Environmental Challenges 10 (2023) 100675

Contents lists available at ScienceDirect

Environmental Challenges

journal homepage: www.elsevier.com/locate/envc

Residential waste segregation: The interconnection with SDG 2 zero hunger

Luis Velazquez[a,*], Nora Munguia[b], Diana Alvarez-Alvarez[c], Guillermo Cuamea-Cruz[a], Carlos Anaya-Eredias[a], Francisco Martinez-Castañeda[d]

[a] Industrial Engineering Department, University of Sonora, Blvd Luis Encinas y Rosales S/N, Colonia Centro, Hermosillo, Sonora CP 83000, Mexico
[b] Industrial Engineering Department, Sustainability Graduate Program, University of Sonora, Blvd Luis Encinas y Rosales S/N, Colonia Centro, Hermosillo, Sonora CP 83000, Mexico
[c] Sustainability Graduate Program, University of Sonora, Blvd Luis Encinas y Rosales S/N, Colonia Centro, Hermosillo, Sonora CP 83000, Mexico
[d] Instituto de Ciencias Agropecuarias y Rurales. Universidad Autónoma del Estado de México. Instituto Literario 100. Centro. Toluca. 50000, México

ARTICLE INFO

Keywords:
SDG 2
Residential waste segregation
The 2030 agenda for sustainable development
Home composting
Awareness

ABSTRACT

In the scientific literature, academics and practitioners have advocated the interconnection between Sustainable Development Goal 2 (SDG 2) and composting. However, despite the importance of separating organic waste at home and this activity's contribution to producing quality compost, relatively few scholars have explored its interconnection with SDG 2. To fill this gap, this article explores the potential of waste segregation in residential areas to meet SDG 2. This quantitative, non-experimental case study is based on an exploratory survey conducted with residents of two middle-class neighborhoods in the capital city of a state in northwestern Mexico, adjacent to the United States of America. The survey aims to measure the practices and knowledge of the participants related to home separation and composting and their understanding of SDG 2. Findings show that the interconnection between residential waste segregation and SDG 2 is harder to prove, even though waste segregation is essential to composting. Results also suggest that SDG 2 is usually pursued on national agendas; thus, it is unlikely that the home segregation of organic waste for small-scale home composting may influence national progress toward SDG 2. Still, this study would provide valuable insights for policymakers to develop comprehensive waste segregation policies that align with SDG 2.

1. Introduction

Sustainability scholars know that current sustainability achievements are not enough to meet the 2030 agenda for sustainable development (United Nations, 2020). Therefore, in a desperate attempt to correct several shortcomings and ensure continuous action on the Sustainable Development Goals (SDGs) targets, the U.N. General Assembly, in 2019, adopted a decade of action starting in 2020 (UN-General Assembly, 2019). Unfortunately, however, the momentum of the decade of action faded entirely because of the emergence of COVID-19. Furthermore, concerning Sustainable Development Goal 2 (SDG 2), all targets have suffered severe disruptions from the consequences of the pandemic. For instance, the shock was introduced into agricultural and food industry supply chains at the beginning of the pandemic because of drastic changes in consumption patterns (Kerr, 2020). At that stage, consumers bought significant amounts of fresh water, food, and medical supplies (Mehta et al., 2020). Also, in light of the uncertainty regarding lockdowns, people started to purchase and stockpile non-perishable food at supermarkets (Naeem, 2020). Furthermore, the development of electronic commerce platforms increased the demand for fresh food, surpassing suppliers' capacity to deliver (Hao et al., 2020).

These changes in consumption patterns during the pandemic caused food shortages and inflated prices (Guo et al., 2020). Moreover, it is expected that while the pandemic lasts, more disruptions up and down supply chains and across industries are likely to occur (Free and Hecimovic, 2021), thus impairing SDG 2. Therefore, the second goal of the 2030 agenda seeks to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture to ensure the sustainability of food systems by 2030 (Blesh et al., 2019). However, even before the COVID pandemic, levels of hunger and malnutrition were already alarming, at more than 750 million worldwide (FAO, 2021). Even more disturbing, the levels of acute food insecurity in specific low- and middle-income countries have sharply increased during the last year (The World Bank, 2021). Hence, SDG 2, which mainly concerns food security, has generated the most concern for the 2030 agenda for sustainable development.

According to the Food and Agriculture Organization of the United Nations (FAO, 2019), food security exists when people have permanent physical, social, and economic access to safe and nutritious food that en-

* Corresponding author.
E-mail address: luis.velazquez@unison.mx (L. Velazquez).

https://doi.org/10.1016/j.envc.2022.100675
Received 27 October 2022; Received in revised form 9 December 2022; Accepted 28 December 2022

ables them to live active and healthy lives. Although food insecurity can be found in urban areas, a high percentage of the population suffering from food insecurity live in rural communities (Pachòn et al., 2018). Furthermore, many factors are involved in food insecurity, including soil deterioration and the contamination of soil steamed by the constant use of chemical fertilizers (Chew et al., 2019). Regarding the last factor, there is a consensus to reduce dependence on agrochemicals due to their hazardousness and potential to affect crop productivity in the long term (Kumar et al., 2014). Therefore, one way to contribute to SDG 2 is to promote and implement sustainable agriculture, which focuses on developing new organic fertilizers to conserve and protect natural resources, the environment, and the health and well-being of humans (Allahyari and Poursaeed, 2019).

