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Introduction of Built-In Stacked Bucket Composter to Support the Farming Practices in Community Garden of Kg Rinching Hulu (Selangor, Malaysia)

Siti Nur Aisyah[1*], *Lis Noer* Aini[1], *Mulyono*[1], and *Siva K* Balasundram[2]

[1]Department of Agrotechnology, Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta, Bantul 55183, Special Region of Yogyakarta, Indonesia
[2]Department of Agriculture Technology, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, 43400, Malaysia

Abstract. Malaysia uses the approach of community garden-based urban farming to build the community awareness about the importance of food resilience, including in Selangor Region. However, most of these community gardens were struggling with the low availability of organic fertilizer due to the low efficacy of organic waste composting. This issue also occurred in Kg Rinching Hulu Community Garden. Therefore, this program was aimed to supervise the local community in Kg Rinching Hulu in making and using the built-in stacked bucket composter for better composting efficacy. This community empowerment program involved 28 members of Kg Rinching Hulu Community Garden (aged ranging from 20-70 years old) and carried out using the experiential learning method through participatory approach. It started with focus group discussion and followed by the practical supervision on the making of built-in stacked bucket composter. Subsequent supervision was focused on performing the composting of municipal waste using the stacked bucket composter. Overall, this program has successfully promoted better technical experience related to municipal waste composting using stacked bucket composter. The introduction of this composter concept was highly approved by the members based on their feedback on the level of technical difficulty.

1 Introduction

Urbanization occurred in many countries worldwide are continuously increasing every year. Uncontrolled urbanization might promote drastic population increase, thus leading to several serious consequences, such as food scarcity and significant loss of arable land [1]. Decrease on agri-food production has been reported to cause remarkable rise on global food price due to low food supply [2]. In line with this urbanization effect, Bellon-Maurel et al. [3] mentioned that production and consumption of agri-food products have much changed following the change on human lifestyles. These issues emphasized the serious impact of agri-food security, thus making it as one of worldwide most critical issues [4]. Therefore,

* Corresponding author: sitinur@umy.ac.id

many countries have set certain policies to avoid similar crisis in the future [5], including the effort to create global awareness related to food self-sufficiency.

Food self-sufficiency is one of efforts on agri-food policy solution specifically taken to achieve the state of food security. This effort is aimed to promote higher domestic production, particularly those considered as mostly consumed agri-food products. Food self-sufficiency is emphasized on the involvement of households in food production which is commonly demonstrated in the form of family farming. This effort has been used in numerous countries as one of key agri-food policies during the last decades [6]. The implementation of food self-sufficiency effort in many countries have generated greater attention towards the urban farming practice. Urban farming is considered as powerful solution to provide food, create employment and sustainable environment [7, 8]. The implementation can be varied in many countries based on the local community need and the urban planning applied in each country.

Government of Malaysia uses the approach of community garden to generate the urban farming practice and promote the public awareness on food self-sufficiency. The implementation of community garden has gained higher popularity in urban areas due to its potential towards the environment, economic, and social aspects. Not only effective for greening the urban areas, but this strategy is also reported to be capable in elevating community resilience, especially the food security for urban communities. Such resilience refers to the ability of a community to survive, adapt, and recover from any disturbance affecting its daily life [9]. Department of Agriculture of Malaysia recorded that number of urban community gardens in Malaysia has increased significantly as the local government provide proper intervention in terms of Urban Farming Programme [10].

Community garden offers high beneficial values for urban communities, in terms of economic, social, public health, and environmental quality [11]. The existence of community garden enables the community to strategically plan the agri-food products to cultivate based on the community needs, thus potentially resulting in higher community welfare. Despite its high benefit, the implementation of urban farming faced various challenges, including the capacity of the community in the nutrient management for the plants itself [12]. This bottleneck was also found in the community garden managed by Kampong Rinching Hulu (Selangor, Malaysia) community. Local community in this area has started a small size community garden since 2022, where the farming practice is focused on organic farming for vegetables. Along with the farming activities, this community garden has actively performed the composting of organic waste. However, the composting efficacy could not support the farming activities optimally due to its low availability. In addition, most of local people were hesitant to perform the composting since it could emit the unpleasant odor during the process.

