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Agricultural waste recycling for environmental sustainability: Way to mitigate climate change by carbon sequestration

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Abstract
The agriculture production system is most vulnerable to climate variability and change. The burning of post-harvest crop residue is also a major concern in North-eastern hill region of India. Though it is almost banned in India, the process is still followed by resource poor farmers due to lack of alternative waste management practices. It has the serious implications like air pollution across rural and urban areas which create negative health impacts associated with smoke inhalation also releases carbon dioxide that could otherwise be sequestered through composting. A survey was done foridentify the major agricultural commodities and their waste product available in Ri-Bhoi District of India in the year 2019-20 and 2020-21. After the survey, the estimation of agricultural waste materials was done for Ri-Bhoi District of Meghalaya, where it is found that around 1, 74,094 metric tonnes waste material was generated from major field crops annually. From those waste there is a possibility of production of 104,247.90 tonnes of vermi-compost annually. From that, 25,019.50metric tonnes of carbon di oxide can be sequestering through vermicompost in entire Ri-Bhoi District of Meghalaya annually. It is the boon for the enhancement of resilience to agriculture to climate change and climate variability through vermi-composting technology in entire Ri-Bhoi District of Meghalaya.

Keywords: Climate resilience, agricultural waste materials, vermi-composting and sustainable agriculture

Introduction

In agricultural production system the plant absorbs nutrients from the soil for normal growth and development. Notwithstanding, to maintain an active and abundant soil life to produce healthy plants, the residues could well be recycled to release and accumulate the organic matter and nutrient to the soil (Bordoloi, 2021; Sanjay-Swami, 2020) [1, 2]. Organic farming is a holistic approach for protecting the environment as it is chemical-free farming and here emphasis is given for efficient use of locally available resources (Bordoloi *et al*., 2020, Arunachalam *et al*., 2003, Sanjay-Swami, 2020) [3, 4, 5]. The organic waste generated from agricultural production system itself can be recycled successfully for balancing the nutrient requirement of the crops and environmental sustainability (Sanjay-Swami, 2019, Bordoloi, 2021, Bordoloi, 2021) [6, 7, 8].

The estimated annual waste production in India ranges to 200 million t of liquid, animal excreta, besides huge quantity of garbage, convertible waste and industrial waste (Bhatnagar *et al*., 2004) [9]. The huge quantity of crop residue and animal excreta is also generated from the agricultural production system of the state Arunachal Pradesh (Bordoloi *et al*., 2007) [10]. The Farmers of the globe has facing lots many challenges for agricultural production system due to the irregularities of weather condition occur due to climate change. The Hilly region farmers are the most vulnerable section of the society for the climate change as they mostly depend on natural resurfaces for their livelihood (Malla, 2014) [11]. According to Greg *et al*. (2011) [12] the variations in the environmental factors like temperature, irregularities of rainfall, drought, floods, cold waves, relative humidity etc. may affect crop growth negatively or positively which shows the impact on economy by altering the crop productivity and food security. The soil which is the base for the agriculture is the world's larger reservoir of carbon, so it has the potential for find out the ways for mitigating the increasing atmospheric concentration of CO_2.Greenhouse gas emissions from the agriculture sector are responsible for approximately 30% of all emissions, come from anthropogenic sources. Due to the use of synthetic fertilizers methane and nitrous oxides emissions are occur which occupies half of the GHG emissions from agriculture, 20 per cent of global carbon dioxide and two thirds of nitrous oxide emissions are comes from the interaction of soil. Carbon sequestration from soil organic matter is directly proportional to a net reduction in greenhouse gases (Drinkwater *et al*., 1998, Pimentel, 2005, Reganold *et al*., 2001) [13, 14, 15].

Soil is the major but manageable resource of the planet's atmospheric carbon sinks. Historically, land-use conversion and soil cultivation have been an important source of greenhouse gases (GHGs) to the atmosphere. According to FAO land-use conversion and soil cultivation are responsible for about one-third of GHG emissions. However, improved agricultural practices can help mitigate climate change by reducing emissions from agriculture and other sources and by storing carbon in plant biomass and soils.