In the scientific literature, academics and practitioners have advocated the interconnection between SDG 2 and composting. The most apparent linkage is the capacity of the latter to enhance land productivity, water use efficiency, and agricultural productivity (Singh and Agrawal, 2020). Composting is a dynamic, biological, and aerobic process in which organic matter is stabilized after passing through a thermophilic phase, fostered by the development of biological degradation, and whose performance is directly dependent on the activity of microorganisms (Siles-Castellano et al., 2020). The product of composting is called compost, an organic fertilizer that adds beneficial properties to soils by providing nutrients and increasing the ground's microbial biomass, improving its texture, and increasing its water content (Bouzaiane et al., 2014).

The potential of industrial compost to improve soil quality has been widely researched from several perspectives, but the potential of homemade composting remains under-researched (Barrena et al., 2014). Quality assurance is one primary constraint in implementing and maintaining home composting programs. The compost's quality depends on its stability and maturity; otherwise, it might be counterproductive or not beneficial for land productivity (Wichuk and McCartney, 2010). While industrial composting firms have strict internal control procedures, home composting programs rely on general guidelines to produce good-quality compost. Composting guidelines aim to enhance good practices to reach a composting measure that allows optimum waste stabilization, an essential property of compost. If this target is reached, the compost will have a preferable initial carbon-to-nitrogen ratio and lower nitrogen loss, which will favor microbiological development and thus achieve the characteristics of mature compost in less time (Castiglioni et al., 2018).

Composting by-products—such as the generation of greenhouse gas emissions, ammonia odors, and others—can be present if the process is not appropriately completed at home (Vázquez and Soto, 2017). However, the concentrations of CH4, NH3, and N2O emissions in household compost are usually lower than those generated in landfills or other industrial settings (Neugebauer and Solowiej, 2017; Ermolaev et al., 2014). Yet, there have been initiatives to increase the quality of homemade compost by introducing additives, such as woodchips, perlite, vermiculite, and zeolite, which increase the degree of maturity and fulfill criteria related to the absence of phytotoxic compounds (Margaritis et al., 2018). More advanced and ambitious strategies mention inoculating the compost with species of Bacillus thuringiensis to produce enriched compost in the household, which is a low-cost process that provides biopesticide properties (Ballardo et al., 2020). Mass balances and life cycle inventory studies have also been used in environmental assessments to increase the quality of home composting (Andersen et al., 2011).

Around the world, municipal governments and their stakeholders have played an essential role in fostering home composting programs. Local governments promote home composting for different reasons. Yet, most aim to reduce the cost of transportation and the final disposal of organic waste (Mandape et al., 2020; Lekammudiyanse and Gunatilake, 2009; Ince et al., 2015; Agbefe et al., 2019). In this light, maintaining rigor in waste segregation is a strict conditionality for safeguarding compost quality. To some extent, household source segregation determines the success or failure of home composting programs by directly influencing compost quality (Sulewski et al., 2021; Storino et al., 2016). However, previous studies suggest that the factors influencing the intentions to segregate waste at home have not been thoroughly analyzed. Still, they agree that socio-demographic characteristics might play a relevant role (Takahashi and Selfa, 2015; Nguyen et al., 2015; Xu et al., 2017; Knickmeyer, 2020). Therefore, it is also recommended that scholars consider the cultural background of residents concerning their environmental values, awareness, and knowledge about waste segregation and home composting (Hussain et al., 2014; Van der Werff et al., 2019; Kaplan. et al., 2019; Mofid-Nakhaee et al., 2020). Despite the importance of separating organic waste at home and this activity's contribution to producing quality compost, relatively few scholars have explored the interconnection with SDG 2. To fill this gap, this article explores the potential of SDG 2 to encourage good practices of organic waste separation in residential areas or if waste segregation practices support SDG 2.

2. Materials and methods

This quantitative, non-experimental case study is based on an exploratory survey conducted with residents of two middle-class neighborhoods in the capital city of a state in northwestern Mexico, adjacent to the United States of America. The survey aims to measure the perception and awareness of the participants related to home separation and composting practices and their knowledge about SDG 2. The study comprised two questionnaires. The first is a 40-item survey questionnaire with three sections addressing household waste separation, home-composting knowledge, and SDG2 knowledge. This questionnaire was applied to one neighborhood participating in a local household waste segregation project. In addition, a briefer version of the questionnaire, 36 items, was used in one community not participating in the municipality waste project. The surveys were pilot tested in both settings, after which the questionnaire template was further edited. One of the neighborhoods in the study is part of the registry of communities participating in a municipality's source-separated organic household waste project, which was initiated two years ago. The other neighborhood does not participate in the municipal initiative. In addition, both communities are similar in size and construction design. A non-probability purposive sampling technique was used to determine the inhabitants' sampling size. Participants were recruited via convenience/snowball techniques, which provided access to a diverse sample. After learning the study details, including the risks and benefits, all participants signed an informed consent form. Those who agreed to partake in the study were directed to an online platform via Google forms. Data were collected from January to July 2021. First, a univariate descriptive analysis was performed for each item in the questionnaire to describe general properties in each category. Secondly, a comparison of two population proportions was performed to test hypotheses concerning the difference in the proportion of some questions of interest. The null hypothesis was no differences between proportions, and the alternative hypothesis was the difference between proportions:

