eight sample have OM below 30% which is lower than required (Herity, 2003), and from these eight sample we have two samples from WadiFukin (5.74%) and An- Nasrih (9.8%) contain only a very small percent of OM.

Total Nitrogen: It is very important and considered as one of the main factors in getting good compost. Nitrogen is present in the compost as organic (proteins) and some amounts of these changes into ammonia and nitrate through ammonification and nitrification. The total Kjeldahl nitrogen provides estimates of possible nitrogen available. It is not only the quantity of Nitrogen that is important, but also the form of is important in determining the quality of compost.

In this study the nitrogen contents were larger in the Thinnaba composts than in other samples.

For ten samples out of 14 compost samples tested for TN, the TN content was found to be over 1%, dry wt. By reference to the table (3.1) the concentration of TN must be more than 1.0% dw (Qadomi, 2014). But in four samples from different sources (WadiFukin, Dura, Garden Bio /Israel, Gennass /Israel), it was found that they contain TN of less than 1%. Additional nitrogen fertilizer is required in case the compost is to be utilized as a soil improver or in potting media, to note also that these four samples contain less than 0.6%, so there is a fear that nitrogen immobilization will occur (Herity, 2003).

Available Nitrogen as NO_3-N:

The concentration of NO_3-N in the Jeftlek compost sample has the highest value (28.6 ppm), which is within the recommended limits. All of the samples were above the recommended lower threshold, as NO_3-N content in all compost samples that were tested are more than 20 ppm.

The mean NO_3-N values for the compost samples was found to be between (20.2 ppm-28.6 ppm) which is in the range of favorite Value (20-150 ppm) of NO_3-N content (Qadomi, 2014).

C/N Ratio: The mean of the C:N ratio for the Quasmeh compost was found to be 16.8, this value is less than the recommended limit set up by the EPA which is 25.

In the all Compost samples the average of the C:N ratio was found to be lower than 25, which is below the EPA limit, thus, in accordance to the EPA all the samples are considered mature.

The ratio of C/N can be used to find out the degree of disintegration of compost, so it will represent the maturity of the compost. But, depending only on the C/N ratio may be misleading. It is known that microbial organisms can utilize only part of the carbon such as in composted pine bark and peat. In addition, if nitrogen content is reduced for any reason, C/N ratios will get larger in the final stages of composting.

The C/N ratio will decrease throughout composting process, and this ratio gives indication about the stability of the compost (Sánchez-Monedero et al. 2002), though the feedstock characteristics will govern the final ratios. For compost to be considered stable the C/N ratio should be 17 or less. In this study the al Qwasmeh composts showed C/N ratios (16.8).

EC: It is used as indication of amount of salts in soil, as the electrical conductivity will increase as the percentage of soluble salts increases. Unit of conductivity is dS/m. The main ions contributing to salinity are sulphate, nitrate, ammonia, Cl, K, and Na. Small values are indication of shortage of available salts, on the other hand, large values are indication of high amounts of soluble salts which can prohibit biological activity or can be inadequate to be applied on soil for large amounts as it may increase the soil salinity.

The EC of WadiFukin samples were small if we compare them with that of other samples, which have relatively close values of low nutrient contents.

Range of recommended conductivity in compost is between 2,000-6,000 μS/cm (2-6 dS/m). In the (WadiFukin, Haifa /Israel, Garden Bio /Israel) compost, the mean conductivity of (2.4, 4.6, 3.95 dS/m) was reported which is within this range. Eleven samples did not coincide within these limits, and this may be attributed to the variation in the feedstock and the salts leaching during the process of composting in the windrows which are normally uncovered.

Nutrient elements like Ca, K, Mg, and P are essential factors for the growth of plant. The concentration of such elements may be expressed as available or total form.

PO_4– P: The average of the PO_4-P content of the fourteen samples was calculated and it was lower than the recommended limits between 0.3 to 0.9.

The average of the PO4-P content was recorded to be lower than 0.3 percent dry weight. This is a small value especially none of these samples achieved the minimum threshold limit of PO_4-P.

Available Potassium (K_2O)

The mean content of available K in Thirteen compost samples was found to be more than 0.1% dw which is within the typical range of favorite value more than 0.1% dw of K_2O(Qadomi, 2014), while only one sample (Aqaba /Holand) was below the threshold level 0.1% dw.

Magnesium

The average of the total magnesium concentration in eight of the compost samples was recorded to be more than 0.02% dw, which is just within the typical range of 0.02-0.49% (Qadomi, 2014). In six compost samples the concentration was recorded to be lower than0.02% dw. So, the concentrations of the total magnesium in these samples are very low and may be attributed to the feedstock substances that did not contain appropriate amounts of magnesium (Barker, 1997).

Calcium

The average of the total calcium concentration in two samples (Tubas /Holand, Mothalath/Israel) was recorded to be higher than 0.08% dw, which lies inside the recommended limits of 0.08-1.49% dw (Qadomi, 2014 ; Herity, 2003). Twelve samples of the compost were lower than the recommended limit of 0.08% dw.

5.2 Farmers' Survey Results

Farmer's viewpoints are very essential. So, a questionnaire was set up in order to investigate trends, beliefs, ideas, awareness, and practices of farmers in relation to compost manufacturing and utilization in agriculture. The questionnaire is designed to measure the awareness and concerns of farmers about organic waste (compost) issues.

The questionnaire was designed to achieve some goals of which investigating awareness about the use of organic waste fertilizer and reducing the MSW that is landfilled and the best suitable ways for making use of these wastes and benefitting from them, in order to minimize the environmental impacts, and to get vegetarian food products free of pesticides and chemical contaminant

The response of the farmers for suggesting proposals to improve solid waste management system will be detected.

5.2.1 Socioeconomic characteristics of the Sample

The population sample consisted of 321 farmers. The surveyed sample distribution was based on locality type, number of household members, gender, type of house; education level and monthly income are presented in Table 4.2.

The largest percentage of respondents (90%) with respect to locality type were those who are living in urban areas, whereas the largest percentage (54%) of respondents was who are living in houses where the number of persons in the household is between 5 and 8 persons and the lowest percentage was for the household having less than 5 persons. With respect to gender, the highest percentage (80%) of the respondents was males. With respect to the type of house, the highest percentage (82%) were living in independent house, whereas in terms of education level the highest percentage (47 %) of respondents have higher education, the highest percentage (67%) of respondents have monthly income in the range of 1501 – 3000 NIS.

