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Socioeconomic, agricultural, and individual factors influencing farmers' perceptions and willingness of compost production and use: an evidence from Wadi al-Far'a Watershed-Palestine

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Abstract In Palestine, open dumping and/or burning the waste, including agricultural waste, are prevalent practices resulting in emitting leachate and acidifying greenhouse gases. Composting the agricultural waste can reduce emissions and provide 'compost' as an organic fertilizer and soil amendment; yet, it has not been implemented at the national level. To develop a local marketing strategy for compost, this study views a need to identify farmers' perceptions and willingness of compost production and use in agriculture and examine various socioeconomic, agricultural, and individual factors shaping them. The case of Wadi al-Far'a watershed (WFW) is investigated, where farmers practice inappropriate waste disposal and overuse of agrochemicals. A semi-structured questionnaire is administered to 409 farmers through face-to-face interviews. Descriptive statistics, bivariate analyses, Chi-square test, and binary logistic regression are used for data analysis. High acceptance level (84%) is disclosed among farmers in WFW for the hypothetical idea of producing and using compost. Farmers also have high, yet lower, willingness level (63.6%) of the more salient option of producing compost themselves and using it in agriculture. Tenure systems, large cultivated areas, rainfed irrigation, and lack of access to training sessions inhibit farmers' acceptance of the idea of compost production (overall p value = 0.000). Large cultivated areas and rainfed irrigation is also associated with farmers' unwillingness to produce compost, besides high household monthly income, animal or mixed animal-plant farming, experience in compost production, and use of pesticides (overall p value = 0.000).

Keywords Agricultural waste · Compost · Farmers' willingness · Farmers' perceptions · Socioeconomic factors · Palestine

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Introduction

Agricultural waste is waste and residues produced on a farm through various agricultural/farming activities. These activities include, but are not limited to, planting and harvesting fields and trees, creeping plant crops,

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seed growing, poultry houses, livestock breeding and slaughterhouses, dairy farming, horticulture, grazing land, nursery plots, and even woodlands (Ashworth and Azevedo 2009; Worrell and Vesilind 2011). Agricultural waste, including organic and inorganic waste, can be in the form of liquid, slurry, semi-solid, or solid. This research deals with the organic fraction of agricultural solid waste (ASW). This fraction can be a viable input when utilized as an energy source or converted material through biological conversion technologies, such as composting (Asim et al. 2015; UNEP 2009; Pellejero et al. 2017; Malakahmad et al. 2017). 'Composting' is defined as a controlled microbial aerobic decomposition process with the formation of stabilized humus-like organic materials that may be used as soil conditioners and/or organic fertilizer (Külcü and Yaldiz 2014; Sarangi and Lama 2013). That is, the organic amendment of the waste, the so-called "compost", can be used, as a substitute for chemical fertilizers, in cropping systems to enhance plant growth and productivity of agricultural fields (Rajaie and Tavakoly 2016; Azim et al. 2017; Oliveira et al. 2017). It can also be used as a soil conditioner and fertilizer to improve the soil physical, chemical, and biological properties, including porosity, soil water storage capacity, and reduced transpiration (Nguyen 2013; Scoton et al. 2016; Wu et al. 2015; Zhang et al. 2018). Animal manure, crop residues, and bedding materials (e.g., straw and sawdust) generated on the farm are common composting ingredients.

Despite the fact that 90% of the localities in Palestine are provided with solid waste collection services, the efficiency of these services is low, which encourages practices of open dumping or burning the waste (Palestinian National Authority (PNA) 2010). According to the German Society for International Cooperation (GIZ) (2014), only 33% and 44% of the solid waste (including agricultural waste) in Palestine and the West Bank (WB), respectively, disposed in sanitary landfills while the rest is disposed of in random dumpsites and/or burned. Disposal of the waste in open dumps emits methane and leachate from the decomposed waste biomass and burning the waste produces acidifying and greenhouse gases and other local pollutants. The waste sector in Palestine is identified as a major sector contributing to greenhouse gas emissions with 23% in 2011 (EQA 2016). Recycling remains at minimal rate of less than 1% of the waste (GIZ 2014). Hence, the current situation of handling waste in many Palestinian localities poses serious threats to the public health and the environment (Applied Research Institute-Jerusalem (ARIJ) 2007; UNEP 2003). Lack of technical and financial aspects, such as application of waste minimization principles and efficient and adequate collection of service fees, limited financial and human capacities, incomplete legal framework, weak enforcement and monitoring systems, and continued political conflict have constrained the efficiency of the Palestinian solid waste management system (Al-Khatib et al. 2010). Composting, being an environmental friendly recycling method, can reduce greenhouse gas emissions, contributing to mitigation of climate change (Seo et al. 2004).

Besides emission reduction, composting can contribute considerably to alleviating the problem of solid waste management in Palestine. Similar to other developing countries, organic waste in Palestine constitutes the largest waste fraction of municipal solid waste, and thus, composting can considerably reduce the waste stream volume. It was estimated that the total solid waste (i.e., household, industrial, agricultural, and commercial waste) generation rate in Palestine, including the WB, is approximately 78,644 tons/month, out of which 80% is organic waste (PNA 2010). In 2012, the municipal solid waste generation rate in Palestine is estimated at 1.387 million tons, out of which 59% is organic waste (GIZ 2014). Yet, less than 0.5% of the municipal waste is composted (GIZ 2014). In the WB, where the study area of Wadi al-Far'a watershed (WFW) is located, organic waste constitutes 54.3% of the total solid waste produced (Musleh and Al-Khatib 2010). These high proportions of waste of organic origin suggest that "composting might be a highly effective method of reducing waste volume, with an added bonus of producing a valuable agricultural commodity" (ARIJ 2007 p.127) and enhancing soil conservation.

The Palestinian agricultural sector is a major economic sector in achieving food security and absorbing labor force (ARIJ 2007). Economic benefits of composting, therefore, would be considerable. These benefits can be achieved particularly through increased agricultural productivity and reduced purchase of chemical fertilizers (Mohee 2007). Composting can also compensate the shortage of chemical fertilizers in the Palestinian markets resulting from Palestinians' restricted access to these fertilizers imposed by the Israeli occupation in the Second Palestinian Uprising in 2000. The Ministry of Agriculture (MoA), accordingly, prioritized local production of organic fertilizers (MoA 2011).

Based on the aforementioned advantages, composting in Palestine can be a viable solution for reducing pollution, alleviating soil deterioration, conserving water and natural resources, protecting the public health, and improving the economy.

Despite its promise, composting has not been implemented at the Palestinian national level due to political, institutional, regulatory, and financial constraints (ARIJ 2007). Past and newly implemented demonstration composting projects have been suspended due to damage of the composting plants by the Israeli occupation, lack of composting standards, the need to develop market for locally produced compost, adaption of suitable technologies, and unwillingness of the communities nearby the plants to allow building them (ARIJ 2007; Musleh and Al-Khatib 2010).

One of the main aspects to develop a marketing strategy for compost is to assess willingness of the Palestinian farming communities to compost their domestic and agricultural waste and use compost in agriculture. This aspect has been viewed as an inevitable one by the Palestinian researchers (ARIJ 2007; GIZ 2014). Yet, local studies on farmers' willingness to produce or use compost are limited. Despite inconsistencies, international studies conducted in Ethiopia, Cameroon, Ghana, China, and Palestine identify general determinants of farmers' adoption of organic farming including on-farm compost production and/or application. These determinants include farm characteristics, farmers' socioeconomic conditions, livelihood strategies, utilizations of agricultural waste (feed and fuel vs. soil amendment), and individual knowledge and experience (Al-Sari et al. 2018; Danso et al. 2002; Folefack 2008; Kassie et al. 2009; Nigussie et al. 2015; Wang et al. 2016). A survey conducted in Centre Province of Cameroon by Folefack (2008) with 108 farmers discloses that young male farmers practicing agriculture in small plots of lands are the most motivated ones to use compost. Compost being relatively a new product in Cameroon, farmers prefer to test it in smaller plots of lands to prove its efficacy and productivity before extending its use to larger plots. The subsidized non-governmental organizations dealing with compost production and use in agriculture are a main reason behind farmers' motivation to use compost. The high price and transport cost of compost, however, are the main reasons inhibiting compost use by non-compost users.

In China, a review conducted by Wang et al. (2016) for local studies reveals that the value of the agricultural waste being a resource is perceived positively and highly accepted by farmers. This acceptance is also influenced by a combination of socioeconomic, demographic, agricultural, and individual factors. In line with findings of Folefack (2008) on gender and age, Wang et al. (2016) emphasized that acceptance of compost is particularly prevalent among young male farmers. Additionally, proponent farmers are those who are highly educated, highly experienced in technology, aware and enthusiastic of environmental protection, and agriculture constitutes their main source of living and livelihood.

Contradictory findings on gender are disclosed by Kassie et al. (2009) who used a survey conducted with 348 Ethiopian farming households. The survey examines influence of socio-economic characteristics of the household head/farmer (gender, age, education) and those of the household (household labor intensity, access to information and extension services, market distance, household farm size and wealth) as well as farm plot characteristics (ownership, distance, slope, type of soil) on farmers' adoption of compost. It reveals that educated female-headed household that owns livestock and farmland and has access to information and agricultural extension services is a typical adopter of compost use. They also reveal that socioeconomic characteristics influence adoption of compost even when farm plots have similar characteristics.

In partial agreement with Kassie et al. (2009) are findings from the socioeconomic survey of Nigussie et al. (2015) with 220 farmers in Ethiopia. The authors' binary logistic model reveals that regardless of gender, age, and income, educated household head (farmer) who has better access to extension services and owns the agricultural land is willing to participate in urban waste composting more than the less educated farmer who has less access to information and adopts tenure system. Additionally, it uncovers farmers' experience of compost contributing significantly in their willingness to participate in composting. Al-Sari et al. (2018) study in Hebron-Palestine, however, shows insignificant influence of socioeconomic characteristics, such as farmers' income, livelihood strategy reflected in type of plants they cultivate, and size of cultivated lands, on farmers' attitudes towards compost use. Alternatively, the authors report that farmers' attitudes are conditional to individual factors such as farmers' prior experience of compost use and their perceived benefits and superiority of organic fertilizers (compost) over chemical ones.