$$H_0 : \ p_1 = p_2$$

$$H_0 : \ p_1 \langle p_2 \ o \ p_1 \rangle p_2$$

The equation for the test statistic in large sampling size was:

$$z = \frac{p_1 - p_2}{\sqrt{\frac{p(1-p)}{n_1} + \frac{p(1-p)}{n_2}}}$$

Where p

$$p = \frac{n_1 p_1 + n_2 \ p_2}{n_1 + n_2}$$

Table 1
Socio-demographic profiles in both neighborhoods.

Socio-demographic characteristics	Neighborhood participating in the municipal project		Neighborhood not participating in the municipal project	
	Number of participants (101)	Percentage (%)	Number of participants (101)	Percentage (%)
Gender				
Female	55	54	57	56
Male	46	46	44	44
Age (years)				
18–23	11	11	8	8
24–29	10	10	16	17
30–35	12	12	18	19
36–41	16	16	9	9
42–47	20	20	10	10
48–53	6	6	13	13
54–59	8	8	13	13
+60	17	17	12	12
Maximum Level of education				
Lower than High School	5	5	0	0
High school	21	21	13	13
Bachelor's degree	58	58	76	75
Master/Doctor	16	16	12	12
Monthly income (USD)				
> $950	17	17	29	26
> $1400	79	78	63	62

and

$z_{0.025} = \pm 1.96$

3. Results

3.1. Socio-demographic profiles

As shown in Table 1, the socio-demographic data was slightly different among inhabitants in both neighborhoods. The total sampling was 202 residents, with 101 participants in each community. In addition, 55% of the sample was female, and 45% was male. The participants' age range was from 18 to above 60 years old. The most representative range of age in both communities was between 30 and 42 years old. Average schooling in both neighborhoods is a bachelor's degree, at 58% and 75%, respectively. Finally, 78% of the inhabitants participating in the project have an average household income of more than 1400 American dollars per month. In the other community that does not participate in the waste segregation project, the same average household income is earned by 62% of survey participants.

3.2. Community involvement

98% of residents participating in the source-separated organic waste municipal project were aware of and enrolled in such a program. Accordingly, 99% claimed to separate organic from inorganic waste at home, and the vast majority had a container for organic waste. However, 80% of the inhabitants declared they had not received training in separating waste beyond the indication to place their garbage on the sidewalk on collection days. 95% follow this indication. Although the program does not provide financial or other benefits to participants, 58% would like compensation. Nearly 30% would like to get compost, and 18% an economic bonus. Despite their involvement, just 21% of participants know how the organic residue is disposed of.

3.3. Organic waste separation awareness

Most of the residents enrolled in the program, six in ten (60%) responded that they know about composting techniques, but only 11% compost at home. Moreover, 92% asserted that compost is safer and better than chemical fertilizers. On the other hand, nearly three in ten inhabitants (34%) not participating in the source-separated organic waste municipal project claimed to separate their household waste, and 18% of the participants have a bin for organic residue. Consequently, roughly three in ten respondents (28%) declared they use their organic waste. In addition, most residents, nearly seven in ten (67%), responded that they know about composting techniques, but only 25% carry them out. Many of them, 89%, asserted that using compost is safer and better than using chemical fertilizers. In the event that the municipality implements a waste separation program in their neighborhood, about 72% of the survey participants would like to participate in exchange for a benefit. This benefit could be to receive compost, 33%, or receive a financial bonus, 20%. See Table 2.

3.4. Perception of composting efforts

When asked about composting efforts, nearly three in ten residents enrolled in the program, 33%, partially agreed that composting food scraps at home was laborious, and 11% fully agreed with this asseveration. Mainly, 40% partially agreed it was time-consuming, and about 50% fully agreed that it required technical knowledge. Furthermore, nearly 40% fully believed that it attracts pests, such as insects and vermin. In addition to this disadvantage, 40% said it generates terrible odors. Despite these drawbacks, 78% fully considered that the community must produce homemade compost. Hence, 90% fully agreed that composting at home is good for the environment as it enriches the soils. In the neighborhood not participating in the source-separated organic waste municipal project, about six in ten residents (58%) partially agreed that composting food scraps at home was laborious, and 11% fully agreed. Mainly, 67% partially thought it was time-consuming, and about 52% partially claimed it required technical knowledge. 80% of those surveyed fully agreed that composting at home is good for the environment as it enriches the soils, so composting is worth the effort.