Table 5.2: Surveyed sample distribution

Independent group	Number of respondents (percentage in parentheses)			Total
Locality Type	Camp	Rural	Urban	100%
	13 (4%)	18 (6%)	290 (90%)	
Number of household	more than 8	5-8	Less than 5	100%
	91 (28%)	174 (54%)	56 (18%)	
Gender		Female	Male	100%
		63 (20%)	258 (80%)	
Type of house	apartment	rented	Independent	100%
	35 (11%)	22 (7%)	264 (82%)	
Education level	higher education	secondary education	preparatory or less	100%
	152 (47%)	125 (39%)	44 (14%)	
Monthly income	more than 3000 NIS	1501-3000 NIS	Less than 1501 NIS	100%
	54 (17%)	215 (67%)	52 (16%)	

5.2.2 Overall Farmers response to the survey questions.

This part of the survey questionnaire was to investigate the willingness and practices of farmers toward, source separation, recycling and reuse of waste on.

Table 5.4shows the results of a question about the need to improve SWMS in the district. It was concluded that about 97% of the respondents said that there is need to improve SWMS. 51% of the respondents see that steps needed for improving SWMS is source separation of SW, while about 45% see steps needed are time scheduling for collecting SW and about 13% see that recycling SW is the practice for improving SWMS.

The results showed that majority of the respondents) 80.7%) said that the best method for disposing SW in respondent viewpoint is recycling as shown in Table 5.3.

Table 5.3: Existing system for SWM service and management in Hebron District.

There is need to improve SWMS (solid waste management)	Yes	97%
	No	3%
Steps needed for improving SWMS	Source separation of SW	51.1%
	Time scheduling for collecting SW	44.5%
	Recycling SW	13.4%
	Improving existing landfill	11.2%
	Constructing new landfill site	10.9%
	Conducting awareness campaigns	9.7%
Methods for disposing SW in respondent viewpoint	Burning	12.7%
	Recycling	80.7%
	Changing into compost	6.6%

Table 5.4: Surveyed sample distribution According to agricultural practices

Type of plants	Vegetables	53.9%
	Fruits	44.5%
	decorative plants	18.4%
	plants in containers	7.2%
	Other	7.2%
	Herbs	4.4%
Planted area	Less than 2 Dunums	33%
	2-5 Dunums	37%
	5 Dunums or more	30%
Annual manure quantity in Kg per dunum	Less than 350 kg	34%
	350-1300 kg	33%
	1300 kg or more	33%
Annual chemical fertilizer quantity in Kg per dunum	Less than 40 kg	31%
	40-200 kg	34%
	200 kg or more	35%
Annual compost quantity in Kg per dunum	Less than 70 kg	34%
	70 -400 kg	36%
	400 kg or more	30%

5.2.3Awareness of citizens

It is interesting to note that 59% of compost source is home product (Table 5.5). This may be good indicator that the farmers are producing their own compost; however, commercial investments should be directed toward compost production on large scale. One of the good indicators is that 88% of respondents have knowledge about compost before. So any awareness campaign should take into considerations these advantages.

One of the findings is that farmers who answered that compost is better than chemical fertilizer was because of environmental reasons in 62% of the cases. This indicates the high manners of citizens regarding environmental issues and the respect they have to their environment. About one third believe that compost is better because it contains useful substances while only 25.7% believe that it is less costly.

Regarding the frequency of adding material for producing compost 43.9% of respondents were adding it seasonally, and 7.9% monthly. This trend should be improved so that it may be on a daily or weekly basis, and not taking so long time for composting. Regarding the knowledge about the importance of compost for plants, 77% believe in its importance. This is a good percentage; however it should be improved more. Better percentage appears for belief of role of compost in defeating plant diseases 85%. A good indicator is 94% believe that compost is a marketable material, which indicates the willingness of these respondents to purchase it.

Table 5.5: Awareness of citizens about compost project and important of compost.

Source of compost	home product	59%
	Purchasing	41%
Supports project for recycling organic waste into compost	Yes	95%
	No	5%
Belief compost is better than chemical fertilizer	Yes	92%
	No	8%
Compost is better than chemical fertilizer because it	contains useful substances	32.4%
	has less cost	25.7%
	environmental reasons and chemical fertilizer has adverse side effects	62%

Knowledge about compost before	Yes	88%
	No	12%
frequency of adding materials for producing compost	Daily	7%
	Weekly	24.6%
	every two weeks	16.7%
	Monthly	7.9%
	Seasonally	43.9%
Desire for producing compost	Yes	88%
	No	12%
Knowledge about importance of compost for plants	Yes	77%
	NO	23%
Belief of role of compost in defeating plant diseases	Yes	85%
	No	15%
Belief that compost is a marketable material	Yes	94%
	No	6%
Privileges of compost over chemical fertilizers	Cheaper	52.6%
	more useful to soil	52.6%
	more healthy food	51.7%
	effects are more sustainable	30.5%

It is positive indicator that the percent of respondents has reached (51%) have been using compost (Table 4.6). but 49 % of respondents are not using the Compost. The reasons for this have been outlined in figure below.

Table5.6: Do you use the compost in your garden before.

Answer	**Count**	**Percentage**
Yes	153	49%
No	162	51%
Sum	315	100%

The majority of respondents (48%) have not been using compost because they do not know how to use, and this slice represents the largest one as shown in Fig5.1.

the other reasons for farmers not using compost is the farmers do not know from where to start (25%), while 23% find it unnecessary, about 17.3% have no place to use it.

Knowing the reasons why citizens do not use the compost will be important in the design of future guidance campaigns and promotions. Clear and user-friendly instructions should be set up.