The formation of odor during the organic waste composting process is commonly occurred when the waste is being degraded and decomposed [13, 14]. Moreover, various physiochemical factors might also contribute to the odor emission during the composting process, such as temperature, aeration, carbon to nitrogen ratio, and moisture content [15]. Managing the composting process, particularly related to this odor emission issues, is highly challenging and requires proper supervision. Therefore, the present community service initiated the introduction of built-in stacked bucket composter as a practical solution to manage the composting of municipal waste with low risk of odor emission. This community service aimed to supervise the local community in Kg Rinching Hulu in making and using the built-in stacked bucket composter. The result of this program was expected to increase the willingness of local community to intensify the composting activity, so it could improve the availability of organic fertilizers required for the farming practices.

2 Methodology

This community service involved the local people of Kg Rinching Hulu, Selangor, Malaysia who joined the management of Kg Rinching Hulu community garden. About 28 members of this community garden, ranging from 20 to 68 years old, joined in the implementation of this community service. There were three main activities arranged during this community service, namely focus group discussion (FGD), supervision on the making of built-in stacked bucket composter, and supervision on the municipal waste composting using stacked bucket composter. During the FGD session, an interactive discussion was generated to allow the members of community garden to discuss about their experience in managing the community garden. In this session, pre-test was performed to analyse the preliminary knowledge as well as the interest from the members regarding this community service. In addition, the concept of built-in stacked bucket composter was also introduced in this session as the reference for the members. The making of built-in stacked bucket composter was demonstrated by the facilitator and the members were participated actively during the assembly process. Once the assembly of stacked bucket composter had completed, the members performed the trial of municipal waste composting under the supervision from the facilitators. Progress on the composting process was regularly observed from the members of the community garden.

3 Results and Discussion

This present community service began with the focus group discussion to identify the preliminary knowledge and experience from the members of the community garden related to the zero-waste agriculture and composting of municipal waste. Considering the age distribution, this community garden showed well-balanced proportion between members from the productive ages and those considered as senior citizen (above 60 years old) (Fig. 1). In terms of preliminary knowledge related to zero-waste agriculture, most of the members have ever heard about this topic (Fig. 2a). In line with this result, such well-informed knowledge was assumed to be associated with the frequency of member's participation in the farming practice conducted in the community garden (Fig. 2b). About 53.6% of the members were regularly involved in the farming activities (Fig. 2b), hence suggesting such high interest and awareness from the local community regarding the importance of food self-sufficiency.

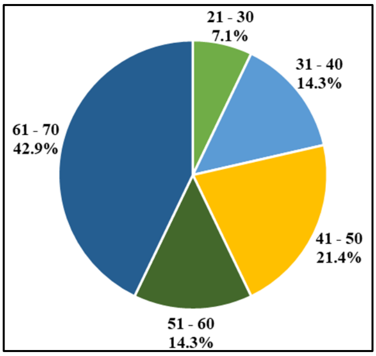

Fig. 1. Age distribution among the members of Kg Rinching Hulu community garden participated during the community service. Data was collected from 28 members.

The implementation of urban farming cannot be separated from the need of plant nutrients management through the using of fertilizer. The community garden managed by Kg Rinching

Hulu community is focused on the implementation of organic farming. This choice of farming practice requires the availability of organic fertilizer which can be generated through the utilization of municipal waste, such as food waste. Production of this organic fertilizer can be performed through composting process. Fig. 3a highlighted that majority of the members had the experience in performing the composting of organic waste. However, some members expressed their complain about the challenges found during the composting process that resulted in the reluctance from the members to perform the composting in the future. Among several bottlenecks in the composting process, about 50% of the members pointed out their reason on the issue of unpleasant odor emission (Fig. 3b). In addition, some members (35.7%) also complained about the difficulty in maintaining the composting progress consistently (Fig. 3b). Despite the complains mentioned, after the FGD was completed, most of members stated their willingness to learn more about the composting process (Fig. 4).