Regarding the potential disadvantages of composting in the house, 68% partially believed it attracts insects and vermin. In addition, 55% said that it generates terrible odors. Finally, 55% fully agreed that the community must produce homemade compost. See Table 3.

Table 2
Organic waste separation awareness.

	Neighborhood participating in the municipal project		Neighborhood not participating in the municipal project	
Variables	Yes (%)	No (%)	Yes (%)	No (%)
Composting awareness				
Knowledge about composting techniques	60	40	67	33
Separate organic from inorganic waste	99	1	34	66
Use your organic waste to compost	11	89	25	75
Compost is better than chemical fertilizer	92	8	89	11

Table 3
Perception about home composting.

	Neighborhood participating in the municipal project			Neighborhood not participating in the municipal project		
Variables	Agree (%)	Partially agree (%)	Disagree (%)	Agree (%)	Partially agree (%)	Disagree (%)
Perception about composting						
Composting is too much work	11	33	56	11	58	31
Requires a lot of time	19	40	41	15	67	18
Requires technical knowledge	50	22	28	33	52	15
Is good for the environment	90	5	5	80	16	4
Nourishes soils	92	5	3	81	14	5
Attracts pests	40	34	26	24	68	8
Generates terrible odors	40	32	28	28	55	17
Hermosillenses must compost food scraps	78	19	3	55	40	5

Table 4
Comparison of two population proportions of composting knowledge.

Criteria	Neighborhood not participating in the municipal project	Neighborhood participating in the municipal project	Value z	Null hypothesis Result
Do you have knowledge about composting?	0.6733	0.6040	1.0251	Not Rejected
Do you know the type of waste that can be composted?	0.7228	0.6634	0.9152	Not Rejected
Do you think that compost is better than a chemical fertilizer?	0.8911	0.9208	0.7231	Not Rejected

3.5. SDG 2 zero hunger knowledge

The respondents in both neighborhoods were questioned about several issues to understand their knowledge and perspectives regarding SDG 2. For example, when asked about the purpose of the 2030 agenda, many inhabitants in both neighborhoods, 90% and 95%, respectively, reported having no idea. Similarly, just 25 and 28% have heard about SDG 2. Yet, despite ignoring the goal of SDG 2, the majority responded positively to questions related to SDG 2. For instance, nearly 98% of all participants claimed that the government should increase zero hunger awareness and foster sustainable and small-scale agriculture. In addition, about 91% and 87% considered that organic fertilizers could improve access to sufficient, safe, and nutritious food for all people. Similarly, about 90% of all respondents felt that reducing food leftovers and spoiled food might increase healthy food access in the least developed communities.

3.6. Comparison of two population proportion

(a) Composting knowledge

The proportion of inhabitants claiming to have reliable composting knowledge in both neighborhoods is above 50%. When testing the null hypothesis, no difference was found between the inhabitants' response proportions in both communities; hence, the null hypothesis was not rejected. Similarly, there was no difference between the proportion of respondents in each sample that knew what kind of waste could be composted, although both proportions were higher than 65%. Finally, the null hypothesis related to those claiming that compost is better than chemical fertilizers and is highly beneficial for the soil was also not rejected. Table 4 shows the proportions and the z-score.

(a) Segregation practices

According to Table 5, the proportion of inhabitants in the neighborhood participating in the municipal project that performs waste segregation is more significant than the proportion of the other sample, approximately 99% against 33%. Therefore, the computing of the statistic test resulted in a statistically significant difference, so the null hypothesis was rejected. On the other hand, the community members not participating in the municipal project got a more considerable proportion in household composting practices than the other community, which led to reject the null hypothesis.

(a) SDG 2 awareness

Last but not least, the computing of statistical tests to measure SDG 2 knowledge indicates the need for a more considerable effort of the municipality to raise awareness. Data in Table 6 shows that the three null hyphotheses were not rejected due to no a statistically significant difference was found.

4. Discussion

As learned in the introduction section, scholars have theorized the importance of home composting in addressing SDG 2, but have ignored the role of household waste segregation. The findings in this study revealed a weak interconnection between residential waste segregation and SDG2. Therefore, regarding the respondent's awareness of SDG 2 in both neighborhoods, the lack of knowledge on the subject is hardly surprising. Furthermore, the hypothesis tests determined no differences in the proportion of positive answers for the questions related to the 2030 Agenda of Sustainable Development and SDG 2, suggesting that participating in a residential waste segregation program does not necessarily

Table 5
Comparison of two population proportions of waste segregation.

Criteria	Neighborhood not participating in the municipal project	Neighborhood participating in the municipal project	Value z	Null hypothesis Result
Do you segregate waste?	0.3366	0.9901	−9.8272	Rejected
Do you compost your organic waste?	0.2475	0.1089	2.5738	Rejected

Table 6
Comparison of two population proportions of SDG 2 support.