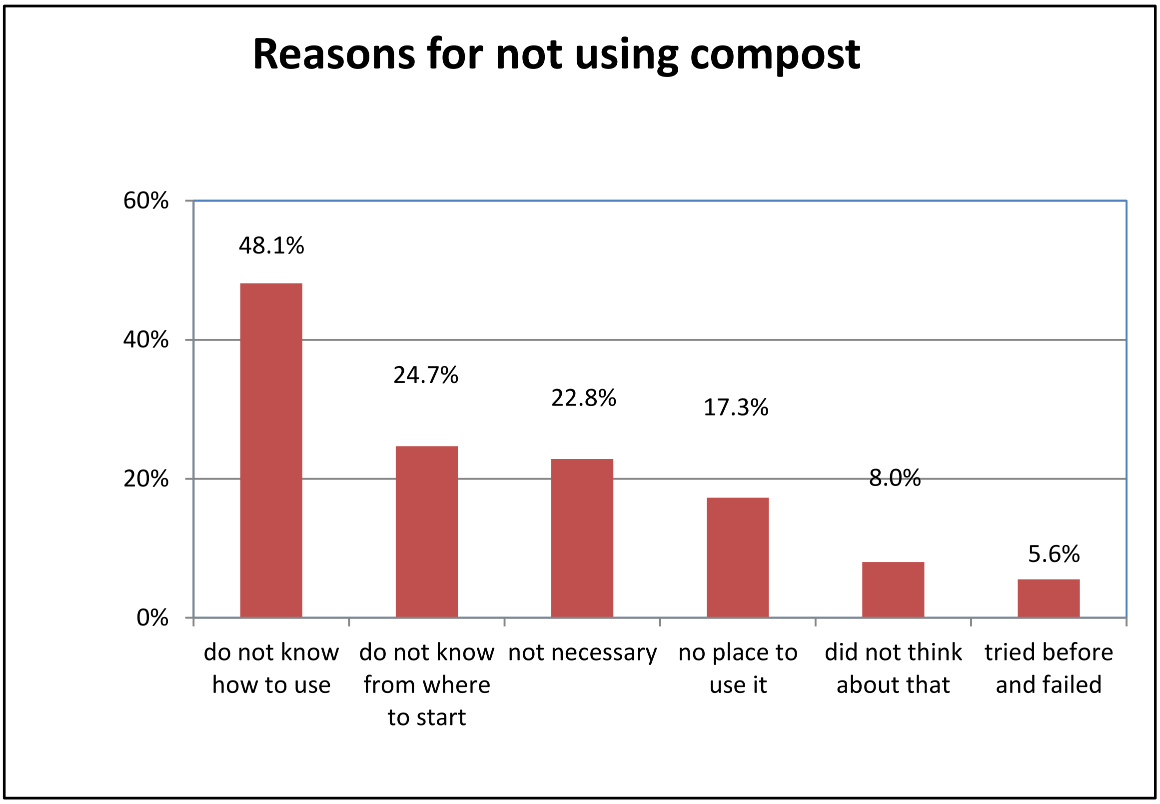

Fig. 5.1. Reasons why farmers do not use Compost.

The percent of respondents has reached (64 %%) who have not been producing compost before (Table5.7), but 36 % of respondents were producing compost before. The farmers who have been producing compost before, use several types of materials for producing compost, this have been outlined in Fig. 5.2.

Table 5.7. Did you produce compost before?

Answer	Count	Percentage
Yes	114	36%
No	198	64%
Sum	312	100%

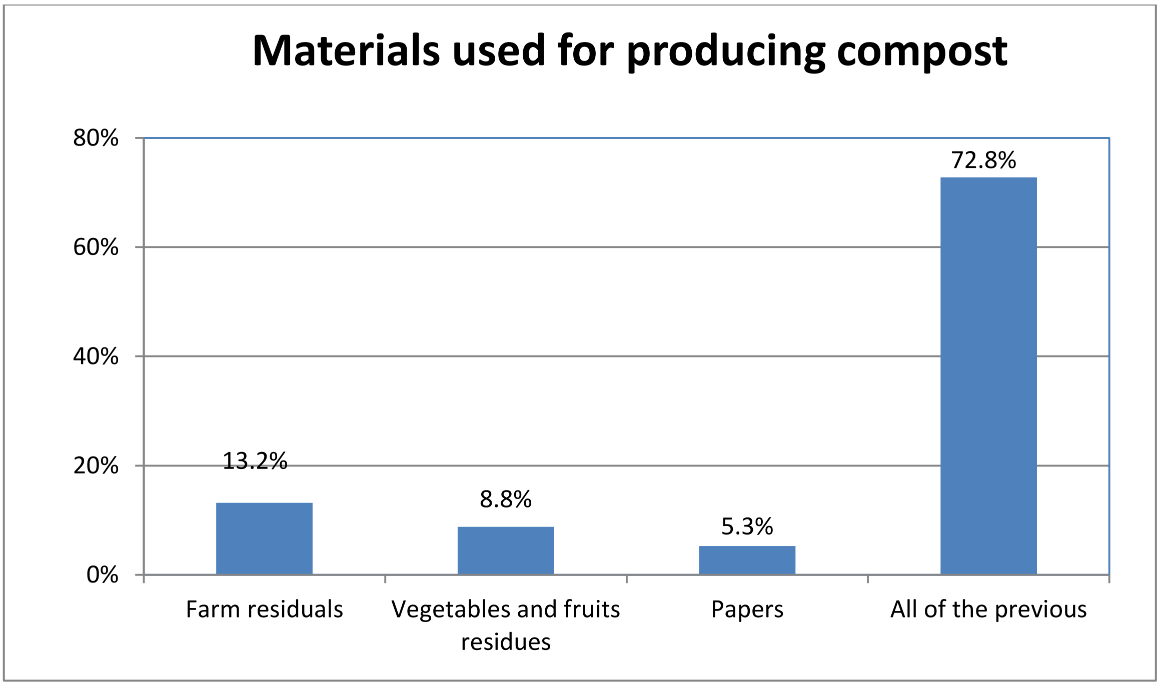

Fig. 5.2: Materials used for producing compost.

83% of respondents did not experience problems in using the compost, which implies that the farmers did not have problems as shown in Table 5.8. 17% of the farmers who did answer have the facing problems in using compost. As the compost provides to the farmers for use in the garden and agricultural activities, it is important for the supplier to ensure that farmers are happy with the service and using of compost. Only 17% of respondents had problems with the using of compost.

Table 5.8. Facing problems in using compost.

Answer	Count	Percentage
Yes	42	17%
No	211	83%
Sum	253	100%

5.2.4 Effect of the level of education on some variables.

In order to investigate the influence of education on the perceptions of farmers that compost is better than chemical fertilizer, cross tabulation using Chi square test was done between education level and the question whether farmers' perception that compost is better than chemical fertilizer (Table 5.9).

Table 5.9. Education level of respondents verses the perception that compost is better than chemical fertilizer

			V37C Compost is better than chemical fertilizer because it produces healthy food without chemicals		
			yes	**No**	**Total**
V06A Education level of respondent	preparatory or less	**Count**	**31**	**13**	**44**
		% within V06A Education level of respondent	**70%**	**30%**	**100%**
	Secondary education	**Count**	**57**	**69**	**126**
		% within V06A Education level of respondent	**45%**	**55%**	**100%**
	Higher education	**Count**	**81**	**70**	**151**
		% within V06A Education level of respondent	**54%**	**46%**	**100%**
Total		**Count**	**169**	**152**	**321**
		% within V06A Education level of respondent	**53%**	**47%**	**100%**

(chi-square = 8.431, df = 2, p-value = 0.0147)

Generally 53% of respondents believe that compost is better, while this percentage increases in the case of farmers who have preparatory or less education and decreases to 45% in the case of secondary education, with a significant statistically relationship as p-value is 0.0147.

The effect of the level of education of respondent on responses of farmers on the variable "I do not use compost because it is not necessary" was also investigated. The Chi square test revealed that there is a statistically significant relationship between the level of education and this variable as shown in Table4.10 with a p-value of 0.0447.