Given the limited Palestinian body of research examining farmers' willingness to produce or use compost, this study views a need to identify farmers' perceptions and willingness of compost production and use in agriculture. It also examines various socioeconomic, agricultural, and individual factors shaping farmers' perceptions and willingness. Socioeconomic factors such as gender, age, educational level, household monthly income, etc. Agricultural factors such type of the agricultural business (plant vs. animal agriculture), type of the agricultural system (land ownership vs. rental or sharecropping), area of cultivated lands, etc. Individual factors are factors related to the individual such as knowledge and experience associated with compost production and use.

Farmer's perception in this study refers to farmer's opinion about the general concept or the hypothetical idea of compost production. Farmer's willingness, however, assumes farmer's readiness for producing and using compost in practice—a specific more tangible proposal that is closer to a reality. The assumption is that the support for the mere idea of compost production (i.e., a general option) cannot be assumed an approval or willingness of its implementation (i.e., a salient option). Social studies on waste reuse options, mainly treated wastewater (WW) reuse, highlight the issue of salience. They reveal changes in perceptions of respondents who become less supportive as reuse options become more salient (Marks 2004; Russell and Hampton 2006). The study findings provide insights for academics and policy-makers on opportunities and constraints associated not only with farmers' acceptance of the idea of compost production but also with their willingness to produce compost themselves. They can support conservation agriculture policies with action plans to promote adoption of organic farming practices including composting. Additionally, they can be consulted in further development and upgrading of the Palestinian guidelines and policies for agricultural waste management.

Research design and methodology

This is a cross-sectional study that adopts a case study research design. While this design often falls short in representativeness, it provides depth in analysis and interpretations of issues intrinsic to the case investigated and in its particular context (Yin 2003). It is ideal for studies, such as the current one, seeking understanding of the participants' different perspectives (Green and Thorogood 2004) and aiming at providing explanations that cope with the complexity and subtlety of real-life situations through studying processes and relationships within a setting (Denscombe 2007). The case study approach is, therefore, context-sensitive and particularly appropriate in areas of research where little is known (Eisenhardt 1989). It is commonly identified as a "theory-building" exercise since its exploratory nature and "subjectivity" allow for uncovering and developing new casual relationships (Gerring 2004).

Study area

Wadi al-Far'a watershed (WFW), a natural watershed comprising a valley over 20 km long and up to 2 km wide, located in the northeastern region of the WB as part of the Lower Jordan Valley, is the "case" selected for investigation. WFW has an area of 331 km^2 (that accounts for 6% of the WB area) with a population of 60,927 (PCBS 2018). Its total agricultural area is 124,790 dunums, which constitutes 37.8% of the total land-use in the watershed (Environmental Quality Authority (EQA) 2006). Fruit, vegetables, and livestock are common agricultural activities in WFW, which can generate considerable amount of organic waste. Figure 1 shows a close-up map of the West Bank locating Wadi Al-Far'a Watershed within the WB's districts, adopted from Shadeed (2008).

WFW is a unique ecosystem characterized with climatic variability, availability of fresh water from natural springs and wells, and high soil fertility (EQA 2006). These conditions make it one of the most important ecological and agricultural productive areas in the WB—known as the "food basket of the WB". Hence, the case of WFW was selected based on the issue of necessity reflected in its agricultural importance and the poor environmental and sanitation conditions prevailing in it. Discharge of raw wastewater into the environment, random dumping sites and burning of waste, inappropriate management of animal waste, and overuse of agrochemicals are prevailing practices and main sources of pollution in WFW (Thawabe 2006). Accordingly, it becomes "necessary" and of considerable national benefits to conduct this study to improve and sustain the livelihood of main farming communities in the WB.

Data collection

Farmers' questionnaire

The study data were collected through (1) direct semi-structured field observations and (2) face-to-face interviews with individual farmers in WFW using a standardized semi-structured questionnaire. The observations were conducted to observe local conditions, human activities, and farmers' practices associated with ASW management. They provided supplementary data to the interviews. The interviews provided major insights on what shapes farmers' perceptions and willingness of compost production and use, focusing on socioeconomic, agricultural, and individual factors. Farmers' questionnaire, hence, collected information on two dependent variables including farmer's perception of the idea of compost production in WFW and farmer's willingness to produce and use compost after receiving relevant training. Each of the dependent variable is a dummy variable. The variable of farmer's perception reflects whether a farmer accepts or does not accept the idea of compost production in WFW. The variable of farmer's willingness reflects whether a farmer is willing or unwilling to produce and use compost after receiving relevant training.

The questionnaire also covered 24 independent variables related to the following three categories:

- Farmers' socio-economic and demographic characteristics including gender, age, number of household members, level of education, type of farmer's work, average household monthly income, and area of residence in WFW.
- Farmers' agricultural profile including type of agricultural business (plant vs. animal agriculture), type of agricultural system (land ownership vs. rental or sharecropping), type of practiced agriculture (rainfed vs. irrigated agriculture), area of cultivated lands, farm's production of plant waste, method of plant waste management, farm's production of animal waste, method of animal waste management, kind of fertilizers used, use of pesticides.
- Individual variables related to farmer's perception and willingness of compost production and use, including farmer's previous knowledge of compost, previous use of compost as a fertilizer, experience of compost production, previous training attained on compost production, perceived economic benefits of compost production. The coming section "Results and discussion" describes the quantitative and qualitative variables used in the study with frequencies and percent distribution of farmers' responses.

Farmers' questionnaire was developed in English language and translated to Arabic. Afterwards, it was submitted to a pilot test with 10 randomly selected respondents from WFW and adjusted accordingly.

Procedures of farmers' sampling, selection, and interviews

A statistically representative sample size of 409 farmers is determined using a stratified random sampling technique considering ten stratums. The stratums represent five farming communities in the upstream area of the watershed (Talluza, Ras Al-Far'a, Wadi Al-Far'a village, Al-Badan, and Tamoun) and five communities in the middle and downstream areas (Al-'Aqrabaniyya, An-Nassariyya, 'Ein Shibli, Froush Beit Dajan, Al-Jiftlik). The premise stems from expected cross-location variations in farmers' perceptions and willingness to produce and use compost. A sample from each stratum is taken in a number proportional to the stratum's size when compared to the population of the stratum. Field visits are conducted to the WFW in July and August 2017. The simple random sampling method is used to select the study respondents. A total of 409 farmers are interviewed, of which 301 (73.6%) are from the upstream area and 108 (26.4%) are from the middle and downstream areas. The interviews are conducted in Arabic language—the participants' mother tongue language—and each interview lasts for 25–35 min.

Data analysis

The questionnaire data is analyzed using statistical and econometric methods using the Statistical Package for Social Science (SPSS) software (SPSS Inc., Chicago, IL, USA) version 20. Descriptive statistics (including frequency, percentage, mean, and standard deviation) are used to describe the socioeconomic characteristics and agricultural profile of the study population. Bivariate analyses are conducted to compare, from the one hand, the characteristics of farmers who accept the idea of compost production in WFW to those of farmers who refuse it and the characteristics of farmers who are willing to produce and use compost to those of farmers who are unwilling, from the other hand. Farmers who did not answer the question on perception (73 farmers) or the question on willingness (88 farmers) are excluded from the bivariate and regression analyses. This results in reduction in sample size to $n = 336$ for the 'perception' question and $n = 321$ for the 'willingness' question. The statistical significance of the relationships

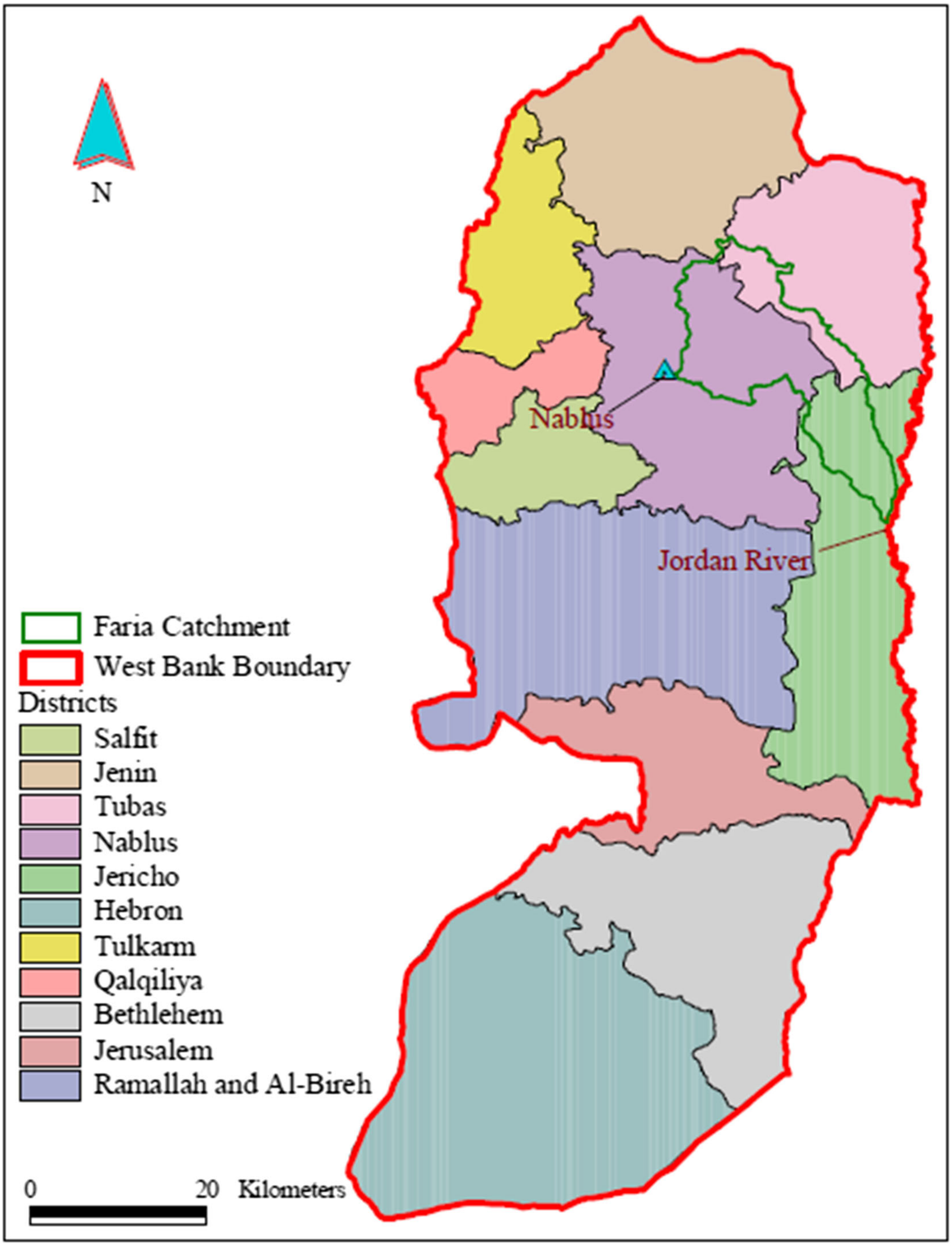

Fig. 1 A close-up map of the West Bank locating Wadi al-Far'a watershed within the WB's districts (adopted from Shadeed 2008)

between the dependent and independent variables was tested. Chi-square test and Student's *t* test (independent samples test) are used to test for the statistical significance of the categorical and continuous variables, respectively. Variables with *P* value < 0.05 are considered statistically significant.