Criteria	Neighborhood not participating in the municipal project	Neighborhood participating in the municipal project	Value z	Null hypothesis Result
Do you know about the 2030 Agenda?	0.099	0.0495	−1.3417	Not Rejected
Do you know about SDG 2	0.2772	0.2475	0.4798	Not Rejected
Do you think it is necessary to raise awareness about Zero Hunger?	0.9802	1	−1.4212	Not Rejected

imply raising awareness. Conversely, increasing residents' attention to meeting SDG 2 may drive household waste segregation and strengthen the current city hall program. Furthermore, after being introduced to SDG 2, a significant percentage of participants clearly showed empathy with the philosophy behind SDG 2.

Testing the study's hypothesis revealed no statistical differences in the proportions of respondents in both communities when they referred to composting knowledge. Still, differences were found related to waste segregation and composting practices. Still, some preliminary considerations based on the univariate descriptive analysis suggest that household waste segregation might align with SDG 2. First, analyzing the socio-demographic results is a good starting point for understanding this study's relevance. The findings of this study show similarity in socio-demographic data among residents in both communities, which might significantly explain the strong consciousness in general about organic waste segregation and composting.

Regarding income, residents in both areas fall into the middle-class income category. This category favors operating organic segregation at the source programs since environmentalism has been linked to middle- and upper-class lifestyles (Hickcox, 2018). This premise is confirmed by a Pew Research Center study (Pew Research Center, 2009) in emerging countries, including Mexico, which reports that middle-class populations are more concerned about environmental issues than low-income groups.

When looking at the age breakdown, most of the survey's participants in both communities are millennials, born between 1981 and 1986. This finding is another relevant factor in explaining the strong conscientiousness in both communities because a growing body of research suggests that millennials' sustainability values are environmentally friendly (Hanson-Rasmussen and Lauver, 2018; Allen and Spialek, 2018). In addition, it is reported that the average schooling in both communities is a bachelor's degree, although there is also an acceptable percentage of residents with graduate studies. Several studies have emphasized schooling as a favorable predictor of optimizing waste management at the source (Kodua and Anaman, 2020; Bunditsakulchai and Liu, 2021).

Concerning gender, our data show that the gender distribution in the sample was equitable. Since there is a balanced gender diversity, no gender distinctions can be made from this data. However, there is little knowledge about the influence that gender can have on the willingness of people to segregate their waste at home. In general, gender evidence in the literature is usually not conclusive. For instance, Labib et al. (2021) have reported that gender moderately affects the intention to sort waste. Another problem with gender evidence is that it is conflicting. On one end of the position spectrum, some scholars assume that females have more knowledge about waste management (Mukherji et al., 2016); therefore, it is necessary to increase their involvement to optimize the process (Asteria and Haryanto, 2021). On the other side of the spectrum, it has been found that women are less likely to segregate waste at home (Al-Khateeb et al., 2017). These socio-demographic findings are relevant for local policymakers to expand the current program to other neighborhoods with the same environmental conscientiousness and literacy level. Yet, the program presents some areas of opportunity.

Perhaps one of the program's weaknesses, in general, is the lack of feedback about the fate of the waste collected. Our results indicate that despite the strong involvement, just a tiny percentage of the participants know the final disposal of their organic waste. Timely feedback ensures that residents improve their segregation practices; otherwise, initial interest may decline. Research shows that when feedback is poor, initial interest is lost (Hosono and Aoyagi, 2018). Interest may also decrease if residents perceive waste segregation as an unsafe practice. In this context, universities have a long tradition of supporting industry to manage environmental and other risks (Velazquez et al., 2000; Munguía et al., 2010; Álvarez-Chávez et al., 2019). Therefore, local governments may partner with universities to develop household competences to manage environmental and other risks. The survey also identified volunteering as the main driver of participation in the waste segregation program, yet it would be advisable not to rely solely on volunteers. Boonrod et al. (2015) have suggested that traditional, voluntary, reward, and business community mechanisms are four behavioral triggers toward the normalization of organic waste separation in community settings. In particular, the rewards scheme could be appropriate for strengthening the residents' intentions to separate household waste, since one third of respondents would like to receive compost or a financial bonus.

5. Conclusions

The interconnection between residential waste segregation and SDG 2 is harder to prove, even though waste segregation is essential to composting. The 2030 Agenda for Sustainable Development's second goal is to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture. Result suggests that SDG 2 is usually pursued on national agendas; thus, it is unlikely that the home segregation of organic waste for small-scale home composting may influence national progress toward SDG 2. Still, this study would provide valuable insights for policymakers to develop comprehensive waste segregation policies that align with SDG 2. In contrast, the philosophy involved in SDG 2 may be a driver for encouraging all relevant stakeholders' willingness to segregate at the source. Furthermore, participants in this study have shown similar ways of environmental sustainability thinking; they may

also share their sustainability social values to accept SDG2 as a driver for waste segregation rather than in the opposite way.

Furthermore, empirical evidence has shown that income, age, gender, and education are not only good predictors of waste segregation intentions but also contribute to achieving SDG 2.

Funding

This research received no external funding.

Data availability

Data supporting reported results can be obtained on demand.