This relationship can be explained as follows only 7% of citizens who have higher education are not using compost because they believe it is unnecessary, while this percentage is 16% in the case of citizens having preparatory or less education, and the same percentage decreases to 70% in case of citizens with secondary education.

Table 5.10. Education level of respondent versus I do not use compost because it is not necessary

			V40C I do not use compost because it is not necessary		
			yes	No	Total
V06A Education level of respondent	preparatory or less	Count	3	16	19
		% within V06A Education level of respondent	16%	84%	100%
	Secondary education	Count	1	68	69
		% within V06A Education level of respondent	1%	99%	100%
	Higher education	Count	5	69	74
		% within V06A Education level of respondent	7%	93%	100%
Total		Count	9	153	162
		% within V06A Education level of respondent	6%	94%	100

(chi-square = 6.213, df = 2, p-value = 0.0447)

5.2.5 Effect of the plant type in farm on some variable

The Chi-square test revealed that there is a statistically significant relationship(i.e., P < 0.05) between plants in the farm are vegetables and farmers perception that compost is better than chemical fertilizer, as shown in table.

Table 5.11shows that 54% of citizen planted the vegetables on the farm the percentage 95% of them belief that compost is better than chemical fertilizer while just 5% belief that compost is not better than chemical fertilizer. This reflects the interest and knowledge of the farmers of the importance and usefulness of compost.

Table 5.11.Plants in the farm are vegetables versus farmers' belief compost are better than chemical fertilizer.

			V23 Belief compost is better than chemical fertilizer		Total
			yes	No	
V10D Plants in the farm are vegetables	Yes	Count	162	8	170
		% within V10D Plants in the farm are vegetables	95%	5%	100%
	No	Count	130	16	146
		% within V10D Plants in the farm are vegetables	89%	11%	100%
Total		Count	292	24	316
		% within V10D Plants in the farm are vegetables	92%	8%	100%

(chi-square = 4.376, df = 1 p-value = 0.036)

There is no significant relationship between the Plants in the farm are herbs and compost is better than chemical fertilizer because its effect are more sustainable in soil (p value = 0.052) as shown in Table 5.12.

Table 5.12.Plants in the farm are herbs versus Compost are better than chemical fertilizer because its effect is more sustainable in soil.

			V37D Compost is better than chemical fertilizer because its effect are more sustainable in soil		Total
			yes	No	
V10A Plants in the farm are herbs	Yes	Count	1	13	14
		% within V10A Plants in the farm are herbs	7%	93%	100%
	No	Count	97	210	307
		% within V10A Plants in the farm are herbs	32%	68%	100%
Total		Count	98	223	321
		% within V10A Plants in the farm are herbs	31%	69%	100%

(chi-square = 3.774, df = 1 p-value = 0.052)

Table 5.12 shows that 7% of the citizens plants in the farm are herbs belief that Compost is better than chemical fertilizer because its effect are more sustainable in soil. While, 93% believes the opposite and does not agree that Compost is better than chemical fertilizer because its effect are more sustainable in soil.

Table5.13.Plants in the farm are vegetables versus Belief that compost is important in defeating plant diseases.

			V34 Belief that compost is important in defeating plant diseases		
V10D Plants in the farm are vegetables			**yes**	**No**	**Total**
	yes	Count	149	19	168
		% within V10D Plants in the farm are vegetables	89%	11%	100.00%
	no	Count	114	27	141
		% within V10D Plants in the farm are vegetables	81%	19%	100.00%
Total		Count	263	46	309
		% within V10D Plants in the farm are vegetables	85%	15%	100.00%

(chi-square = 3.718, df = 1 p-value = 0.054)

There is a statistically significant relationship between plants in the farm are vegetables and farmers' belief that compost is important in defeating plant diseases (.98% of farmers who cultivate vegetables believe that compost is important in defeating plant diseases, while only 11% of the farmers cultivate vegetables do not believe that compost is important in defeating plant diseases.

Table5.14.Plants in the farm are vegetables versus compost source

			V21Compost source		
			Home Product	**Purchasing**	**Total**
V10D Plants in the farm are vegetables	**Yes**	Count	46	22	68
		% within V10D Plants in the farm are vegetables	68%	32%	1.0
	No	Count	27	28	55
		% within V10D Plants in the farm are vegetables	49%	51%	1.0
Total		Count	73	50	123
		% within V10D Plants in the farm are vegetables	59%	41%	1.0

(chi-square = 4.340, df = 1 p-value = 0.037)

It is found that 68% of farmers who cultivate vegetables the compost source is home product, while 32% of them buy the compost from market.

Chapter Six

Conclusions and Recommendations

6.1 Conclusions

Solid waste management in Hebron District is a problem that affects the human and environmental health. This problem requires attention with sufficient and high priority consideration.

The survey results of this study spotlight farmers' feelings toward MSW and organic waste management in Hebron district; 97% of farmers surveyed believed that the district needs to develop and improve a new system for solid waste management. 51% of farmers accepted source separation of waste. Regarding time scheduling for collecting SW, 44.5% considered it as a step needed for improving SWMS, only 13.4% considered recycling SW as a needed step, and only 11.2% considered improving existing landfills as needed step, this percentage goes down to 9.7% regarding conducting awareness campaigns. These percentages show that a large percentage of farmers underestimate the importance of recycling SW and having a good landfill site and also underestimate the importance of awareness of these environmental issues.

From the survey it was found out that in 59% of the cases the source of compost was home product, which indicates a good indicator that farmers are using their own SW to make their own compost. But on the other hand this raise concerns about the quality of the compost produced.

Almost 95% of farmers support having a project for recycling organic waste into compost, 92% of farmers believed that using compost is better than chemical fertilizers in agriculture.

A good indicator was that 88% of respondents knew about compost before. This will facilitate any awareness campaign or project for making use of SW in manufacturing compost. Regarding frequency of adding materials for producing compost it is noted that 43.9% add it seasonally, which implies long inactive period, that may be attributed to carelessness or insufficient knowledge or desire for following up with the composting process. This practice contradicts with the desire of farmers for producing compost which is 88%. In fact, this is the case with many issues that one knows the best thing to be done, but for different reasons, he is not doing it himself. This is clear also regarding the knowledge about importance of compost for plants which is 77%. So there should be efforts to decrease the gap between the knowledge and the practice to accommodate with that knowledge.

It was found that farmers agree and are willing to support the development and improvement of a new system for solid waste management and support source separation of waste (95%). This is also clear from the fact that 92% of farmers believe that compost is better than chemical fertilizer. This means that there is a good chance for the separation system to be successful in the target area, if a proper system is adopted. This is essential to reuse the amount of waste to be disposed.