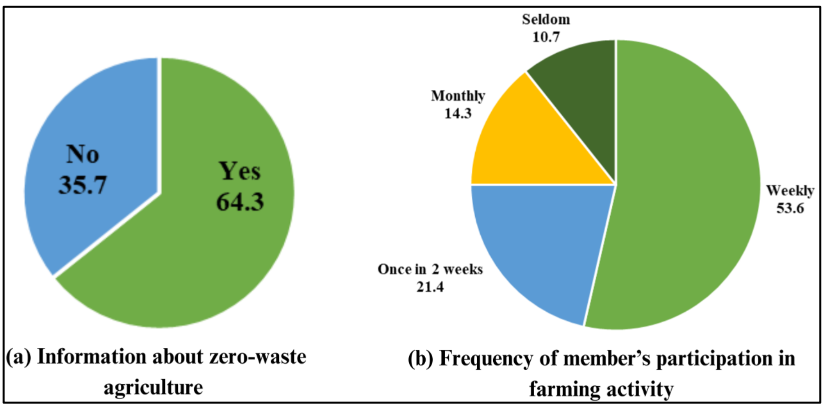

Fig. 2. Mapping of the basic knowledge (a) and hands-on experience (b) among the members related to the implementation of zero-waste agriculture. Data was collected from 28 members.

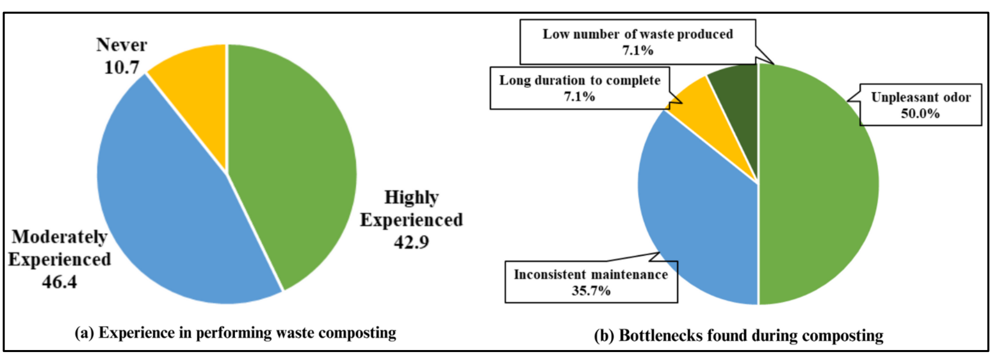

Fig. 3. Mapping of member's feedback regarding the previous experiences (a) and the bottlenecks (b) found during the composting of organic waste. Data was collected from 28 members.

Practical supervision performed after the FGD session was focused on the making of built-in stacked bucket composter where all members were involved during the making process (Fig. 5b). This type of composter is considered as the simplest yet the most applicable composter for home-scale composting. The making of this composter was designed to utilize the unused capped buckets (Fig. 5a) which then stacked to facilitate the separation between the solid and liquid parts of the municipal waste (Fig. 5c). This feature would be helpful in reducing the odor emission during the composting. Moreover, the utilization of reused buckets offered smaller size composter, thus making it more suitable for household use with smaller amount of daily waste production.

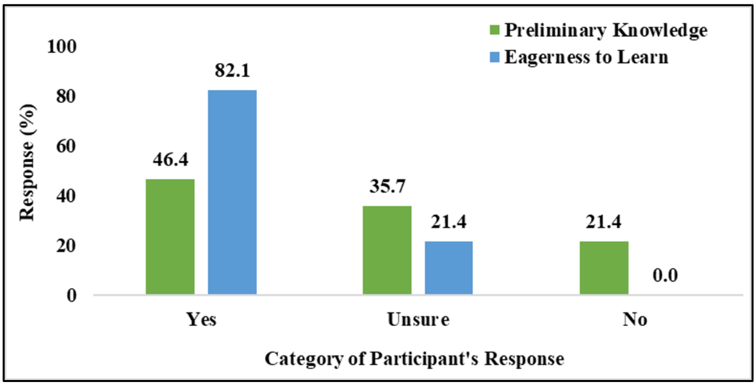

Fig. 4. Mapping of member's perspective and interest to learn more about the composting. Data was collected from 28 members.

Stacked bucket composter is designated with two major components, namely upper bucket and bottom bucket. Upper bucket is used to facilitate the composting of solid waste, while the bottom bucket is used to collect the liquid waste. Composting of the solid waste in the upper bucket occurs under anaerobic conditions with the help of decomposer microbes stimulated by the addition of sugar or dairy products. After being incubated for 1-2 months, the solid compost can be collected and used for gardening. In contrast, the liquid waste is incubated for 15-30 days in the bottom bucket. Afterwards, the liquid waste is collected and further incubated for maturation until the colour and aroma are changed. Once the colour become brownish black and the aroma gets milder, the liquid compost can be used as liquid fertilizer [16].