CRediT authorship contribution statement

Luis Velazquez: Conceptualization, Methodology, Data curation, Formal analysis, Supervision, Writing – review & editing, Writing – original draft. **Nora Munguia:** Conceptualization, Methodology, Data curation, Formal analysis, Writing – review & editing, Writing – original draft. **Diana Alvarez-Alvarez:** Data curation. **Guillermo Cuamea-Cruz:** Data curation, Formal analysis. **Carlos Anaya-Eredias:** Data curation, Formal analysis. **Francisco Martinez-Castañeda:** Data curation, Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Álvarez-Chávez, C.R., Marín, L.S., Perez-Gamez, K., Portell, M., Velazquez, L., Munoz-Osuna, F., 2019. Assessing college students' risk perceptions of hazards in chemistry laboratories. J. Chem. Educ. 96 (10), 2120–2131. doi:10.1021/acs.jchemed.8b00891.

Agbefe, L.E., Tweneboah, E., Yirenya-Tawiah, D., 2019. Awareness on waste segregation at source and willingness to pay for collection service in selected markets in Ga west municipality, Accra, Ghana. J. Mater. Cycles Waste Manag. 21 (4), 905–914. doi:10.1007/s10163-019-00849-x.

Al-Khateeb, A.J., Al-Sari, M.I., Al-Khatib, I.A., Anayah, F.F, 2017. Affecting the sustainability of solid waste management system—the case of palestine. Environ. Monit. Assess. 189 (2). doi:10.1007/s10661-017-5810-0.

Allahyari, M.S., Poursaeed, A., Leal Filho, W., Azul, A., Brandli, L., Özuyar, P., Wall, T., 2019. Sustainable agriculture: implication for SDG2 (zero hunger). Zero Hunger. Encyclopedia of the U.N. Sustainable Development Goals. Springer, Cham doi:10.1007/978-3-319-69626-3_50-1.

Allen, M.W., Spialek, M.L., 2018. Young millennials, environmental orientation, food company sustainability, and green word-of-mouth recommendations. J. Food Prod. Mark. 24 (7), 803–829. doi:10.1080/10454446.2017.1415827.

Andersen, J.K., Boldrin, A., Christensen, T.H., Scheutz, C., 2011. Mass balances and life cycle inventory of home composting of organic waste. Waste Manag. 31 (9–10), 1934–1942. doi:10.1016/j.wasman.2011.05.004.

Asteria, D., Haryanto, J.T, 2021. Empowerment key factors in shaping women's awareness of household waste management. Glob. J. Environ. Sci. Manag. 7 (3), 1–14. doi:10.22034/GJESM.2021.03.01.

Ballardo, C., Vargas-García, M.C., Sánchez, A., Barrena, R., Artola, A., 2020. Adding value to home compost: biopesticide properties through Bacillus thuringiensis inoculation. Waste Manag. 106, 32–43. doi:10.1016/j.wasman.2020.03.003.

Barrena, R., Font, X., Gabarrell, X., Sánchez, A., 2014. Home composting versus industrial composting: influence of composting system on compost quality with focus on compost stability. Waste Manag. 34 (7), 1109–1116. doi:10.1016/j.wasman.2014.02.008, JulEpub 2014 Mar 1. PMID: 24594253.

Blesh, J., Hoey, L., Jones, A.D., Friedmann, H., Perfecto, I., 2019. Development pathways toward "zero hunger". World Dev. 118, 1–14. doi:10.1016/j.worlddev.2019.02.004.

Boonrod, K., Towprayoon, S., Bonnet, S., Tripetchkul, S., 2015. Enhancing organic waste separation at the source behavior: a case study of the application of motivation mechanisms in communities in Thailand. Resour. Conserv. Recy 95, 77–90. doi:10.1016/j.resconrec.2014.12.002.

Sustainable Development and Biodiversity Bouzaiane, O., Jedidi, N., Hassen, A., Maheshwari, D., 2014. Microbial biomass improvement following municipal solid waste compost application in agricultural soil. In: Composting For Sustainable Agriculture. Springer, Cham, p. 3. doi:10.1007/978-3-319-08004-8_10 Sustainable Development and BiodiversityComposting for Sustainable.

Bunditsakulchai, P., Liu, C., 2021. Integrated strategies for household food waste reduction in Bangkok. Sustainability 13 (14), 1–21. doi:10.3390/su13147651, (Switzerland).

Castiglioni, G.L.L., Vasques, M.R., Bilhalva, M.R., Torma, B.f., da Paz, M.F., Bilhalva, C.L., Kunde, C.E., 2018. Home composting using different ratios of bulking agent to food waste. J. Environ. Manag. 207, 141–150. doi:10.1016/j.jenvman.2017.11.031.

Chew, K., Chia, S., Yen, H., Nomanbhay, S., Ho, Y., Show, P., 2019. Transformation of biomass waste into sustainable organic fertilizers. Sustainability 11, 1–19. doi:10.3390/su11082266.