Lack of enough environmental awareness leads farmers not to comply with innovations in SWM issues like source separation, which have a positive effect on environment by reducing pollution, and a positive economical effect by making use of the wasted materials that are separated.

The results clearly show that insufficient attention is paid for holding awareness campaigns for farmers to present new innovations in SWM and to promote their knowledge, trends, and practices. Educating the farmers and focusing on environmental issues should be highlighted as it is very important for a balanced social, economical, and humanitarian development.

Organic portion forms the largest fraction that requires special consideration, because it is the largest portion of solid waste. Composting of these waste either aerobically or in aerobically should be done for its beneficiary to environment as well as for economical considerations and advantages. Therefore, there is a good opportunity to initiate a composting program in the study area of this study in order to recycle the organic fraction of household waste, and it can pose a good option to prevent the adverse impact of solid waste on the environment and public health. At the same time composting minimizes the waste amount to be land-filled. Best limits of organic matter are in the range of 30-70%, while in this study only six samples are within these limits and the rest are outside these limits. Some samples are very well beyond these limits in the range of 6%. This is unacceptable and the OM should be monitored and controlled in order to enhance the soil properties like the water holding capacity and nutrients content.

The study results assure that composting can be applied successfully as a good option to solid waste management in Hebron district. It can produce a benefit final product with a suitable quality when compared with international standards, and has the potential for many useful uses in agriculture as a soil amendment.

The pH of the samples ranges between 6.56-8.88 compared to the acceptable limits of 6.9-8.3. This is not a large variation and small effort should be carried out to lower the pH values to be within the acceptable limits, as lowering pH will control odors. The high percentage of compost samples (10 out of 14) contained adequate amounts of TN and may be regarded to have good fertilizing capabilities and may be utilized as an organic fertilizer in pots and agriculture. But in the four types of compost (WadiFukin, Dura, Garden Bio /Israel, Gennass /Israel) compost contained is insufficient amounts of TN however, all of compost samples contained adequate amounts of available NO_3-N, the compost samples contained adequate quantities of available NO_3-N that can be used in growing media, but large variation in NO_3-N contents was encountered among the tested samples. There should be more systematic monitoring and control of the composting procedures especially in regard to moisture, temperature, and pH as they may affect the N turnover from organic forms into inorganic forms in order to produce composts with more stable quality having a good fertilizing capacity (Körner and Stegmann 2003.

For the C/N ratio it was found to be 16.8 which indicate mature compost.

The electrical conductivity in most samples (11 out of 14) exceeded the recommended limits of 2-6dS/m. This indicates a high percentage of soluble salts which may affect the biological activity and considered to be unacceptable.

The concentration of available PO_4-P was found to be quite low in the all compost samples. The fourteen compost samples contained inadequate concentrations of PO_4-P. Potassium concentrations of these composts, contained sufficient amounts. However, one sample (Aqaba /Holand) it contained low concentrations of potassium. For the MG in six samples there was no enough MG according to recommendation as it was less than 0.02% of dw. This applies also to CA where 12 out of 14 samples content was below the recommended of 0.08% of dw.

The concentration of K was within the limits.

Furthermore, there are other factors that may support the implementation of the integrated approach, these are:

• Willingness of farmers to separate waste at source;

• Willingness of farmers to use compost;

• Willingness of farmers to pay higher fees for a better service; and

• Availability of trained personnel to operate recycling, composting and incineration facilities.

6.2 Recommendations

Based on the previous results and the entire study, some recommendations may be drawn.

1- Increasing awareness of farmers and citizens in regard to the environmental issues. This can be achieved through awareness campaigns, leaflets, bulletins, workshops, and through media.

Increased financial support for organic domestic waste management sector and awareness campaigns should target farmers to enhance the use of compost for agricultural purposes.

2- Ministry of Education should prepare simple teaching materials in the curriculums, and school children should be encouraged to participate in public awareness in composting and compost advantages over chemical fertilizers.

3-Ministry of Agriculture should encourage farmers to use compost in order to improve the soil properties, and explain the impacts of using fresh manure of animals and poultry or excessive amounts of chemical fertilizers.

4-Environmental health institutions, academic institutions and NGOs should be encouraged to promote and support pilot projects to increase community participation to develop compost facilities.

5-The Higher Joint Service Council for Solid Waste Management in Hebron and Bethlehem districts should give consideration to involve the private sector in solid waste management, especially composting the organic waste.

6-Training efforts should be undertaken to prepare a good team of engineers, managers and workers in order to achieve healthy and safety requirements for composting.

7. Compost as an option should be seriously taken into consideration as the organic portion constitutes the largest fraction among solid waste, paying attention that Hebron provenance possesses considerable areas of agricultural lands.

8. The physical, microbiological and chemical quality of compost that is sold in the Palestinian market should be monitored by the Ministry of Agriculture to make sure that it is safe to use and has the required quality according to the Palestinian and International standards. The pH should be monitored and it is to be lowered if it exceeds the limit of 8.3 by adding sulfur. The OM should be monitored and controlled in order to provide good compost that enhances soil properties; this can be done through control of the materials entering the compost batch. Although in general there was

sufficient N in the samples, but the great variation in its content requires more monitoring and control, to ensure stable compost with less variety. The maturity of compost is good and to sustain this result. The monitoring of input material to the compost batch and the composting process should be carried out to ensure acceptable limits of the EC as they were well beyond acceptable limits. Farmers should add fertilizers that contain P, as the available content of P in almost all samples was very well below recommended limits. Conversely, the concentration of K was enough and no requirement for additional K fertilizer. For the Mg additional fertilizer should be added to substitute the shortage in Mg. This applies also for the Ca where additional Ca fertilizer is required.

9. The high support of farmers to composting should be well addressed and invested in, in order to make use of this high human resource in developing mechanisms for composting and marketing and utilization in agriculture.

References

ADEME, 2005, Impacts environnementaux de la gestion biologique des déchets, Agence de l'Environnement et de la Maîtrise de l'Energie.

Ali, M. (2004). *Sustainable Composting: Case studies and guidelines for developing countries.* Loughborough University. Switzerland: Water, Engineering and Development Centre . http://r4d.dfid.gov.uk/pdf/outputs/R8063.pdf

Applied Research Institute – Jerusalem(ARIJ). (2005). *Analysis of Waste Management Policies in Palestine: Domestic Solid Waste and Wastewater*

Applied Research Institute – Jerusalem(ARIJ) (2000). Infringements in Hebron district, ARIJ, Bethlehem, Palestine.