Finally, a binary logistic regression is performed and a logistic regression model (LRM) is developed for each of the dependent variables of farmer's perception (LRM-P) and farmer's willingness (LRM-W) as per Ali et al. (2012), Al-Khateeb et al. (2017), Al-Sari et al. (2011), Al-Sari et al. (2018), Begum et al. (2006), Begum et al. (2009), and Ittiravivongs (2012). While the bivariate analyses examine the effect of each of the influencing factors independently, the LRMs examine the effect of a factor when joint with the effect of other factors. The selection of the independent variables that are included in the regression model is based on their P values and their collinearity with other variable(s). That is, variables revealed in the bivariate analysis with P value < 0.25 and are not strongly correlated to other variable(s) are included in the regression analysis. When variables found to be strongly correlated to each other, the selection of any of them is based on testing the effect of each on the dependent variables adjusting for the other variables and choosing the one that has the best effect. Tables 1 and 2 present description of the independent variables included in the LRM-P and LRM-W, respectively.

The general form of each of the LRM is as follows:

$$Log\frac{P_i}{1-P_i} = Z_i = \beta_0 + \beta_i X_i + e \quad (1)$$

where Pi is the farmer's perception of compost production in WFW and/or farmer's willingness to produce and use compost in agriculture; $Pi = 0$ if the farmer's perception is positive (yes) and/or willing to produce and use compost; and $Pi = 1$ if the perception is negative (No) and/or unwilling to produce and use compost; Xi = the independent variable; βo = a constant term; βi = a coefficient of the independent variable; e = the error term and $i = 1, 2 \ldots, n$ which is the number of the independent variables in the model. The direction of the relationship between the dependent variable Pi and the independent variable Xi is determined by the sign of the coefficient βi.

Coefficients in the LRM are estimated by the maximum likelihood method. The probability of a certain event occurring was estimated by a logistic regression model through calculating the changes in the logarithm of the dependent variable. The likelihood function as defined in Eq. (2) expresses the values of β in terms of known and fixed values of y (β is related to P) and is derived from the probability distribution of the dependent variable so that the values of β that maximize the output of Eq. (2) are the maximum likelihood estimates (Begum et al. 2009).

$$L\left(\frac{\beta}{y}\right) = \prod_{i=1}^{N} \frac{n_i!}{y_i!(n_i-y_i)!} P_i^{y_i}(1-P_i)^{(n_i-y_i)} \quad (2)$$

The statistical significance of each coefficient is evaluated using the Wald test (Begum et al. 2009).

Table 1 Description of the independent variables in the LRM-P

Variable	Description	Definition
X_1	Age (year)	1 = 17–31 2 = 31–40 3 = 41–49 4 = 50 or more
X_2	Level of education	1 = Illiterate 2 = Primary 3 = Lower secondary 4 = Upper secondary 5 = Post-secondary or university
X_3	Average household monthly income (NIS)	1 = 1500 or less 2 = 1501–2000 3 = 2001–2500 4 = 2501–4000 5 = 4001 or more
X_4	Type of agricultural business	1 = cultivating vegetables 2 = growing trees 3 = growing grains 4 = combined plant agriculture 5 = poultry farming 6 = livestock raising 7 = combined animal agriculture 8 = combined plant and animal agriculture
X_5	Area of cultivated agricultural land (dunum)	1 = 1–3 2 = 4–8 3 = 9–15 4 = 16 or more
X_6	Type of practiced agriculture	1 = rainfed agriculture 2 = irrigated agriculture 3 = rainfed and irrigated agriculture
X_7	Type of the agricultural system	1 = ownership 2 = rental 3 = sharecropping 4 = combination of more than one system
X_8	Knowledge of compost use or production	1 = Yes 2 = No
X_9	Training attained on compost production	1 = Yes 2 = No
X_{10}	Previous use of compost as a fertilizer	1 = Yes 2 = No
X_{11}	Experience of compost production	1 = Yes 2 = No

Table 2 Description of the independent variables in the LRM-W

Variable	Description	Definition
X_1	Age (year)	1 = 17–31 2 = 31–40 3 = 41–49 4 = 50 or more
X_2	Level of education	1 = Illiterate 2 = Primary 3 = Lower secondary 4 = Upper secondary 5 = Post-secondary or university
X_3	Average household monthly income (NIS)	1 = 1500 or less 2 = 1501–2000 3 = 2001–2500 4 = 2501–4000 5 = 4001 or more
X_4	Type of agricultural business	1 = cultivating vegetables 2 = growing trees 3 = growing grains 4 = combined plant agriculture 5 = poultry farming 6 = livestock raising 7 = combined animal agriculture 8 = combined plant and animal agriculture
X_5	Area of cultivated agricultural land (dunum)	1 = 1–3 2 = 4–8 3 = 9–15 4 = 16 or more
X_6	Type of practiced agriculture	1 = rainfed agriculture 2 = irrigated agriculture 3 = rainfed and irrigated agriculture
X_7	Kind of fertilizers used	1 = chemical fertilizers only 2 = compost only 3 = chemical fertilizers + compost 4 = dried animal manure 5 = wet animal manure 6 = chemical fertilizers + dried manure 7 = combinations of the above
X_8	Use of pesticides	1 = Yes 2 = No
X_9	Knowledge of compost use or production	1 = Yes 2 = No
X_{10}	Training attained on compost production	1 = Yes 2 = No
X_{11}	Previous use of compost as a fertilizer	1 = Yes 2 = No
X_{12}	Experience of compost production	1 = Yes 2 = No

$$W_i = \left(\frac{\beta_i}{S.E_{\beta_i}}\right)^2 \quad (3)$$

Where $i = 1, 2 \ldots, n$ and SE = standard error.

The model was evaluated using four different tests: the log-likelihood function, the omnibus test, Cox and Snell R^2, and NaglekerkeR^2 (Al-Khateeb et al. 2017; Al-Sari et al. 2011, 2018). The log-likelihood function is used to measure the goodness of fit and is defined as presented in Eq. (4) (Begum et al. 2009).

$$Log{-}likelihood = \sum_{i=1}^{n} \left[Y_i \ln\left(\hat{Y}_i\right) + (1-Y) ln\left(1-\hat{Y}_i\right)\right] \quad (4)$$

where Y_i = the actual result and Y_i = the predicted probabilities of this result. This is also quoted as -2log-likelihood because it has an approximate Chi-squared distribution. The Omnibus test indicates the goodness of fit if the coefficients of the variables in the model are all jointly equal to zero. Cox and Snell $R^2$and Nagelkerke$R^2$are indicating the proportion of the variation in the dependent variable explained by the independent variable of the model. Since Cox and Snell R^2 cannot achieve a maximum value of 1, NagelkerkeR^2, which is an adjusted version of the Cox and Snell R^2 and covers a full range from 0 to1, is used because it is often preferred (Bewick et al. 2005). The multi-collinearity occurrence between the independent variables is studied using the correlation matrix in order to insure that none of each two independent variables have a correlation in excess of 0.7.

Results and discussion

Respondents' socioeconomic and demographic characteristics

Results of frequencies and percent distributions reveal that more than quarter of the interviewed farmers (n = 409) are women (28%). They are relatively young with an average age of 40.7 years and more than half of them (57.7%) are between 31 and 49 years old. Table 3 presents frequencies and percent distribution of responses related to farmers' socio-economic and demographic characteristics. Respondents have an average household size of 6.12 members with the highest percentage (32%) for those having 6–7 members. The majority of the them

Table 3 Frequencies and percent distribution of responses related to farmers' socio-economic and demographic characteristics (n = 409)

Variable	*N* (%)
Gender	
Male	293 (71.6)
Female	116 (28.4)
Age	
17–30	72 (17.6)
31–40	114 (27.9)
41–49	122 (29.8)
≥ 50	101 (24.7)
	Mean = 41.7, SD = 10.9
Number of household members	
1–3	65 (15.9)
4–5	106 (25.9)
6–7	131(32)
≥ 8	107(26.2)
	Mean = 6.12, SD = 2.61
Level of education	
Illiterate	2 (0.5)
Primary	39 (9.5)
Lower secondary	91 (22.2)
Upper secondary	147 (35.9)
Post-secondary or university	130 (31.8)
Type of work	
Farmer only	257 (62.8)
Other work (addition to agriculture)	152 (37.2)
Average household monthly income (NIS) (n = 407)	
≤ 1500	19 (4.7)
1501–2000	46 (11.3)
2001–2500	173 (42.5)
2501–4000	123 (30.2)
≥ 4001	46 (11.3)
Area of residence in WFW	
Upstream area	301 (73.6)
Middle and downstream area	108 (26.4)

(67.7%) attained upper-secondary and post-secondary educational levels while 22.2% and 9.5% attained lower-secondary and primary levels, respectively, and less than 1% are illiterate. Around 63% of the interviewed farmers work only in agriculture while the rest (37%) have other kind of work additional to agriculture. As for income, the highest percentage of respondents (42.5%) consisted of those whose households have an average monthly income of 2001–2500 New Israeli Shekels (NIS) (On 17 June 2018, 1 NIS = 0.28 USD) (equivalent of 560–700 USD). Only 4.7% and 11.3% of farmers' households earn an average monthly income that is less than 1500 NIS (= 420 USD) and more than 4001 NIS (≈ 1120 USD), respectively.