Ermolaev, E., Sundberg, C., Pell, M., Jönsson, H., 2014. Greenhouse gas emissions from home composting in practice. Bioresour. Technol. 151, 174–182. doi:10.1016/j.biortech.2013.10.049.

FAO, 2019. Food Security Statistics. FAO Available online:.

WHO, 2021. The State of Food Security and Nutrition in the World 2020. Transforming food Systems For Affordable Healthy Diets. FAO, Rome Available onlineacceded on 20 July doi:10.4060/ca9692en.

Free, C., Hecimovic, A., 2021. Global supply chains after COVID-19: the end of the road for neoliberal globalisation? Account. Audit. Account. 34 (1), 58–84. doi:10.1108/AAAJ-06-2020-4634.

Guo, H., Liu, Y., Shi, X., Chen, K.Z., 2020. The role of E-commerce in the Urban food system under COVID-19: lessons from China. China Agric. Econ. Rev. doi:10.1108/CAER-06-2020-0146.

Hanson-Rasmussen, N.J., Lauver, K.J., 2018. Environmental responsibility: millennial values and cultural dimensions. Glob. Responsib. 9 (1), 6–20. doi:10.1108/jgr-06-2017-0039.

Hao, N., Wang, H.H., Zhou, Q., 2020. The impact of online grocery shopping on stockpile behavior in COVID-19. China Agric. Econ. Rev. 12 (3), 459–470. doi:10.1108/CAER-04-2020-0064.

Hickcox, A., 2018. White environmental subjectivity and the politics of belonging. Soc. Cult. Geogr. 19 (4), 496–519. doi:10.1080/14649365.2017.1286370, 4.

Hosono, T., Aoyagi, K., 2018. Effectiveness of interventions to induce waste segregation by households: evidence from a randomized controlled trial in Mozambique. J. Mater. Cycles Waste Manag. 20 (2), 1143–1153. doi:10.1007/s10163-017-0677-2.

Hussain, F., Chaudhry, M.N., Batool, S.A., 2014. Assessment of key parameters in municipal solid waste management: a prerequisite for sustainability. Int. J. Sustain. Dev. World Ecol. 21 (6), 519–525. doi:10.1080/13504509.2014.971452.

Ince, O., Gozde, E., Akyol, C., Ince, O., Ince, B., 2015. Composting practice for sustainable waste management: a case study in Istanbul. Desalin. Water Treat. 1–15.

Kaplan, K., Henn, L., Park, J., Kurman, J., 2019. What predicts household waste management behaviors? Culture and type of behavior as moderators. Resour. Conserv. Recycl. 145 (January), 11–18. doi:10.1016/j.resconrec.2019.01.045.

Kerr, W.A., 2020. The COVID-19 pandemic and agriculture: short- and long-run implications for international trade relations. Can. J. Agric. Econ. 68, 225–229. doi:10.1111/cjag.12230.

Knickmeyer, D., 2020. Social factors influencing household waste separation: a literature review on good practices to improve the recycling performance of Urban areas. J. Clean. Prod. 245, 118605. doi:10.1016/j.jclepro.2019.118605.

Kodua, T.T., Anaman, K.A., 2020. Indiscriminate open space solid waste dumping behaviour of householders in the Brong-Ahafo Region of Ghana: a political economy analysis. indiscriminate open space solid waste dumping behaviour of householders in the Brong-Ahafo Region of Ghana: a political economy analysis. Cogent Environ. Sci. 6 (1). doi:10.1080/23311843.2020.1779553.

Kumar, M.D., Dheeman, S., Agarwal, M., Maheshwari Disesh, K., 2014. Decomposition of organic materials into high value compost for sustainable crop productivity. In: Composting For Sustainable Agriculture. Springer, New York Dordecht, London, pp. 67–82. doi:10.1007/978-3-319-08004-8_4.

Labib, O., Manaf, L., Hamzah, S.A., Mohamad Zaid, S.S., 2021. Moderating effects on residents' willingness in waste sorting to improve waste handling in Dammam City, Saudi Arabia. Recycling 6 (24), 1–18. doi:10.3390/recycling6020024.

Lekammudiyanse, L.M., Gunatilake, S.K., 2009. Efficiency of the household compost bin as a waste management technique in Sri Lanka (a case study in gampaha municipal council area). Int. J. Basic Appl. Sci. 10, 89–94.

Mandape, A., Kumari, S., Kumar, S., Hettiarachchi, H., Caucci, S., Schwärzel, K., 2020. Composting as a municipal solid waste management strategy: lessons learned from Cajicà, Colombia. Organic Waste Composting Throgh Nexus Thinging. Springer Open, Cham, Switzwerland doi:10.1007/978-3-030-36283-6.

Margaritis, M., Psarras, K., Panaretou, V., Thanos, A.G., Malamis, D., Sotiropoulos, A., 2018. Improvement of home composting process of food waste using different minerals. Waste Manag. 73, 87–100. doi:10.1016/j.wasman.2017.12.009.

Mehta, S., Saxena, T., Purohit, N., 2020. The new consumer behaviour paradigm amid COVID-19: permanent or transient? J. Health Manag. 22 (2), 291–301. doi:10.1177/0972063420940834.