Asian Institute of Technology (AIT) (2004). Comparative study on municipal solid waste management in Asia. Thailand.www.faculty.ait.ac.th

Australian Alps Best Practice. (2000). *Human Waste Management Workshop.* Canberra and Jindabyne: Karen Civil, Environment ACT and Brett McNamara, Australian Alps national parks (BEST PRACTICE HUMAN WASTE MANAGEMENT WORKSHOP). http://theaustralianalps.files.wordpress.com/2013/12/human-waste.pdf

Barker, A.V. (1997). Composition and uses of compost, agricultural uses of by products and wastes. ASC Symposium Series, American *Chemical Society*, 668:140-162.

Bizukojc, E. L., andLedakowicz, S. (2003). *Stoichiometry of the aerobic biodegradation of the organic fraction of municipal solid waste (MSW).* Technical University of Lodz, Department of Environmental Engineering. Lodz, Poland: Kluwer Academic.

Bord na Mona, 2003, Compost Testing And Analysis Service – Interpretation of Results, available from Bord na Mona, Newbridge, Co. Kildare.

Brinton, W.F. (2000) Compost quality standards and guidelines. An international view. Final report to New York State Association of Recyclers. Woods End Research Laboratory.

BSI (2005) Publicly available specification for composted materials PAS 100: 2005. London: BSI.

California Compost Quality Council (CCQC), (2001). Compost maturity index *June 2001.www.epa.gov/compost/pubs/ca-index.pdf*

Canadian Council of Ministers of the Environment (CCME). (2005). *Guidelines for Compost Quality*. Canada. www.ccme.ca

CEC (2006) Commission Decision of 3 November 2006 establishing revised ecological criteria and the related assessment and verification requirements for the award of the Community eco-label to soil improvers (2006/799/EC). Official Journal of the European Union L325, 28-34.

Center for Integrated Agricultural Systems (CIAS). (2002). *The Art and Science of Composting: A resource for farmers and compost producers.* University of Wisconsin-Madison.
http://www.cias.wisc.edu/wp-content/uploads/2008/07/artofcompost.pdf

De Bertoldi, M., Vallini G., Pera A. (1983). The biology of composting: A review. Waste Manag. Res., 1: 157-176.

DEFRA, 2004, Review of environmental and health effects of waste management: municipal solid waste, Department for Environment, Food and Rural Affairs.Retrieved from: http://archive.defra.gov.uk/environment/waste/statistics/documents/health-report.pdf

Diaz LF, Savage GM, Eggebert LL & Golueke CG. 1993. Composting and recycling municipal solid waste. London: Lewis Publishers.

Dickson, N., T. Richard, Kozlowski, R. (1991). Composting to reduce the waste stream: a guide to small scale food and yard waste composting, 1991.Retrieved on 26/4/2014 from https://www.gov.uk/government/publications.

EC (2014). End-of-waste criteria for biodegradable waste subjected to biological treatment (compost anddigestate). Technical proposals, Final Report, December 2013.http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6869

Environment Agency, UK (2000). An Assessment of the quality of waste derived composts produced by a range of processes, *Environment Agency*, Research and Development Technical Report p229.http://dclg.koha-ptfs.co.uk/vufind/Record/18324

EPA, 1995. Decision Makers' Guide to Solid Waste Management, Volume. II, Washington, (EPA 530-R-95-023), 1995. http://www.epa.gov/waste/nonhaz/municipal/dmg2/index.htm

EPA, US (2009), Backyard Composting It's Only natural, October 2009 EPA530-F-09-026.Retrieved from: http://www.epa.gov/waste/conserve/tools/greenscapes/pubs/compost-guide.pdf

Eunomia, 2000. Economic analysis of options for managing biodegradable municipal waste, Final report of Eunomia Research and Consulting to the European Commission.

European Commission (2001), Applying compost benefits and needsSeminar Proceedings Brussels, 22 – 23 November 2001.Retrieved on November, 2014 fromhttp://ec.europa.eu/environment/waste/pdf_comments/040119_proceedings.pdf

European Commission (2007). End of Waste – Compost Case Study, Working document, March 2007. Retrieved on July2014from: http://www.mmediu.ro/protectia_mediului/gestiune_deseuri/fluxuri_deseuri/06.pdf

EVAP and JICA, 2013. EVAP: Extension for Value-Added Agriculture Project Collaborated Project between the Ministry of Agriculture and Japan International Cooperation Agency (JICA), General Directorate of Extension & Rural Development, Ministry of Agriculture, Palestine State. Vol. 11 (August 2013). www.ershad.moa.pna.ps

Fricke, K., and H., Vogtmann, 1994, Compost Quality: Physical Characteristics. Nutrient Content, Heavy Metals and Organic Chemicals, Toxicological and Environmental Chemistry, Vol 43: 95-114.

Harrison, R. (2011).Soil amendment research, University of Washington, 2011.Retrieved on July2014from: http://followscience.com/content/541193/p-availability-since-the-ongoing-processes-in-an-alder-stand-affect-p.

Herity L. (2003). A study of the quality of waste derived compost in Ireland. Queens University of Belfast, September 2003. Retrieved on July2014from: http://www.cre.ie/docs/quality_wastederived_compost160104.pdf

Holmer, R. (2002). *Basic Principles for Composting of Biodegradable Household Wastes.* Xavier University College of Agriculture. Cagayan de oro City: Urban vegatable Gardening Seminar, Sundayag Sa Amihanag Mindanao Trade.

Holmer R., Gabutin, L., and Schnitzler, W. (1997). Organic fertilizer production from city waste: a model approach. Kasetsart J. (Nat. Sci.) 32: 50 - 53.

Hogg, D., Barth, J., Favoino, E., Centemero, M., Caimi, V., Amlinger, F., Devliegher, W., Brinton, W., Antler, S., 2002. Comparison of compost standards within the EU, North America and Australasia, The Waste and Resources Action Programme (WRAP), 98p.

Hoornweg, D., Thormas, L., and Otten, L. (2000). Composting and its applicability in developing countries. The World Bank Group, 2000, Retrieved on November2014from: https://www.whenyouwish.com/upload/54e42da6-6412-494b-a57c 53d6cb09875d.pdf

Jovičić, N., Jaćimović, M., Petrović, D., Jovičić, G. (2005-2008). A feasibility study of plant for composting organic waste in the city of Kragujevac, Mašinskifakultet, University Kragujevac, Serbia. International Journal for Quality Research, 3(3), 21–27.

Khatib, A., Aqra , F., andYaghi, N. (2010). *Biological Degradation of Olive Mill Solid Wastes Produced from Olive Oil Extraction.* Faculty of Science and Technology, Hebron University, Department of Chemistry. Hebron, West Bank, Palestine: Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 1 (1): 79-84 .