Respondents' agricultural profile

Irrigated agriculture is the dominant type of agriculture practiced by 54.3% of the respondents, followed by combined rainfed and irrigated agriculture (28.0%) and rainfed agriculture (17.7%). Table 4 shows frequencies and percent distribution of responses related to farmers' agricultural profile. Ownership of the agricultural land is the dominant agricultural system practiced by 55.3% of the respondents if compared to the rental and sharecropping systems (24.9% and 19.3%, respectively). As for area of cultivated lands, the highest percentage (39.1%) of the respondents cultivate areas between 1 and 3 dunums, followed by 27.7% who cultivate 4–8 dunums while lower percentages of farmers cultivate areas between 9 and 15 dunums (16.3%) and 16 dunums or above (16.8%).

More than half of the interviewed farmers practice exclusively plant agriculture (54.8%) with the highest percentage goes to cultivation of vegetables (39.6%). The rest goes to growing trees (4.9%), grains (2%), or both (8.3%). Around a quarter (25%) of farmers practice combined plant and animal agriculture and around 20% practice exclusively animal agriculture including mainly poultry (6.1%) and livestock (12.5%). Hence, farms run by three quarters of the respondents (75%) produce plant waste while farms run by around 47% of the farmers produce animal waste.

As for waste management methods, data shows that most plant waste is not reused, and if so, they are reused as fertilizer or animal feed. Animal waste (manure), however, is mostly used as fertilizer. More than half of the farmers (58.9%) whose farms produce plant waste (n = 301) do not treat or reuse the waste to benefit from it. Rather, they burn the waste (41.2%), dispose it randomly or inside household waste containers (13%), or donate it to other farmers (4.7%). In contrast, 39.5% of the farmers benefit from the plant waste produced on their farms by reusing it as a soil fertilizer (whether immediately or after decomposition) (23.6%) or animal feed (15.9%). Contrary to plant waste, the majority of the farmers (52.8%, n = 191) benefits from the animal

Table 4 Frequencies and percent distribution of responses related to farmers' agricultural profile

Variable	N (%)
Type of practiced agriculture ($n = 368$)	
Rainfed agriculture	65 (17.7)
Irrigated agriculture	200 (54.3)
Rainfed and irrigated agriculture	103 (28.0)
Type of agricultural system	
Ownership ($n = 374$)	207 (55.3)
Rental	93 (24.9)
Sharecropping	72 (19.3)
Combinations	2 (0.5)
Area of cultivated agricultural land (dunum) ($n = 368$)	
1–3	144 (39.1)
4–8	102 (27.7)
9–15	60 (16.3)
≥ 16	62 (16.8)
Type of agricultural business ($n = 409$)	
Cultivating vegetables	162 (39.6)
Growing trees	20 (4.9)
Growing grains	8 (2.0)
Combined plant agriculture	34 (8.3)
Poultry farming	25 (6.1)
Livestock raising	51 (12.5)
Combined animal agriculture	5 (1.2)
Combined plant and animal agriculture	104 (25.4)
Farm's production of plant waste ($n = 407$)	
Yes	305 (74.9)
No	102 (25.1)
If the farm produces plant waste, method of plant waste management ($n = 301$)	
Burn	124 (41.2)
Dispose randomly or in household waste containers	39 (13.0)
Use as soil fertilizer	71 (23.6)
Use as animal feed	48 (15.9)
Donate	14 (4.7)
Combinations of the above	5 (1.6)
Farm's production of animal waste ($n = 405$)	
Yes	192 (47.4)
No	213 (52.6)
If the farm produces animal waste, method of animal waste management ($n = 191$)	
Burn and/or dispose randomly	4 (2.1)
Use as soil fertilizer (wet or dried manure)	74 (38.7)
Sell	27 (14.1)
Donate	22 (11.5)
Combinations of the above	64 (33.5)
Kind of fertilizers used ($n = 374$)	
Chemical fertilizers only	141 (37.7)
Compost only	2 (0.5)
Chemical fertilizers + compost	48 (12.8)
Dried animal manure	105 (28.1)
Wet animal manure	20 (5.3)
Chemical fertilizers + dried animal manure	47 (12.6)
Combinations of the above	11 (2.9)
Use of pesticides ($n = 407$)	
Yes	323 (79.4)
No	84 (20.6)

waste produced in their farm with 38.7% use the waste as a soil fertilizer (whether wet or dried manure) and 14.1% sell it. Only 2.1% of the farmers burn or dispose animal waste randomly and 11.5% donate it while 33.5% depend on combinations of the above management methods.

Regarding kind of soil fertilizers, it is found that the highest percentage of farmers (37.7%) use exclusively chemical fertilizers. A lower percentage of them (≈ 34%) use exclusively organic fertilizers including dried animal manure (28%), wet animal manure (5.3%), or compost (0.5%). A quarter of the farmers (25.4%) use a combination of chemical and organic fertilizers including 12.8% use chemical fertilizer combined with compost and 12.6% use chemical fertilizer combined with dried animal manure. Finding shows a higher number of farmers ($N = 172$) use purchased or donated animal manure as a fertilizer (whether exclusively or combined) than number of farmers who use animal manure produced from their own farms ($N = 74$). Finally, data discloses that the vast majority of the farmers use pesticides (79.4%).

Farmers' perceptions and willingness of compost production and agricultural use

The study findings reveal high acceptance level among farmers in WFW for the idea of producing and using compost for agriculture in the watershed area. Around 84% ($n = 336$) accept this idea compared to only 16% who refuse it. Table 5 presents frequencies and percent distribution of farmers' responses to perceptions and willingness of compost production and further related questions. When farmers are asked about the more salient

Table 5 Frequencies and percent distribution of farmers' responses to perceptions and willingness of compost production and further related questions

Variable	N (%)
Perception of compost production in WFW (n = 336)	
Yes	282 (83.9)
No	54 (16.1)
Willingness to produce and use compost after receiving training (n = 321)	
Yes	204 (63.6)
No	117 (36.4)
Perceived incentives of compost production in WFW (n = 280)*	
Adequate human and technical assets **	107 (38.2)
Gaining economic benefits	37 (13.2)
Farmers' preference for organic fertilizers	5 (1.8)
Mitigation of health and environmental problems	115 (41.1)
Combinations of the above	16 (5.7)
Perceived constraints of compost production in WFW (n = 51)*	
Lack of human and technical assets	10 (19.6)
Compost production is more expensive than purchasing chemical fertilizers	17 (33.3)
Farmers' preference for chemical fertilizers	12 (23.5)
Combinations of the above	12 (23.5)
Knowledge of compost use or production (n = 408)	
Yes	321 (78.7)
No	87 (21.3)
Previous training attained on compost production (n = 408)	
Yes	69 (16.9)
No	339 (83.1)
Previous use of compost as a fertilizer (n = 408)	
Yes	164 (40.2)
No	244 (59.8)
Reasons of not using compost (n = 240)*	
I do not know about it	59 (24.6)
I do not know how to use it or produce it	52 (21.7)
I do not see its importance	66 (27.5)
Compost is more expensive than chemical fertilizer	18 (7.5)
Inadequate area of agricultural lands	40 (16.7)
Combinations of the above	5 (2.0)
Previous experience of compost production (n = 407)	
Yes	63 (15.5)
No	344 (84.5)
In case of experience, perceived economic benefits of compost production (n = 60)	
Yes	47 (78.3)
No	13 (21.7)
In case of perceived economic benefits, they can be achieved through reduce or avoid purchase of (n = 45)*	
Chemical fertilizers	18 (40.0)
Soil amendment	2 (4.4)
Both	16 (35.6)
Others (sell the compost, take wages from farmers in return for producing compost from their waste, and combinations)	9 (20.0)

*Variable used for explanatory purpose and is not included in the bivariate and regression analyses as independent variable

**Human and technical assets include knowledge and experience, technical assistance, and agricultural lands option of their willingness to produce and use compost in agriculture, a lower percentage of willingness is obtained. It is found that 63.6% ($n = 321$) are willing to produce and use compost while 36.4% are unwilling. A percentage difference of 20% between farmers' positive perceptions and their willingness of compost production and use can be noticed. This finding is not unexpected as it is related to the issue of salience highlighted earlier in section "Introduction". That is, support declines when a reuse option becomes more concrete and tangible to the respondents. In this study, the respondents' willingness declines despite that they are inquired about their willingness in case of being offered training sessions on compost production and use.

In undertaking a review of the available Palestinian social studies on compost production and use, the researcher discloses that findings of these studies go in line with the issue of salience. A recent Palestinian survey conducted with farmers ($n = 321$) in Hebron district, south the WB, reveals highly positive perceptions and willingness of compost production and use in agriculture. Findings, however, show less support for the salient option of compost production. They reveal that 95% of farmers support composting as an option of solid waste management. However, lower percentages of farmers are willing to produce compost (88%) and have the desire to use compost in agriculture (91.2%) (Al-Sari et al. 2018; Sarhan 2015).

Another Palestinian survey conducted by ARIJ (2005) in the WB and the Gaza Strip (GS) ($n = 1132$) reveals less preference for composting than that in Hebron. Only 23% of respondents in the WB prefer composting compared to 54% and 40% who prefer sanitary landfills and recycling, respectively, as solid waste management options. Preferences for composting and recycling are attributed to revenues generated from selling the end products, creation of job opportunities, reduced waste volume, and enhanced soil fertility and productivity of agricultural lands. The study also discloses that participants in the WB express less preference for performing backyard composting (49%) than that for utilizing compost in their lands and gardens (87%). The difference in preferences can be partially explained through the "proximity" factor. That is, compost production involves human proximity to the untreated organic waste, and thus lower preference, while the use of the end product of compost involves contact with treated waste. The factor of "proximity", in turn, can be explained through the psychological barrier of "disgust" from the untreated waste—the so-called "yuck factor"—that inhibits preferences for waste (water) reuse (Bruvold 1985; Hartley 2006; Po et al. 2003; Schmidt 2008).

The proponent and opponent groups of interviewed farmers are asked about perceived opportunities and constraints of compost production in WFW, respectively. The highest percentage of the proponents ($n = 280$) think that mitigation of health and environmental problems resulting from improper waste management is the main opportunity for compost production in WFW (41.1%), followed by availability of adequate knowledge and experience, technical assistance, and agricultural lands (38.2%), gaining economic benefits as compost is less expensive than chemical fertilizers (13.2%), and farmers' preference for organic fertilizers (1.8%). As for the opponents ($n = 51$), 33.3% perceive the main constraint of producing compost in WFW is compost production being more expensive than purchasing chemical fertilizers. They also think that farmers' preference for chemical fertilizers (23.5%) and lack of adequate knowledge, experience, and technical assistance (19.6%) are main constraints.