Mofid-Nakhaee, E., Barzinpour, F., Pishvaee, M.R., 2020. A sustainable municipal solid waste system design considering public awareness and education: a case study. Waste Manag. Res. 1–13. doi:10.1177/0734242X20910.

Mukherji, S.B., Sekiyama, M., Mino, T., Chaturvedi, B., 2016. Resident knowledge and willingness to engage in waste management in Delhi, India. Sustainability 8 (10), 1–14. doi:10.3390/su8101065, (Switzerland).

Munguía, N., Zavala, A., Marin, A., Moure-Eraso, R., Velazquez, L., 2010. Identifying pollution prevention opportunities in the Mexican auto refinishing industry. Manag. Environ. Qual. Int. J. 21 (3). doi:10.1108/14777831011036885.

Naeem, M., 2020. Understanding the customer psychology of impulse buying during COVID-19 pandemic: implications for retailers. Int. J. Retail Distrib. Manag. doi:10.1108/IJRDM-08-2020-0317.

Neugebauer, M., Solowiej, P., 2017. The use of green waste to overcome the difficulty in small-scale composting of organic household waste. J. Clean.Prod. 156, 865–875. doi:10.1016/j.jclepro.2017.04.095.

Nguyen, T.T.P., Zhu, D., Phong, L.N., 2015. Factors influencing waste separation intention of residential households in a developing country: evidence from Hanoi, Vietnam. Habitat Int. 48, 169–176. doi:10.1016/j.habitatint.2015.03.013.

Pachòn, J.P., Medina-Moreno, M., Pachòn-Ariza, F.A., 2018. Hunger: from food security to the right to food. Gest. Ambient. 21 (2), 292–302. doi:10.15446/ga.v21n2.75815.

Pew Research Center, 2009. The Global Middle Class Is Here: now What?. Pew Research Center Available online:.

Siles-Castellano, A.B., López, M.J., López-González, J.A., Suárez-Estrella, F., Jurado, M.M., Estrella-González, M.J., Moreno, J., 2020. Comparative analysis of phytotoxicity and compost quality in industrial composting facilities processing different organic wastes. J. Clean. Prod. 252. doi:10.1016/j.jclepro.2019.119820.

Singh, R.P.; Agrawal, R.C. Farmers' Varieties and Ecosystem Services With Reference to Eastern India; Bauddh, K., Kumar, S., Singh, R.P., Korstad, J., Eds.; Springer Nature Singapore Pte Ltd.: Singapore Pte Ltd. 2020. 10.1007/978-981-15-3372-3_7.

Storino, F., Arizmendiarrieta, J.S., Irigoyen, I., Muro, J., Aparicio-Tejo, P.M., 2016. Meat waste as feedstock for home composting: effects on the process and quality of compost. Waste Manag. 56, 53–62. doi:10.1016/j.wasman.2016.07.004.

Sulewski, P., Kais, K., Gołaś, M., Rawa, G., Urbańska, K., Was, A., 2021. Home bio-waste composting for the circular economy. Energies 14 (19), 1–25. doi:10.3390/en14196164.

Takahashi, B., Selfa, T., 2015. Predictors of pro-environmental behavior in rural American communities. Environ. Behav. 47 (8), 856–876. doi:10.1177/0013916514521208.

The World Bank, 2021. Food Security and COVID-19. The World Bank 2021 Available online.

UN-General Assembly. Political declaration of the high-level political forum on sustainable development convened under the auspices of the General Assembly, A/RES/74/4. Available online: https://undocs.org/en/A/RES/74/4, 2019 (acceded on 01 June 2021).

United Nations. The Sustainable Development Goals; 2020. Available online: https://sdgs.un.org/sites/default/files/2020-09/The-Sustainable-Development-Goals-Report-2020.pdf, 2020 (acceded on 27 March 2021).

Vázquez, M.A., Soto, M., 2017. The efficiency of home composting programmes and compost quality. Waste Manag. 64, 39–50. doi:10.1016/j.wasman.2017.03.022.

Van der Werff, E., Vrieling, L., Van Zuijlen, B., Worrell, E., 2019. Waste minimization by households – a unique informational strategy in the Netherlands. Resour. Conserv. Recycl. 144 (January), 256–266. doi:10.1016/j.resconrec.2019.01.032.

Velazquez, L., Munguia, N., Platt, A., 2000. Fostering P2 practices in northwest Mexico through inter-university collaboration. J. Clean. Prod. 8 (5). doi:10.1016/S0959-6526(00)00047-0.

Wichuk, K.M., McCartney, D., 2010. Compost stability and maturity evaluation - a literature review. Can. J. Civ. Eng. 37 (11), 1505–1523. doi:10.1139/L10-101.

Xu, L., Ling, M., Lu, Y., Shen, M., 2017. External influences on forming residents' waste separation behaviour: evidence from households in Hangzhou, China. Habitat Int. 63, 21–33. doi:10.1016/j.habitatint.2017.03.009.