(a) Preparation of unused capped buckets (b) Making of stacked bucket composter (c) Process of buckets stacking

Fig. 5. Practical supervision on the making of stacked bucket composter.

Followed the supervision of composter making, the members were also supervised in performing the composting using this stacked bucket composter. The facilitators explained the sequences of ingredients that needed to prepare before demonstrating the procedure of the composting itself (Fig. 6a). During this supervision, facilitators pointed out the use of easily accessible daily ingredients, such as brown sugar (as the substitute of molasses) (Fig. 6b-c) and yoghurt (as the substitute of EM4), to provide more practical experience for the members. The members of this community garden showed high enthusiasm during this supervision marked by active discussion generated between the members and the facilitators.

(a) Preparation of municipal waste **(b) Preparation of sugar solution** **(c) Application of sugar solution to the composter**

Fig. 6. Practical supervision on the composting of municipal waste using stacked bucket composter.

Composting has been established as the most widely used technology in organic waste management. However, numerous studies have reported the shortcomings of this method [17-19], thus making it less favorable compared to other advanced methods. The most concerned challenges found in organic waste composting are related to offensive odor release and gas emission [18, 20]. Both issues are considered to affect the climate change directly when it is unable to be managed properly. Other study also mentioned that the emission of both gas and odor could be caused due to improper handling during the initial preparation as well as during the composting process [17]. Addressing these challenges, Ayilara et al. [18] recommended that the control of temperature and oxygen flow must be taken into account to generate highly effective composting. In addition, the recent organic waste composting is performed with the integration of certain species of insects, such as *Hermetia illucens*, *Tenebrio molitor*, *Alphitobius diaperinus*, and *Musca domestica* [21-26]. The involvement of these necrophagous insects had successfully minimized the gas emissions, hence resulting in more sustainable composting process with better efficacy [18, 23].

Feedback from the members of Kg Rinching Hulu community garden was carefully observed after all supervisions completed. The feedback observed was consisted of four aspects, mainly interest on technology adoption, technical difficulty level, knowledge understanding level, quality of supervision provided (Fig. 7a-d). Majority of members confirmed their high interest to adopt this composting technology (Fig. 7a) as the results of very helpful supervision (Fig. 7d) and easily understood procedure (Fig. 7c). Regarding the practicality aspects, most of members found this stacked bucket composting were easy to perform independently; meanwhile some members still considered this technique to be quite tricky to perform (Fig. 7b).

The introduction of stacked bucket composter would be a new yet helpful reference to improve the efficacy of municipal waste composting performed in the community garden. The utilization of this type of composter could support the availability of organic fertilizer for the farming practices managed by the members of community garden. Moreover, the feature of this composter could facilitate home-scale composting with low amounts of waste input and odorless process. The separation of solid and liquid parts of the waste facilitated by this stacked bucket composter could prevent the moisture excess and maintain sufficient aeration. Cerda et al. [19] emphasized that moisture content and aeration during the composting process contributed to the formation of unpleasant smell. The moisture content is suggested to be maintained within the range of 40-60% [27]. Furthermore, Chennaoui et al. [28] also highlighted that water excess might inhibit the metabolic activity of decomposing microbes due to low oxygen diffusion. Therefore, it is important to control the aeration rate and the anaerobic condition [19] since it will stimulate better performance from the decomposing microbes resulting in more odorless composting process.