As for farmers' knowledge and experience associated with compost production and use, it is found that 78.7% of farmers have previous knowledge of compost use or production while only 16.9% of the farmers attained training on compost production and use. In spite of having the knowledge, less percentage of farmers has ever used compost (40.2%). Those who have never used it ($n = 240$) expressed reasons related to perceived unimportance of compost (27.5%), lack of knowledge of compost use or production (24.6%) or methods of producing and using it (21.7%), inadequate area of agricultural lands for waste handling and compost production process (16.7%), and compost being more expensive than chemical fertilizers (7.5%). A low percentage of 15.5% of farmers has ever produced compost, out of which 78.3% ($n = 60$) perceive economic benefits from compost production mainly through reduced purchase of chemical fertilizers only (40%, $n = 45$) or both chemical fertilizers and soil amendment (35.6%).

Factors shaping farmers' perceptions and willingness of compost production and use

Findings of the bivariate analyses and binary logistic regression models suggest that a combination of several socio-economic, demographic, agricultural, and individual factors have statistically significant associations (P value < 0.05) with farmer's perception and willingness of compost production and use in WFW. While some factors proved significant in influencing the two dependent variables of farmer's perception and willingness, other factors are only associated with one of them. This is expected due to the issue of salience. Social studies on WW reuse, for example, argue that not only support declines when the reuse option is more salient but also factors shaping this support and their influences vary between the general and salient options (Bruvold 1988; Hartley 2003; Marks 2003). This section reveals findings of the bivariate and logistic regression analyses only for variables statistically significant with P values < 0.05. Discussion will focus more on variables proved significant in the regression models as the models reveal clearer effect of each factor when tested jointly with the effects of other factors.

Findings of the bivariate analyses

Among the socioeconomic and demographic factors, the bivariate analyses disclose the average household monthly income and farmers' area of residence in WFW as significant factors shaping farmers' perceptions of compost production. They also disclose level of farmers' education and farmers' area of residence in WFW as significant factors shaping farmers' willing (ness) to produce and use compost (WTPUC). Table 6 shows findings of the bivariate analyses on significant socioeconomic and demographic shaping farmers' perceptions and willingness.

It is found that the average household monthly income has a significant negative relationship on farmers' perceptions of compost production (P value = 0.040). Higher percentages of farmers accepting the idea of compost production constitute of low-income groups gaining ≤ 1500 NIS or between 1501 and 2000NIS (6.0% and 13.2%, respectively) compared to percentages of low-income opponent farmers (3.7% and 0%, respectively). On the contrary, higher percentages of the opponents constitute of medium- and high-income groups gaining 2001–2500 NIS, 2501–4000 NIS, and ≥ 4001 (50%, 33.3%, and 13%, respectively) than percentages of the medium-to-high-income proponents (35.6%, 32.7%, and 12.5%, respectively). When the 'household income' factor is tested for farmers' WTPUC, no significant relationship is found (P value = 0.157). The regression analyses, however, show contradictory findings. The LRM-W proves significant effect of the household income on willingness. The LRM-P proves insignificant effect of income on perceptions since it is dominated by the factor of 'type of the agricultural system' when entered the regression, as will be explained in the next section.

Despite that farmers' level of education does not explain their perceptions of compost production (P value = 0.741), it significantly shapes their responses to the more salient option of WTPUC (P value = 0.021). The relationship, however, swings both ways. That is, higher percentages of those who are WTPUC attained primary education (10.8%) as well as post-secondary or university education (37.7%) than percentages of the unwilling group (8.5% and 25.6%, respectively). Around 31% of the unwilling group, compared to ≈ 16% of the willing group, attained lower-secondary level of education while almost no difference appears between the two groups for those who attained upper-secondary level. In the regression analyses, the association between level of education and farmers' WTPUC becomes insignificant.

Regarding farmers' area of residence in WFW, this factor proved significant in shaping both farmers' perceptions and willingness (P value = 0.000 and 0.000, respectively). Higher percentages of those who accept the idea of compost production (84%) or are WTPUC (82%) live and work in the upstream area of the watershed compared to percentages of the opponents (46.3%) and unwilling group (61.5%). More farmers from the opponent and unwilling groups reside in the middle and downstream areas of the watershed (53.7% and 38.5%, respectively) compared to the proponent and willing groups (16% and 18.1%, respectively). Despite its significance, the factor of 'farmers' area of residence' is excluded from the regression analyses due to its strong collinearity with the agricultural variables, such as type of practiced agriculture and the agricultural system. The two studies of Al-Madbouh (2013) and EQA (2006) in WFW explain that irrigated agriculture as well as landownership system are prevalent in the upstream areas of WFW while rainfed agriculture and rental or sharecropping systems are prevalent in the downstream areas.

Six agricultural factors have significant associations with farmers' perceptions and/or willingness of compost production and use in WFW. It is found that area of cultivated lands, type of practiced agriculture, type of the agricultural system, and methods of animal waste management are highly significant factors shaping farmers' perceptions. Similarly, these factors significantly influence farmers' WTPUC, except for 'type of the agricultural system'. Kind of fertilizers used and use

Table 6 Findings of the bivariate analyses on significant socioeconomic and demographic variables shaping farmers' perceptions and willingness

Variable	Perception of compost production			Willingness to produce and use compost		
	Yes *N* (%)	No *N* (%)	*P* value < 0.05	Yes *N* (%)	No *N* (%)	*P* value < 0.05
Level of education			0.741			0.021
Illiterate	2(0.7)	0 (0.0)		1 (0.5)	0 (0.0)	
Primary	22 (7.8)	5 (9.3)		22 (10.8)	10 (8.5)	
Lower Secondary	60 (21.3)	12 (22.2)		33 (16.2)	36 (30.8)	
Upper Secondary	107 (37.9)	16 (29.6)		71 (34.8)	41 (35.0)	
Post-Secondary or university	60 (21.3)	21 (38.9)		77 (37.7)	30 (25.6)	
Average Household monthly income (NIS)			0.040			0.157
≤ 1500	17 (6.0)	2 (3.7)		13 (6.4)	6 (5.2)	
1501–2000	37 (13.2)	0 (0.0)		18 (8.8)	16 (13.8)	
2001–2500	100 (35.6)	27 (50.0)		73 (35.8)	52 (44.8)	
2501–4000	92 (32.7)	18 (33.3)		73 (35.8)	33 (28.4)	
≥ 4001	35 (12.5)	7 (13.0)		27 (13.2)	9 (7.8)	
Area of residence in WFW			0.000			0.000
Upstream area	237 (84.0)	25 (46.3)		167 (81.9)	72 (61.5)	
Middle and downstream areas	45 (16.0)	29 (53.7)		37 (18.1)	45 (38.5)	

of pesticides are additional agricultural factors found significant in shaping farmers' willingness. Table 7 reveals findings of the bivariate analyses on significant agricultural factors shaping farmers' perceptions and willingness.

Results indicate significant negative relationship between area of cultivated land and farmers' perceptions (*P* value = 0.001). Around 46% of the proponents, compared to 16% of the opponents, have an area of cultivated land between 1 and 3 dunums. On the contrary, higher percentages of the opponents cultivate larger areas of lands between 4 and 8 dunums, 9–15 dunums, and 16 or more dunums (31.8%, 18.2%, and 34.1%, respectively) compared to the percentages of the proponents cultivating same sizes of lands (24.6%, 12.9%, and 16.2%, respectively). Similarly, significant negative relationship is revealed between area of cultivated land and farmers' WTPUC (*P* value = 0.001). Almost half of the willing group (48.5%), compared to 23.6% of the unwilling group, have an area of cultivated land between 1 and 3 dunums. Percentages of the unwilling group cultivating lands between 4 and 8 dunums, 9–15 dunums, and 16 or more dunums are higher (31.5%, 21.3%, and 23.6%, respectively) when compared to the corresponding areas of the willing group (24.6%, 12.9%, and 16.2%, respectively). Concurrent findings are demonstrated by the Palestinian survey of Al-Sari et al. (2018) and the socioeconomic survey of Nigussie et al. (2015) with 220 farmers in Ethiopia. The authors show that larger areas of agricultural lands contribute to lower attitudes towards compost use and lower willingness of its production, though the relationship is insignificant. This is due to the intensive efforts and large investment needed to transport agricultural inputs, including manure and the end product of compost. Transport cost inhibiting farmers' demand for compost is evident by different studies (Danso et al. 2002; Folefack 2008; Mohee 2007).

Type of practiced agriculture is another factor that significantly shapes farmers' perceptions and WTPUC (*P* value = 0.000 and 0.000, respectively) but in different ways. More proponents depend on irrigated agriculture (58.5%) or a combined system of rainfed and irrigated agriculture (29.8%) when compared to the opponents (47.7% and 15.9%), respectively). More opponents (36.4%) than proponents (11.8%), however, depend on exclusive rainfed agriculture. As for willingness, a lower percentage of the willing group depends on irrigated agriculture (51%) than that of the unwilling group (69.7%). Yet, the former still depends more on combined rainfed and irrigated agriculture and less on exclusive rainfed agriculture (35.9% and 13.1%, respectively) than the later

Table 7 Findings of the bivariate analyses on significant agricultural factors shaping farmers' perceptions and willingness