Organic farming is the boon for sequester atmospheric carbon in the soil which otherwise may be the cause for the environmental pollution as well as for the climate change. The abundance and biodiversity of resident earthworm populations can be considered as the tool for success and sustainability of the environment by confirming the storage and transformation of soil organic carbon. The biological waste processing through earthworm activities which produces vermicompost has the potential benefits to reduce climate change, decrease pollution and ensure food security. Earthworms stimulate carbon sequestration in the soil, which may be helpful for reduction of greenhouse gas emissions. Vermicompost resembles a stable organic matter that can promote the sequestration or storage of carbon. The carbon flow in vermi-composting system can be successfully utilized to improve the microbiological physical and chemical properties of the soil and that enhance fertility and productivity (Sanjay-Swami, 2019) [16]. The role of earthworms in the reduction of greenhouse gases through the stimulation of carbon sequestration has been raised recently. Due to the earthworm activity in the soils around 42 percent increase in nitrous oxide and 33 percent emission of carbon dioxide was reported by a team of researchers from Europe, the United States, and Columbia. The research community as well as the farmers are developing extensive range of agricultural practices which could augment farming systems, resiliency to climate change (Bertora *et al*., 2007, Rizhiya *et al*, 2007) [17, 18].

The productivity of crops is very low in North-eastern region of India primarily because of low use of organic and inorganic fertilizer coupled with soil acidity problem (Kumar *et al*. 2012; Sanjay-Swami and Singh, 2020, Bordoloi, 2020) [19, 20, 21]. So, this vermi-composting technology can be effectively use for increased the productivity of crop, manage soil health and income generation of the Farmers of this region. The increased yield of vegetable and field crops of Meghalaya is recorded by the use of vermicompost along with lime and reduced rate of chemical fertilizers (Yadav and Sanjay-Swami, 2019; Bordoloi & Islam, 2020, Bordoloi, 2021) [22, 23, 24]. Many farmers from different parts of India are adopting this vermi-cultural biotechnology for sustainable soil health management and for income generation.

Keeping in view a survey was done about the major agricultural commodities and their waste product available in Ri-Bhoi District of India. After the survey, the estimation of agricultural waste materials was done for Ri-Bhoi District of Meghalaya. The demonstration on vermicompost production was conducted under National Innovations in Climate Resilient Agriculture (NICRA) project at Kyrdem village by the KVK Ri-Bhoi for considering the climatic vulnerabilities and to identify, develop and promote the technology those reduces greenhouse gas emissions and sequester carbon.

Materials and Methods

A survey was done in the year 2019-20 and 2020-21for identify the major agricultural commodities and their waste product available annually in Ri-Bhoi District of Meghalaya,which could be recycled easily to the crop field by the way of vermi-compost preparation for C sequestration and to reduce the greenhouse gas emission for maintaining climate resilience agriculture.

The estimation of Agricultural waste materials was done for Ri-Bhoi District of Meghalaya. The amount of crop waste of major agricultural crops was worked out on the basis of economic yield (grain, cane or tuber) with the corresponding ratio of economic yield and residue yield, using the FAO document as cited by Bharadwaj (1995) [25]. The yield of crops has been taken from crop wise production data recorded by the Anonymous (2019) [26], Handbook of Area, Production and Yield of Principal crops in Meghalaya, (2019), Directorate of Economics and Statistics, Govt. of Meghalaya.

From the results obtained from the demonstration done on "Vermi-composting for climate resilience agriculture" for the year 2019-20 and 2020-21, the calculation was done for the possibility of total amount of Vermicompost production annually in entire Ri-Bhoi District. The amount of Carbon sequestration percentage was also calculated based on available review of Literature (Shah *et al*., 2018) [27].

Results and Discussion

Estimated amount of crop waste of some major agricultural crops in Ri-Bhoi District

The agricultural crop waste available in Ri-Bhoi District which could be recycled easily for increased the productivity of crops are straw, leaves, husk etc. The major crops grown in Meghalaya are rice, maize, millet, wheat, pulse crops and vegetables (Table 1). The yield of the major crop grown in Ri-Bhoi District is taken from the Handbook of Area, Production and Yield of Principal crops in Meghalaya (2019), Directorate of Economics and Statistics, Govt. of Meghalaya.The amount of crop waste of major agricultural crops was worked out on the basis of economic yield (grain, cane or tuber) with the corresponding ratio of economic yield and residue yield, using the FAO document as cited by Bharadwaj (1995) [28].