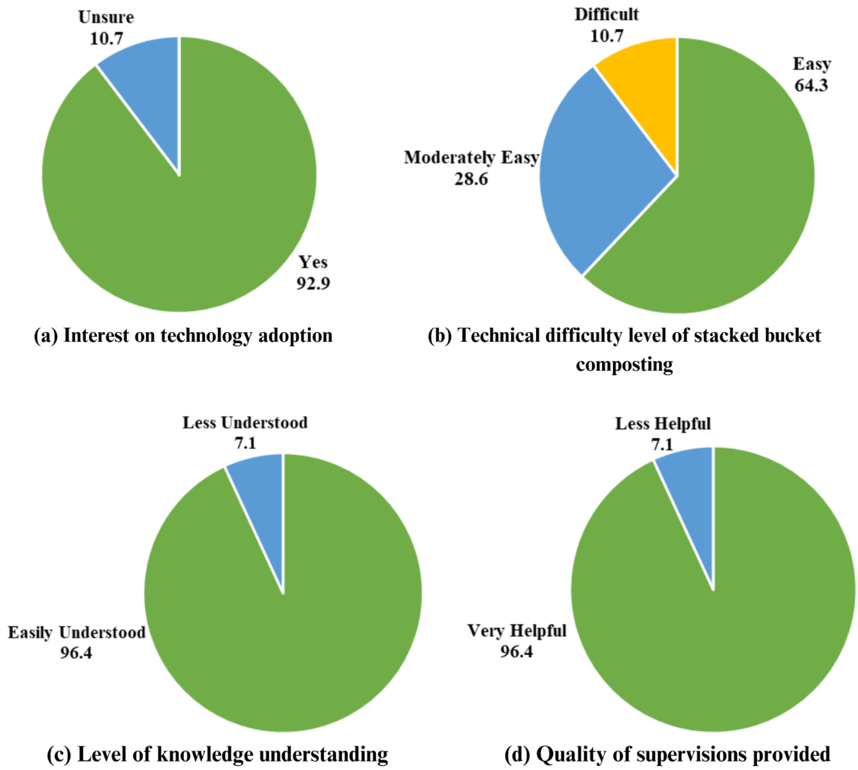

Fig. 7. Mapping of member's feedback after completing all supervisions provided. Data was collected from 28 members.

The use of stacked bucket composter has been massively implemented in Indonesia to generate higher involvement from the society related to organic waste management [16, 29-34]. These reports strengthen that the level of society adoption and acceptance towards this technology is high. This high level of acceptance and adoption may be associated with the aspects of budget-friendly and easy operation provided by this stacked bucket composter. In terms of technology adoption, the clarity of technical know-how and access to knowledge sharing could increase the adopter's decision in adopting new technology [35-37]. Previous studies also noted that certain level of intervention from the government could also promote faster society adoption towards the new technology through subsidy, extension service, technical workshop, input and market access availability [38-42].

4 Conclusions

The implementation of this present community service successfully promoted better technical experience for the member of Kg Rinching Hulu community garden related to municipal waste composting using stacked bucket composter. The introduction of this composter concept was highly approved by the members based on their feedback on the level of technical difficulty. This success was also associated with moderate level of previous experience and preliminary knowledge from the members, thus resulting in easier adoption towards the introduced technology.

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References

[1] Orsini F, Kahane R, Nono-Womdim R, Gianquinto G 2013 *Agronomy for Sustainable Development* **33** 695-720.
[2] Mohamed Arshad F, Hameed A A A 2010 *Journal of Consumer Research and Resource Center* **2010**.
[3] Bellon-Maurel V, Brossard L, Garcia F, Mitton N, Termier A, Barbier S 2022 *Inria INRAE White Book) doi* **10** 1-185.
[4] Abiri R, Rizan N, Balasundram S K, Shahbazi A B, Abdul-Hamid H 2023 *Heliyon*.
[5] Alam M M, Siwar C, Wahid A N, Talib B A 2016 *Review of Urban & Regional Development Studies* **28** 2-15.
[6] Pieters H, Vandeplas A, Guariso A, Francken N, Sarris A, Swinnen J, et al. 2012.
[7] Hussain M R M, Yusoff N H, Tukiman I, Samah M A A 2019 *International Journal of Recent Technology and Engineering* **8** 341-5.
[8] Murdad R, Muhiddin M, Osman W H, Tajidin N E, Haida Z, Awang A, et al. 2022 *Sustainability* **14** 4155.
[9] Nursey-Bray M, Fergie D, Arbon V, Rigney L I, Palmer R, Tibby J, et al. 2014 *Applied studies in climate adaptation* 316-25.
[10] Tajuddin Z, Sum S M, Zainol R M, Jusoh H 2019 *Sarjana* **34** 56-68.
[11] Ramaloo P, Liong C-Y, Siwar C, Isahak A 2018 *Jurnal pengurusan* **53** 83-91.
[12] Razak S, Roff M. Status and potential of urban and peri-urban agriculture in Malaysia. 2007.
[13] Bidlingmaier W, Müsken J 2007 Odor emissions from composting plants. Waste Management Series: Elsevier 215-324.
[14] Binner E, Grassinger D, Humer M 2002 Composting conditions preventing the development of odorous compounds. Microbiology of Composting: Springer 551-60.
[15] Andraskar J, Yadav S, Kapley A 2021 *Applied Biochemistry and Biotechnology* **193** 2331-56.
[16] Salawati S, Syadik F, Tony T, Masriani M, Fatima S, Nurmala N, et al. 2021 *Abditani* **4** 149-53.
[17] Awasthi S K, Sarsaiya S, Awasthi M K, Liu T, Zhao J, Kumar S, et al. 2020 *Bioresource technology* **299** 122555.