Variable	Perception of compost production			Willingness to produce and use compost		
	Yes *N* (%)	No *N* (%)	*P* value < 0.05	Yes *N* (%)	No *N* (%)	*P* value < 0.05
Area of cultivated land (dunum)			0.001			0.001
1–3	126 (46.3)	7 (15.9)		96 (48.5)	21 (23.6)	
4–8	67 (24.6)	14 (31.8)		44 (22.2)	28 (31.5)	
9–15	35 (12.9)	8 (18.2)		25 (12.6)	19 (21.3)	
≥ 16	44 (16.2)	15 (34.1)		33 (16.7)	21 (23.6)	
Type of practiced agriculture			0.000			0.000
Rainfed agriculture	32 (11.8)	16 (36.4)		26 (13.1)	18 (20.2)	
Irrigated agriculture	159 (58.5)	21 (47.7)		101 (51.0)	62 (69.7)	
Rainfed and irrigated agriculture	81 (29.8)	7 (15.9)		71 (35.9)	9 (10.1)	
Type of the agricultural system			0.029			0.439
Ownership	158 (57.5)	24 (52.2)		114 (57.3)	44 (47.3)	
Rental	67 (24.4)	8 (17.4)		47 (23.6)	27 (29.0)	
Sharecropping	50 (18.2)	13 (28.3)		37 (18.6)	21 (22.6)	
Combinations of the above	0 (0.0)	1 (2.2)		1 (0.5)	1 (1.1)	
If the farm produces animal waste, method of animal waste management			0.001			0.004
Burn and/or dispose randomly	1 (0.8)	0 (0.0)		0 (0.0)	2 (4.1)	
Use as soil fertilizer	63 (51.6)	3 (14.3)		54 (50.9)	12 (24.5)	
Sell	6 (4.9)	6 (28.6)		11 (10.4)	10 (20.4)	
Donate	14 (11.5)	3 (14.3)		10 (9.4)	10 (20.4)	
Combinations of the above	38 (31.1)	9 (42.9)		31 (29.2)	15 (30.6)	
Kind of fertilizers used			0.838			0.013
Chemical fertilizers only	96 (35.0)	18 (39.1)		60 (30.0)	39 (42.4)	
Compost only	2 (0.7)	0 (0.0)		2 (0.0)	0 (0.0)	
Chemical fertilizers + compost	36 (13.1)	6 (13.0)		37 (18.5)	6 (6.5)	
Dried animal manure	81 (29.6)	10 (21.7)		64 (32.0)	20 (21.7)	
Wet animal manure	13 (4.7)	4 (8.7)		9 (4.5)	6 (6.5)	
Chemical fertilizers + dried manure	37(13.5)	7 (15.2)		22 (11.0)	18 (19.6)	
Combinations of the above	9 (3.3)	1 (2.2)		6 (3.0)	3 (3.3)	
Use of pesticides			0.553			0.042
Yes	234 (83.0)	43 (79.6)		166 (81.4)	83 (71.6)	
No	48 (17.0)	11 (20.4)		38 (18.6)	33 (28.4)	

(10.1% and 20.2%, respectively). The regression analyses, however, clarify the direction of the relationship where irrigated agriculture is significantly associated with farmers' positive perceptions and their willingness of compost production, as shown in the next section.

Type of the agricultural system significantly shapes farmers' perceptions of compost production (P value = 0.029). Ownership of the agricultural land or rental system enhances farmers' perceptions. Among the proponents, it is found that 57.5% own their lands compared to 52.2% of the opponents and 24.4% rent their lands compared to 17.4% of the opponents. In contrast, a higher percentage of the opponents (28.3%) are sharecroppers compared to 18.2% of the proponents. While type of the agricultural system factors in shaping farmers' perceptions of compost production, it does not factor in shaping their willingness to produce and use compost (P value = 0.439). It seems that when farmers in WFW are faced with the more salient option of willingness to produce compost themselves, economic factors, such as average household monthly income, and individual factors, such as experience of compost production, play more important role in their willingness than the issue of landownership, as the regression model (LRM-W) suggests in the next section.

A significant relationship is also identified between methods of animal waste (mainly manure) management practiced by farmers in WFW and farmers' perceptions of compost production (*P* value = 0.001) as well as their WTPUC (*P* value = 0.004). More than half of farmers who accept the idea of compost production (51.6%) or are WTPUC (50.9%) use wet or dried animal manure as a soil fertilizer while only 14.3% of the opponents and 24.5% of the unwilling group resort to this waste management method. Alternatively, the opponents and the unwilling group resort to selling the waste (28.6% and 20.4%, respectively) or donating it (14.3% and 20.4%, respectively) more than the proponents (4.9% for selling and 11.5% for donating) and the willing group (10.4% for selling and 9.4% for donating). Disposal of animal waste randomly or in household waste containers is either minimally or not practiced by the four groups of farmers. It is not unexpected that farmers who reuse raw manure as fertilizers have higher acceptance and willingness to produce compost. This is because the traditional manure management methods can result in adverse impacts on the agricultural lands, water, and soil, in addition to the spread of odors and flies (Mohee 2007). These impacts enhance interest in 'composting' as an environmentally sound method, particularly among farmers who have the experience of managing wet and high-nitrogen manures and thus, would have little difficulty composting (Mohee 2007).

Kind of fertilizers applied by farmers and the use of pesticides do not factor in farmers' perceptions of compost production in WFW (*P* value = 0.838 and 0.553, respectively). In contrast, these two factors significantly influence farmers' WTPUC (*p* value = 0.013 and 0.042, respectively). Higher percentages of farmers who are WTPUC use compost combined with chemical fertilizers (18.5%) or dried animal manure as a fertilizer (32%) than percentages of those from the unwilling group (6.5% and 21.7%, respectively). Higher percentages of the unwilling farmers, however, use chemical fertilizers exclusively (42.4%), wet animal manure (6.5%), or chemical fertilizers combined with animal manure (19.6%) when compared to percentages of the willing group (30%, 4.5%, and 11%, respectively). As for pesticides, more farmers who are WTPUC (81.4%) use pesticides than farmers among the unwilling group (71.6%). While the variable of 'use of pesticides' maintains its significance in shaping farmers' willingness when entered the LRM-W, the model proves 'kind of fertilizers applied' as insignificant factor.

Concerning individual factors, the bivariate analyses reveal significant positive associations between most of the tested individual factors and farmers' perceptions of compost production in WFW. These factors include previous knowledge of compost production attained through training sessions, previous use of compost as a fertilizer, individual experience of compost production, and perceived economic benefits of compost production (*P* value = 0.004, 0.002, 0.010, and 0.000, respectively). It is found that proponent farmers are those who attained training on compost production (22.3%), have previous experience of using compost as a fertilizer (49.3%), have experience of producing compost (20.6%), and perceive economic benefits of compost production (83.6%). However, lower percentages of farmers who refuse the idea of compost production attained training sessions (5.6%) and have previous experience of compost use (25.9%) and production (5.7%) while none of them perceive economic benefits of compost production. Table 8 reveals findings of the bivariate analyses on significant individual factors shaping farmers' perceptions and willingness.

Individual factors shaping farmers' WTPUC are similar to those shaping their perceptions, except for perceived economic benefits of compost production (*P* value = 0.051). It is found that farmers who are WTPUC attained training on compost production (25.5%), have previous experience of using compost as a fertilizer (55.9%), and have experience of producing compost (27%). Yet, lower percentages of farmers from the unwilling group attained training sessions (9.4%) and have previous experience of compost use (23.9%) and production (0.9%). While farmers' general knowledge of compost use and production proved insignificant in shaping their perceptions (*P* value = 0.204), it significantly shapes their WTPUC (*P* value = 0.000). Around 86% of the willing group has knowledge of compost use and production compared to around 69% of the unwilling group.

Findings of the binary logistic regression

The regression analyses reveal that a group of different socioeconomic, agricultural, and individual

Table 8 Findings of the bivariate analyses on significant individual factors shaping farmers' perceptions and willingness

Variable	Perception of compost production			Willingness to produce and use compost		
	Yes *N* (%)	No *N* (%)	*P* value < 0.05	Yes *N* (%)	No *N* (%)	*P* value < 0.05
Knowledge of compost use or production			0.204			0.000
Yes	239 (84.8)	42 (77.8)		176 (86.3)	81 (69.2)	
No	43 (15.2)	12 (22.2)		28 (13.7)	36 (30.8)	
Previous training attained on compost production			0.004			0.000
Yes	63 (22.3)	3 (5.6)		52 (25.5)	11 (9.4)	
No	219 (77.7)	51 (94.4)		152 (74.5)	106 (90.6)	
Previous use of compost as a fertilizer			0.002			0.000
Yes	139 (49.3)	14 (25.9)		114 (55.9)	28 (23.9)	
No	143 (50.7)	40 (74.1)		90 (44.1)	89 (76.1)	
Experience of compost production			0.010			0.000
Yes	58 (20.6)	3 (5.7)		55 (27.0)	1 (0.9)	
No	224 (79.4)	50 (94.3)		149 (73.0)	166 (99.1)	
In case of experience, perceived economic benefits of compost production			0.000			0.051
Yes	46 (83.6)	0 (0.0)		41 (80.4)	0 (0.0)	
No	9 (16.4)	3 (100.0)		10 (19.6)	1 (100.0)	

factors shape farmers' perceptions of compost production in WFW as well as their willingness to produce and use compost. However, factors shaping farmers' perceptions towards compost production and use vary from those shaping the more tangible proposal of their willingness to produce compost. Despite this heterogeneity, significant determinants of perceptions and/or willingness can be broadly classified into (1) farmers' economic status reflected in their household monthly incomes; (2) agricultural factors including area of cultivated agricultural lands, type of practiced agriculture (rainfed vs. irrigated), type of the agricultural system (landownership vs. tenure), type of the agricultural business (plant vs. animal farming), and use of pesticides; and (3) individual factors including farmers' experience of compost production and their access to information provision services such as training sessions on compost production and use.