Kwon, K. (2005). Financial feasibility of composting market waste in Vientiane, Lao Pdr. University of Toronto: Copyright by Kyoungsoo Kwon, 2005.Retrieved on November 2014from: https://www.yumpu.com/en/document/view/7254978/financial-feasibility-of-composting-market-waste-in-vientiane-lao-pdr

Lasaridi, K., Protopapa, I., Kotsou, M., Pilidis, G., Manios, T., Kyriacou, A. 2006. Quality assessment of composts in the Greek market: The need for standards and quality assurance. Journal of Environmental Management 80:58-65.

Maeda (2013). JICA Training on composting management; waste reduction through composting: application of Surabaya's Model. Institute for Global Environmental Strategies (IGES)Kitakyushu Urban Centre, 29 July 2013. Retrieved on Jan 17, 2014 from: http://ershad.moa.pna.ps/?TemplateId=2andPageId=120andParentId=0andCatid=1andLang=en

Ministry of Agriculture (MoA), 2011. Reality and the use of compost in Palestine, General Administration of soil and irrigation, The Department of Soil, 2011 (Internal report).

Otten, L. (2001). Wet-dry composting of organic municipal solid waste: current status in Canada. Canadian Journal of Civil Engineering, 28(1), 124-130.

Palestine Standards Institution (PSI), (2011). Final draft of specification for compost, specification of the Palestinian - organic fertilizers MF 2652-2011.

Palestinian Central Bureau of Statistics (PCBS), (2010). Book Hebron Annual Statistical (2). Ramallah, Palestine. November, 2010. http://www.alzaytouna.net/arabic/data/attachments/2010/Stat_al-Khalil_Book_12-10.pdf

Palestinian Central Bureau of Statistics (PCBS), (2013). Localities in Hebron Governorate by Type of Locality and Population Estimates, 2007-2016. http://www.pcbs.gov.ps/site/803/default.aspx

Paulin, B. (2008). Compost production and use in horticulture Western Australian Agriculture Authority, 2008.Retrieved on January 1st, 2014 from: http://archive.agric.wa.gov.au/pc_92627.html

Paulin, B., O'Malley P. (2008). Compost production and use in horticulture. Department of Agriculture and Food. Government of Western Australia: Western Australian Agriculture Authority. Bulletin 4746, ISSN 1833 7236. July 2008. http://archive.agric.wa.gov.au/pc_92627.html

Qadomi, N. (2014). Good compost quality. Soil Department, Ministry of Agriculture (MoA), Ramallah, Palestine.

Rathi, S. (2005). Alternative approaches for better municipal solid waste management in Mumbai, India. Waste Management 26, 1192-1200.

Rothenberger, S., Zurbrugg, C., Enayetullah, I., Sinha, M. 2006. *Decentralised Composting for Cities of Low and Middle-income Countries. A User's Manual.* Sandec, Switzerland, Waste Concern, Bangladesh.

Rouse, J., Rothenberger, S., & Zurbrügg, C. (2008). Marketing compost: a guide for compost producers in low and middle-income countries. Department of Water and Sanitation in Developing Countries . Retrieved on January 1st, 2014 from: http://www.eawag.ch/forschung/sandec/publikationen/swm/dl/marketing_compost_low.pdf.

Sakai, S., Sawell, S. E., Chandler, A. J., Eighmy, T. T., Kosson, D. S., Vehlow, J., et al.(1996). World trends in municipal solid waste management. Waste Management, 16(5-6): 341-350.

Sánchez-Monedero, M.A., Cegarra, J., García, D., Roig, A., 2002. Chemical and structural evolution of humic acids during composting. Biodegradation 13, 361–371.

Schneider R.M., Hughes L.B. (2001). Kentucky compositing manual.Retrieved on January 1st, 2014 from: http://dca.ky.gov/certification/Test%20Preparation%20Documents/Compost%20Manual%207-11-11.pdf

Silva, M., Menduíña, A., Seijo, Y.,Viqueira, F. (2007). Assessment of municipal solid waste compost quality using standardized methods before preparation of plant growth media, Departamento de Edafología y QuímicaAgrícola, Facultad de Farmacia, Universidad de Santiago de Compostela. Santiago de Compostela, Spain, 2007.Retrieved on April25, 2014 from: http://wmr.sagepub.com/content/25/2/99.long

Silva, M., Menduíña, A., Seijo, Y., Viqueira, F.et al.(2007).Assessment of municipal solid waste compost quality using standardized methods before preparation of plant growth media. *Waste Manage Re,25: 99–108*.

Smith, A.; Brown, K.; Ogilvie, S.; Rushton, K.; Bates, J., 2001, Waste management options and climate change, Final Report of AEA Technology to the European Commission.

SV&A, 2005, European eco-label for soil improvers and growing media, Revision 2005 – background document (phase 1), SV&A Sustainability Consultants.

Swedish International Development Cooperation Agency (SIDA) (2006). Urban solid waste management. Urban issue paper. Supplement to Sida's policy for urban development Fighting Poverty in an Urban World. Retrieved on June7th, 2014 from: www.sida.se/urban

Trautmann, N. & E. Olynciw. 2000. Compost Microorganisms. Cornell Composting University. Available from: http://www.cfe.cornell.edu/compost/microorg.html. (accessed 15 April 2007)

United States Environmental Protection Agency (USEPA), (1994). Composting yard trimmings and municipal solid waste, (EPA 530-R- 94-003).Retrieved on July 30th 2014 from:
http://yosemite.epa.gov/ee/epa/ria.nsf/EIO/8F33445A9EF08A6485256B810055028D

Woods End Research Laboratory, 1998, Interpretation of Waste and Compost Tests, Journal of the Woods End Research Laboratory, Vol 1 (4).

Appendix A. Farmers' Questionnaire

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BIRZEIT UNIVERSITY

معهد الدراسات البيئية والمائية

يهدف هذا الاستبيان إلى جمع المعلومات اللازمة لعمل رسالة ماجستير بعنوان

(Quality of organic domestic waste compost and farmers acceptance of its use: a case study from Hebron district in Palestine)

والتي أقوم بإعدادها أنا الطالب محمد عبد المجيد محمد سرحان لاستكمال درجة الماجستير في تخصص علوم المياه والبيئة من معهد الدراسات البيئية والمائية في جامعة بيرزيت .أرجو تعبئة الاستبيان كاملا علما بان المعلومات الواردة فيه سوف تستخدم لأغراض البحث العلمي والأكاديمي فقط.

عزيزي المواطن: بين يديك استبانة لدراسة علمية في مجال تدوير النفايات العضوية المنزلية و تحويلها إلى سماد عضوي (الكومبوست) في محافظة الخليل بهدف معرفة جدوى استخدام سماد النفايات العضوية والحد من انتشار النفايات الصلبة في المحافظة والطرق الانسب لاستخدامها والاستفادة منها ، والتقليل من اضرارها والحصول على منتجات نباتية غذائية خالية من المبيدات والملوثات الكيميائية.