[18] Ayilara M S, Olanrewaju O S, Babalola O O, Odeyemi O 2020 *Sustainability* **12** 4456.
[19] Cerda A, Artola A, Font X, Barrena R, Gea T, Sánchez A 2018 *Bioresource technology* **248** 57-67.
[20] Nasini L, De Luca G d, Ricci A, Ortolani F, Caselli A, Massaccesi L, et al. 2016 *International Biodeterioration & Biodegradation* **107** 70-6.
[21] Bordiean A, Krzyżaniak M, Aljewicz M, Stolarski M J 2022 *Foods* **11** 3075.
[22] Mannaa M, Mansour A, Park I, Lee D-W, Seo Y-S 2024 *Environmental Science and Ecotechnology* **17** 100287.
[23] Mertenat A, Diener S, Zurbrügg C 2019 *Waste management* **84** 173-81.
[24] Niu Y, Zheng D, Yao B, Cai Z, Zhao Z, Wu S, et al. 2017 *Waste management* **61** 455-60.
[25] Soetemans L, Gianotten N, Bastiaens L 2020 *Insects* **11** 190.
[26] Aisyah S N, Rizki M I 2023 *International Journal of Community Service Learning* **7** 477-85.
[27] Ameen A, Ahmad J, Raza S 2016 *International Journal of Scientific and Research Publications* **6** 35-7.
[28] Chennaoui M, Salama Y, Aouinty B, Mountadar M, Assobhei O 2018 *J. Mater. Environ. Sci* **9** 680-8.
[29] Af'idah N, Wijayadi A W, Hayati N, Fitriyah L A, Rochim R A 2024 *I-Com: Indonesian Community Journal* **4** 1-10.
[30] Azizah D M F, Suswandi M F, Prameswara K N A, Ananda D S, Suwerda B 2024 *JGEN: Jurnal Pengabdian Kepada Masyarakat* **2** 25-9.
[31] Khotimah A, Kumalasari V, Rahmawati L 2023 *Humanism: Journal of Community Empowerment (HJCE)* **5** 32-41.
[32] Nadia N, Juono A, Nugroho D, Nurjanah M, Christiningtyas A, Masriat M, et al. 2022 *Jompa Abdi: Jurnal Pengabdian Masyarakat* **1** 126-33.
[33] Sanjaya M F, Suyono S, Rusmidin R, Mahendra Y 2024 *Jurnal Abdi Insani* **11** 234-42.
[34] Setiawan H, Lestari I 2022 *Anfatama: Jurnal Pengabdian Masyarakat* **1** 67-74.
[35] Bhatta G D, Aggarwal P K, Shrivastava A K, Sproule L 2016 *Environment, Development and Sustainability* **18** 1657-78.
[36] Pingali P, Aiyar A, Abraham M, Rahman A, Pingali P, Aiyar A, et al. 2019 *Transforming food systems for a rising India* 215-40.
[37] Totin E, Segnon A C, Schut M, Affognon H, Zougmoré R B, Rosenstock T, et al. 2018 *Sustainability* **10** 1990.
[38] Alem Y, Eggert H, Ruhinduka R 2015 *Environmental and Resource Economics* **62** 243-63.
[39] Harvey C A, Chacon M, Donatti C I, Garen E, Hannah L, Andrade A, et al. 2014 *Conservation Letters* **7** 77-90.
[40] Mazhar R, Ghafoor A, Xuehao B, Wei Z 2021 *Journal of cleaner production* **283** 124620.
[41] Raj S, Garlapati S 2020 *Global climate change: Resilient and smart agriculture* 273-99.
[42] Sardar A, Kiani A K, Kuslu Y 2021 *Environment, Development and Sustainability* **23** 10119-40.