Specifically, the LRM-P uncovers significant associations of four factors with farmers' perceptions, including area of cultivated agricultural lands, type of agricultural system, type of practiced agriculture, and prior training sessions attained by farmers on compost production and use. The LRM-W, however, reveals significant effects of area of cultivated lands and type of practiced agriculture, but not prior training, on farmers' willingness.[1] It also uncovers significant associations with additional four factors including average household monthly income, type of farmer's agricultural business, farmer's use of pesticides, and farmer's experience of compost production. It can be noticed that agricultural factors are basically the underlying determinants of both farmers' perceptions and willingness to produce compost. The socioeconomic, demographic, and individual factors turn out to be vulnerable when tested jointly with the agricultural factors in the two regression models. The latter dominate the influence of the former on farmers' perceptions and willingness, except for economic and individual factors related to farmers', 'household monthly income', and 'experience of compost production' that revealed significant in the LRM-W. Nevertheless, each of the LRM-P and LRM-W reveals an overall significant effect of the variables entered the regression (*P* value of LRM-*P* = 0.000 and *P* value of LRM-W = 0.000); and these variables build the best fit models. Table 9 presents results of the LRM-P, Table 10 presents summary of the

[1] The factor of 'type of agricultural system' is excluded from the LRM-W since its *P* value in the bivariate analysis is more than 0.25

Table 9 Results of the LRM-P

Variable	Description	Estimated coefficient (ß)	Standard error (SE)	Wald statistics	*df*	Significance (*P* value)
X_1	Age (year)	− 0.063	0.196	0.102	1	0.749
X_2	Level of education	0.149	0.213	0.490	1	0.484
X_3	Average household monthly income	0.183	0.204	0.805	1	0.370
X_4	Type of agricultural business	− 0.086	0.073	1.409	1	0.235
X_5	Area of cultivated agricultural lands	0.551	0.172	10.293	1	0.001*
X_6	Type of practiced agriculture	− 1.063	0.347	9.413	1	0.002*
X_7	Type of the agricultural system	0.515	0.241	4.575	1	0.032*
X_8	Knowledge of compost use or production	0.021	0.520	0.002	1	0.968
X_9	Training attained on compost production	2.319	0.754	9.457	1	0.002*
X_{10}	Previous use of compost as a fertilizer	0.305	0.447	0.463	1	0.496
X_{11}	Experience of compost production	0.057	0.718	0.006	1	0.937
Constant		− 7.609	2.457	9.595	1	0.002

*Significant at $P \leq 0.05$

LRM-P and goodness-of-fit tests, Table 11 presents results of the LRM-W, and Table 12 presents summary of the LRM-W and goodness-of-fit tests. Factors affecting farmer's perception are estimated using Eq. (1) as follows:

$$\begin{aligned} \text{logit (farmer perception)} = & -7.609–0.063X1 \\ & +0.149X2 + 0.183X3–0.086X4 \\ & +0.551X5–1.063X6 + 0.515X7 + 0.021X8 \\ & +2.319X9 + 0.305X10 + 0.057X11 \end{aligned} \quad (5)$$

The factors affecting farmer's willingness are estimated using Eq. (1) as follows:

$$\begin{aligned} \text{logit (farmers willingness)} = & -7.689–0.189X1 \\ & –0.084X2–0.430X3–0.184X4 + 0.816X5 \\ & –0.775X6–0.100X7 + 1.391X8 + 0.586X9 \\ & +0.792X10 + 0.586X11 + 2.668X12 \end{aligned} \quad (6)$$

The bivariate analyses presented earlier in this paper show significant relationship between farmers' level of education and their WTPUC that swings both ways towards low and high educational levels. The LRM-W, however, confirms that higher willingness is related to higher, more than lower, educational level, though the relationship is insignificant (P value = .0.628). In addition to educational level, the LRM-W reveals that effects of lack of farmers' knowledge of compost, lack of previous training on compost production and use, and lack of prior use of compost as a fertilizer on farmers' unwillingness to produce compost are insignificant (P value = 0.151, 0.098, and 0.127, respectively). In Hebron, south Palestine, Al-Sari et al. (2018) also disclose insignificant association between farmers' prior use of compost and their attitudes towards compost use. In contrary, studies of Kassie et al. (2009) and Nigussie et al. (2015) in Ethiopia reveal that farmers' willingness to participate in urban waste compost or their adoption of compost use is significantly related to higher

Table 10 Summary of the LRM-P and goodness-of-fit tests

Test	Results		
Model summary	− 2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
	202.278	0.143	0.260
Omnibus tests of model coefficients	Chi-square	*df*	Sig.
	48.529	11	0.000

Table 11 Results of the LRM-W

Variable	Description	Estimated coefficient (ß)	Standard error (SE)	Wald statistics	*df*	Significance (*P* value)
X_1	Age (year)	− 0.189	0.154	1.512	1	0.219
X_2	Level of education	− 0.084	0.174	0.234	1	0.628
X_3	Average household monthly income	− 0.430	0.163	6.992	1	0.008*
X_4	Kind of agricultural business	− 0.184	0.061	9.071	1	0.003*
X_5	Area of cultivated agricultural lands	0.816	0.181	20.259	1	0.000*
X_6	Type of practiced agriculture	− 0.775	0.297	6.814	1	0.009*
X_7	Kind of fertilizers used	− 0.100	0.091	1.184	1	0.276
X_8	Use of pesticides	1.391	0.518	7.229	1	0.007*
X_9	Knowledge of compost use or production	0.586	0.408	2.060	1	0.151
X_{10}	Training attained on compost production	0.792	0.478	2.739	1	0.098
X_{11}	Previous use of compost as a fertilizer	0.586	0.384	2.334	1	0.127
X_{12}	Experience of compost production	2.668	1.059	6.346	1	0.012*
Constant		− 7.689	2.728	7.945	1	0.005

*Significant at $P \leq 0.05$

educational level. These studies also show that access to information through agricultural extension services and/or membership in at least one farmers' organization significantly conditions farmers' adoption of compost production or use, whether exclusively or combined with other organic farming techniques such as conservation tillage.

In the case of WFW, it seems that the effects of factors related to farmers' education, prior knowledge and use of compost, prior access to information through training sessions are dominated by the effect of farmers' practical real-life experience of compost production, particularly when it comes to the more salient option of famers producing compost themselves. The LRM-W confirms that farmers' lack of experience of compost production significantly contributes to their unwillingness to produce compost even if they would be offered relevant future training sessions (*P* value = 0.012). The other way round, findings from Nigussie et al. (2015) reveal farmers' experience contributing significantly in their willingness to participate in urban waste composting. Accordingly, offering access to information for farmers in WFW through training sessions or other extension services should be based on hands-on learning through which farmers can run real-life experiments of compost production and use. Establishing on-farm demonstration schemes could be one way of active hands-on learning approaches that would enhance willingness of farmers in WFW to produce compost.

The LRM-P, however, shows that lack of the practical experience does not play a significant role in farmers' refusal of the hypothetical idea of compost production when farmers are not necessarily involved in the production process itself (*P* value = 0.937). It also shows that farmers' low educational level, lack of knowledge of compost, and lack of prior use of compost as a fertilizer do not significantly explain their refusal of the idea of compost production (*P* value = 0.484, 0.968, and 0.496, respectively). In contrast, lack of previous training attained by farmers on compost production and

Table 12 Summary of the LRM-W and goodness-of-fit tests

Test	Results		
Model summary	− 2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
	260.188	0.282	0.398
Omnibus tests of model coefficients	Chi-square	*Df*	Sig.
	95.224	12	0.000

use significantly associated with their opposition (P value = 0.002). It seems that lack of the topic-oriented more scientific knowledge and skills that farmers can acquire from training sessions explains their negative perceptions more than lack of the general less scientific knowledge acquired from their trials and errors in using compost or the academic knowledge that is not necessarily related to compost production.

While the average household monthly income proved significant in the bivariate analyses, the LRM-P shows insignificant effect of income on farmers' perceptions (P value = 0.370). It could be that the factor of 'income' is overridden by the factor of 'type of the agricultural system' due to the strong collinearity between the two factors. Al-Madbouh (2013) and EQA (2006), for instance, explain that high-and-medium income farmers in WFW are usually those who own or rent their agricultural lands while low-income farmers are usually those who adopt the sharecropping system. Expectedly, the LRM-W model reveals significant effect of income on farmers' willingness to produce compost where higher income results in higher willingness (P value = 0.008). Being faced with the salient option, farmers seem to consider costs of the compost production process more in their decision when they want to produce compost themselves. This is because for compost production, farmers need to bear equipment, labor, and compost transportation costs. These costs are often considerable (Danso et al. 2002; Folefack 2008) and thus, can be afforded by the high-income farmers who may also be more prone to take economic risks. Once afforded, compost production can offer new income opportunities for farmers through charging waste 'disposal' fees and selling the end product of compost which is usually an economic option for large producers of compost due to substantial labor and capital needed (Mohee 2007). The study of Kassie et al. (2009) in Ethiopia reveals that wealthier farmers tend to adopt compost use as they can have greater access to resources and are better able to take risks.

The bivariate analyses show that methods practiced by farmers in WFW for animal waste management significantly factor in shaping farmers' perceptions and willingness of compost production (i.e., use of wet or dried animal manure as a soil fertilizer is associated with higher acceptance and willingness). When entered the two regression models of perceptions and willingness, this factor, however, is dropped out. Alternatively, the LRM-W uncovers a significant effect of 'type of agricultural business' on farmers' willingness (P value = 0.003), which can explain willingness more than 'methods of animal waste management'.[2] Farmers practicing animal agriculture (poultry and/or livestock) or combined animal-plant agriculture, regardless of the method they use for managing their animal waste, are more willingness to produce and use compost than those practicing exclusively plant agriculture. It seems that production of manure in animal agriculture, whether solely or combined with plant residues, provides an incentive for animal producers in WFW to produce and use (manure) compost regardless whether they used to allocate raw manure for fertilizer use, randomly dispose it, sell it, and/or donate it. This is particularly vital knowing that livestock generates large amounts of manure up to 5.27 kg/day/1000 kg live weight, on a wet weight basis (Overcash 1983). These amounts provide incentives for animal-raising farmers to reuse and compost manure in a more beneficial and environmental-friendly way, particularly in cases when animal production is intensified on a small-size lands (Mohee 2007). Also, inappropriate disposal of raw manure or managing it in traditional ways can result in environmental pollution, soil degradation, and spread of odors, flies, and diseases; impacts that farmers can avoid by reusing and composting manure. Wright (1998 as cited in Mohee 2007) emphasizes that a main concern among animal producers is odors generated from manure production and storage activities. Tittonell et al. (2005) study for smallholder farms in western Kenya attributes the limited allocation of manure for soil amendments to low manure production besides inefficient manure collection process and lack of experience to produce compost.

Nigussie et al. (2015) study in Ethiopia reveals contradictory findings on type of agricultural business. It shows that ornamental-plant and vegetable growers allocate more than 40% of manure and crop residues for soil amendment compared to less than 10% allocated for amendment by mixed plant-animal farming. It reports higher percentages of ornamental-plant and vegetables growers applying manure (96% and 31%, respectively) and plant residues compost (39% and 22%, respectively) than those of mixed plant-animal farming (27% for manure and 18% for plant residues compost).

[2] The bivariate analyses reveal that the factor of 'type of agricultural business' is insignificant in shaping farmers' perceptions and willingness to produce and use compost (P value = 0.060 and 0.129, respectively). Yet, this factor is entered to the regression models as its P value is less than 0.25

Additionally, the association between the number of cattle and allocation of animal manure for soil amendment is found insignificant. Hence, the author explains the allocation of smaller fraction of waste for soil amendment by mixed plant-animal farming through socioeconomic, individual, and agriculture-related factors. These factors include farmers' lower level of education, lower experience with compost, less access to extension services, insecure landownership, and large land size. While this study confirms the influence of these factors on famers' willingness to produce compost, it shows that type of agricultural business still has a distinct significant influence on farmers' willingness.