عزيزي المشارك: أرجو أن تشارك بالإدلاء برأيك بصراحة تامة دون الحاجة لذكر اسمك أو ما يوضح هويتك . (تذكر عزيزي المشارك أن دقة النتائج في هذه الدراسة تعتمد على دقة الإجابات على الأسئلة)

اليوم :	التاريخ :...........................	رقمالاستبانة:........................

1V00	☐	اسم التجمع السكاني:..............................
2V00	☐	نوع التجمع السكاني الذي تسكن فيه؟ 1) بلدية 2)مجلس قروي 3) مخيم4) غير ذلك حدد.............
3V00	☐	ما هو عدد أفراد الأسرة ببيتك: ....
4V00	☐	الجنس: 1) ذكر 2) أنثى
5V00	☐	ما هو نوع البيت الذي تسكن فيه؟ 1) سكن مستقل 2) ايجار 3) سكن في عمارة سكنية 4) غير ذلك
6V00	☐	المستوى التعليمي لمجيب عن الأسئلة: 1- أمي 2- ابتدائي 3- إعدادي 4- ثانوي 5- تعليم عالي
V007	☐	ما هو معدل الدخل الشهري؟ 1)من 1 الى 1500 شيكل 2) من 1501 الى 2000 شيكل 3) من 2001 الى 3000 شيكل 4) من 3001 الى 4000 شيكل 5) أكثر من 4000 شيكل
V008	☐	هل تعتقد أن البلدة بحاجة الى تطوير نظام جديد لإدارة النفايات؟ 1) نعم 2) لا
V009	☐	إذا كانت الإجابة نعم ، أي الخطوات التالية تؤيد لتطوير نظام جديد لإدارة النفايات الصلبة؟ 1) فصل النفايات في المصدر بحيث يوضع كل نوع في حاوية خاصة. 2) تحديد أوقات في برنامج زمني يأتي فيه عمال النفايات لجمعها. 3) تدوير النفايات وإعادة تصنيعها. 4) إعادة تأهيل مكب النفايات الحالي.

		5) إنشاء مكب نفايات صحي. 6) عقد دورات تثقيفية وتوعوية من قبل المؤسسات الأهلية لخلق وعي بيئي لدى المواطنين.
10V0	☐	ما هو نوع المزروعات التي تقوم بزراعتها في أرضك؟ 1)أعشاب 2)نباتات في اوعية زراعية 3)نباتات زينة 4) خضروات 5) فاكهة 6) غير ذلك ....
1V01	☐	ماهي مساحة المزرعة التي تمتلكها .... بالدونم.
2V01	☐	مساحة الأرض المزروعة...............................بالدنم.
3V01		كمية السماد البلدي المستخدم في العام .... كغم.
V014		ما هو نوع السماد البلدي المستخدم ....
V015		ماهي تكاليف السماد البلدي المستخدم في العام .... شيكل.
V016		ما هو مصدر السماد البلدي المستخدم ....
V017	☐	كمية السماد الكيماوي المستخدم في العام .... كغم.
V018	☐	تكاليف السماد الكيماوي المستخدم في العام .... شيكل.
9V01	☐	كمية الكمبوست المستخدم في العام .... كغم.
V020	☐	تكاليف الكمبوست المستخدم في العام .... شيكل.
21V0	☐	ما هو مصدر الكمبوست المستخدم ....
2V02	☐	هل تؤيد أنشاء مشروع لتدوير النفايات العضوية المنزلية وتحويلها إلى سماد عضوي (كمبوست)؟ 1) نعم 2) لا

V023	☐	هل تعتقد أن استخدام الكمبوست أفضل من استخدام السماد الكيماوي؟ 1) نعم 2) لا
V024	☐	إذا نعم فما هو السبب: ....
V025	☐	إذا لا فما هو السبب: ....
V026	☐	ماهي النسبة المئوية للتفاوت في الأسعار بين السماد العضوي (الكمبوست) والكيماوي؟ .... %
V027	☐	هل سمعت عن منتج الكمبوست من قبل: 1) نعم 2) لا
V028	☐	هل قمت باستخدام الكمبوست من قبل: 1) نعم 2) لا
V029	☐	هل قمت بإنتاج الكمبوست من قبل: 1) نعم 2) لا
V030	☐	إذا كانت الاجابة نعم ،ماهي المواد التي تستخدمها في انتاج الكمبوست؟ 1) مخلفات الحديقة 2) بقايا الخضار والفواكه 3)الاوراق 4) جميع ما ذكر 5)غير ذلك ....
V031	☐	ماهي الفترة الزمنية التي تحتاجها عادة لإضافة المواد الى الكمبوست الخاص بك؟ 1) يومياً 2) أسبوعيا 3) مرة كل اسبوعين 4) شهريا 5) موسميا
V032	☐	إذا كانت الاجابة لا ،هل لديك الرغبة في إنتاج السماد العضوي(الكمبوست) في المستقبل: 1) نعم 2) لا
V033	☐	هل تعرف أهمية الكمبوست في تغذية النباتات: 1) نعم 2) لا
V034	☐	من وجهة نظرك هل للكمبوست دور في مكافحة بعض أمراض النبات؟ 1) نعم 2) لا
V035	☐	من وجهة نظرك ماهي الطريقة التي يمكن بها التخلص من النفايات : 1)الحرق 2)التدوير 3)أخرى أذكرها ....
V036	☐	من وجهة نظرك هل الكمبوست منتج يمكن تسويقه: 1) نعم 2) لا

V037	☐	بم يمتاز الكمبوست عن السماد الكيماوي: 1) أقل ثمناً من السماد الكيماوي 2) يحسن من خصائص التربة مثل خصوبتها وقدرتها على الاحتفاظ بالماء ومقاومة الأفات 3)يؤدي إلى انتاج غذاء صحي وخالي من الملوثات الكيماوية. 4) يدوم تأثيره في التربة لفترة زمنية طويلة.
V038	☐	هل كان لديك أي مشاكل من استخدام سماد الكمبوست؟ 1) نعم 2) لا
V039	☐	اذا كانت الاجابة نعم فماهي المشكلة ....
V040	☐	إذا لم تقم باستخدام الكمبوست ، لماذا لا؟ 1) أنا لا أعرف كيف أستخدمه 2) أنا لا أعرف من أين أبدأ 3)أنا لا أرى حاجة له. 4) لا يوجد لدي مكان لاستخدام الكمبوست . 5) لم أفكر بذلك. 6) حاولت إنتاجها سابقا وكانت منتجات ذات جودة رديئة 7) غير ذلك.