The two regression models of perception and willingness confirm findings of the bivariate analysis on the significant inverse relationship between area of cultivated lands and farmers' acceptance (*P* value = 0.001) and willingness (*P* value = 0.000), respectively. Larger areas contribute to farmers' lower acceptance of the idea of compost production as well as their unwillingness to produce compost themselves. Sorting and handling the large volume of waste produced in large-scale farms as well as transportation and application of compost to the lands necessitate increasingly considerable investments of land, labor, time, equipment, and capital (Danso et al. 2002; Mohee 2007). In contrast, costs allocated to deal with small to moderate quantities of waste and compost produced in small-scale farms are insignificant (Mohee 2007). The study descriptive statistics show that costs of compost production are concerns of 33.3% of farmers who oppose compost production in WFW and think that it is more costly than purchasing chemical fertilizers. While large-scale farms can be one indicator of farmers' wealth/higher economic status, and consequently their ability to bear costs of compost production and transportation, it seems that in the case of WFW, type of agricultural system practiced (landownership or tenure system) is a stronger indicator of wealth as suggested by Al-Madbouh (2013) and EQA (2006) earlier in this paper.

The bivariate analyses reveal significant relationship, yet of unclear direction, between type of practiced agriculture and farmers' perception and willingness. This factor attained its significance and has a clear direction in the two models of LRM-P and LRM-W. Farmers who practice irrigated agriculture exclusively or combined with rain-fed agriculture have higher acceptance for compost production in WFW (*P* value = 0.002) and more willingness to produce compost themselves (*P* value = 0.009). This is expected since applying compost to the agricultural lands reduces moisture loss to the atmosphere and increases water-storage capacity, particularly in the upper soil profile, thus reduces frequency and intensity of irrigation (O'Connor 2014; Mohee 2007). Additionally, compost application improves water infiltration rates by 50–60% (Brown et al. as cited in Mohee 2007), reduces amount of soil erosion—a challenge prevalent in irrigated agriculture (Mohee 2007)—and reduces irrigation costs (Duane 2004). The aforementioned benefits are considerable for farmers practicing irrigated agriculture since irrigation is a costly and time-consuming activity for farmers and, more importantly, agricultural water shortage is a limiting factor for many farmers in WFW. Halloran et al. (2013) conducted a study in the northeastern US on the economic potential of compost amendment as an alternative to irrigation in Maine Potato production systems. The authors find that compost application or irrigation markedly increases potato yield. They conclude that compost is a potentially viable substitute to irrigation for potato considering suitable compost sources and application costs.

Talking about type of agricultural system, it is found that this factor attains its significant relationship with farmers' perceptions in the LRM-P (*P* value = 0.032). Farmers who do not own the agricultural land and practice the sharecropping and/or rental systems accept the idea of compost production in WFW less than those who own their lands. However, when farmers are inquired about the more salient option of their willingness to produce compost themselves, the factor of insecure landownership does not play role in their unwillingness. Farmers' considerations of income and their experiences with compost production become more important in shaping their willingness than the issue of landownership when the former factors can put the feasibility and success of compost production processes at the stake. Findings from Danso et al. (2002) in Ghana and the regression models of Nigussie et al. (2015) and Kassie et al. (2009) in Ethiopia, nevertheless, contradict with the current study. The researchers argue that insecure landownership hinders compost demand and use. The land tenure system in Ethiopia, for example, does not provide an incentive for farmers to invest in the agricultural land and generate more revenue (Nigussie et al. 2015). Kassie et al. (2009) reveals that livestock ownership, as one indicator of wealth and access to resource, enhances farmers' adoption of compost as they are able to take risks.

The LRM-W shows that the variable of 'use of pesticides' attains its significant effect on farmers' willingness to produce compost (P value = 0.007). It is expected use of pesticides is associated with higher willingness to produce and use compost. This is because composting suppresses the use of pesticides in two ways. First, it inhibits the proliferation of flies and insects resulting from improper management of waste randomly dumped in open sites. Second, when compost is produced and applied properly to the soil, it can be an effective method of suppressing pathogens since the beneficial microorganisms in it compete and suppress soil-borne plant pathogens (Mohee 2007).

When entered the LRM-W, the variable of 'kind of fertilizers used by farmers' is found insignificant in shaping their willingness (P value = 0.276). Kind of fertilizers used by farmers, whether chemical and/or organic ones, does not play role neither in farmers' views of compost production in the area of WFW nor in their willingness to produce compost themselves. This finding is unexpected given that interviewed farmers who have experience in compost production (n = 63) and perceive economic benefits of producing compost (n = 47) expressed that the economic benefits can be achieved basically through avoiding or reducing purchase of chemical fertilizers and/or soil amendments (80%, n = 45). Mohee (2007) reports similar economic benefits of compost production. Yet, she emphasized that economics of on-farm composting are beyond calculations of revenues versus cost of production; and other factors on the farm need to be considered. The current study indicates that despite farmers' awareness of the economic benefits of producing compost, there are other factors shaping their willingness to produce compost. These factors are related to human capital and technical and economic capacities needed as prerequisites for successful and feasible production process, including availability/production of compost feedstock material (mainly animal manure), farmers' experience of compost production, and farmers' high level of income to bear production costs.

Overall, the regression analysis shows that the issue of salience results in variation between factors shaping farmers' perceptions of compost production and use and those shaping the more tangible proposal of their willingness to produce compost. More specifically, farmers supporting the idea of compost production and use are those who own their agricultural lands, cultivate small areas of the lands, practice irrigated agriculture, and attained training sessions on compost production and use. Insecure landownership in the tenure system hinders compost demand and use since it does not provide an incentive for farmers to invest in the agricultural land and generate more revenue. Larger cultivated areas also contribute to lower demand of compost when compost transportation and application to larger lands necessitate increasingly considerable investments of land, labor, time, equipment and capital. Irrigated agriculture, however, enhances compost demand since compost application increases soil water-storage capacity, and thus reduces irrigation frequency, intensity, and costs. Small cultivated areas and irrigated agriculture are also determinants of farmers' willingness to produce compost. Willingness, additionally, is associated with farmers being animal or mixed animal-plant producers, enjoying high household monthly incomes, having experience in compost production, and using pesticides.

Contrary to findings from China, Cameroon, and Ethiopia, socio-demographic characteristics of the Palestinian farmers do not condition neither their perceptions nor their willingness to produce and use compost. These characteristics include age, gender, education, number of household members, type of work (agriculture vs. others), and area of residence. Not only the academic knowledge (education) do not factor farmers' perceptions or willingness to produce and use compost but also farmers' general knowledge of compost as well as their previous use of compost as a fertilizer. The effects of these factors are dominated by that of farmers having real-life experience of compost production, particularly when it comes to the more specific and tangible reuse option of famers producing compost themselves.

The study findings on farmers' positive perceptions and high level of willingness to produce compost imply that composting of organic waste in WFW should be encouraged by the Palestinian authorities. Willingness of farmers in WFW to produce and use compost, however, should be effectively enhanced and sustained through, *first*, making raw manure available for farmers, particularly for plant-producers, at a subsidized price. *Second*, encouraging subsidies of manure production and transportation costs, particularly for large-scale farmers, the case that encourages marketing organic food crops at low price. *Third,* alleviating poverty in the watershed farming communities. A one way can be through encouraging and supporting livelihood strategies that secure higher incomes. *Fourth*, developing policies and regulations that ensure security of tenure systems. While type of the agricultural system proved insignificant in shaping farmers' willingness, farmers practicing rental or sharecropping systems tend to have lower willingness. *Fifth*, providing topic-oriented knowledge and skills to farmers by professionals through training sessions or other extension services. Extension services should be based on active hands-on learning approaches more than passive learning or awareness campaigns. Establishing on-farm demonstration schemes could be one approach of hands-on learning through which farmers can run trials of compost production and use. At the community level, a recommendation made by the Food and Agriculture Organization of the United Nations (FAO) on income generation through composting in rural communities is valid for the context of WFW. It is stated that

> "farmers within a community can join together to adopt large scale centralized facilities to enable them to realize economies of scale. This will be a more efficient way of generating income from composting (for selling), especially for those farmers having small amounts of on-farm wastes" (Mohee 2007 p. 5).

We offer four propositions for future research including, *first*, examining influence of socioeconomic, agricultural, and individual factors on agricultural productivity of compost to be produced by farmers in the watershed and achieved economic benefits of compost production and application. *Second*, investigating impacts of using locally produced compost on plant's growth rate, plant's resistance, and crop productivity and quality, particularly for crops commonly cultivated in WFW. *Third*, examining socioeconomic and agricultural determinants of use of agrochemicals by farmers in WFW, including pesticides and chemical fertilizers.

Conclusions

The study findings reveal high acceptance level (84%) among farmers in WFW for the hypothetical idea of producing and using compost for agriculture in the watershed area. Farmers also have high, yet lower, willingness level (63.6%) of the more salient option to produce compost themselves and use it in agriculture. The difference in acceptance and willingness levels is related to the issue of 'salience', according to which support declines when a reuse option becomes more concrete and tangible to the respondents. Farmers' positive perceptions and high level of willingness to produce compost imply that composting of organic waste in WFW should be encouraged by the Palestinian authorities. This will alleviate the inappropriate waste disposal and the resulting water and soil contamination, odors, and nuisances; inhibit overuse of chemical fertilizers and pesticides; reduce waste stream at the landfills; create job opportunities; reduce farmers' purchase of chemical fertilizer and soil conditioners and further achieve economic benefits for them; increase yields; and enhance production of organic food crops. This, in turn, will contribute to alleviating environmental and health deterioration in the area; enhancing farmers' livelihood; and promoting agriculture conservation practices.

Agricultural factors are found to be the underlying determinants of both farmers' perceptions and willingness to produce compost. Yet, factors related to human capital and technical and economic capacities, which are needed as prerequisites for successful and feasible production process, condition farmers' willingness more than perceptions of compost production. These factors include on-farm production of compost feedstock material (mainly animal manure), farmers' experience of compost production, and farmers' high level of income to bear compost production costs. Farmers' awareness of the economic, agricultural, health, and environmental benefits of compost production cannot exclusively enhance their willingness without the aforementioned prerequisites. Subsidizing raw manure price and costs of manure production and transportation as well as providing practice-based extension services will enhance farmers' willingness to produce and use compost.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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