From the Table1, it is seen that around 1, 74,094 Metric tonnes of waste material was generated from major field crops annuallyin Ri-Bhoi District.

Table 1: Estimated amount of crop waste of some major agricultural crops in Ri-Bhoi District of Meghalaya.

Crop	Average grain: straw ratio	Area (ha)	Yield per ha (kg/ha)	Total Yield (Metric tonne)	Straw production (Metric tonne)
Rice	1:1.02	9670	3354	32432	33080.64
Maize	1:1.5	1594	3221	5135	5905.25
Millet	1:1.5	28	1214	34	39.1
Pulse	1:0.75	78	1179	92	69
Total Vegetable	1: 1.5	1577	9980	15739	23608.5
Soybean	1:1.6	260	1250	325	520
Potato	1:1.6	38	6263	238	380.8
Pineapple	1: 1.1.5	4061	13051	53000	79500
Banana	1: 1.16	949	18561	17614	20432.24
Turmeric	1: 0.85	180	8017	1443	1226.55
Ginger	1: 0.85	1030	10655	10975	9328.75
Total					1,74, 090

Vermicomposting for Soil fertility management and C sequestration

Vermi-composting is a composting process using agro waste and earthworms to make nutrient-rich organic compost which is beneficial for soil carbon storage. The role of vermicompost in carbon sequestration is very prominent as a single tonne of vermicompost can sequester up to 0.24 metric tons dioxide of carbon which otherwise depleted from the soil due to negligence of soil health management or may be overuse of chemical fertilizers (Shah *et al*., 2018) [29].

Table 2: Vermicompost production in Ri-Bhoi District

Units	Waste material used (q)	Prodn/harvest (q)	Waste: Vermicompost Ratio	No. of Harvest/yr	Total harvest (q)	Earthworm prod^n (No.)
3	19.4	11.6	1.67:1	3	34.8	5020

Table 3: Material available for Vermicompost production and Calculation of Carbon Sequestration through Vermicompost in Ri-Bhoi District

Total Waste Available (M tonne)	Waste: Vermicompost Ratio	Possibility of Total Vermicompost (M Tonne)	Possibility of Total C-sequestration (M Tonne)
1, 74,094	1.67:1	104,247.90	25,019.50

From the Table 1 it is seen that huge amount of agricultural organic waste are available in Ri-Bhoi District which can be recycled easily for increased the productivity and maintain sustainable agriculture. The results of the present study presented in Table 2 and Table 3 showed that in Ri-Bhoi District around 1, 74,094 Metric tonne of waste material is generated from major field crops annually (estimated by Rice: Straw ratio, based on 2019 crop production data). From those waste there is a possibility of production of 104,247.90 tonnes of vermi-compost annually. So, 25,019.50 Metric tonnes of carbon di oxide can be sequester through vermicompost in entire Ri-Bhoi District of Meghalaya annually.

Conclusion

Most of the farmers of Ri-Bhoi districts depend upon cultivation of agricultural crops as a matter of occupation. The main staple food of this area is rice and so most of the farmers follow the wet rice cultivation and *jhum* cultivation of rice. Apart from this they are cultivating maize, millet, wheat, tuber crops, vegetables crops, oil seeds crops and pulse crops. Overall, it was observed that a huge amount of nutrients in the form of NPK were available in the waste products of plants and animals. This could be utilized as a prime source of nutrients to the crop cultivation and to improve the soil quality to maintain sustainable agriculture. Further, this could also help understanding and strengthening the integrated nutrient management in the traditionally practiced agro-ecosystems and enhance the potentials for organic farming. The Vermicompost production from easily available agricultural waste material has the direct contribution to the reduction of the greenhouse gas emissions by reducing CO_2 by waste processing.

References

1. Bordoloi P. Organic farming for sustainable soil health management: prospects and potential in North Eastern Region of India. Indian Journal of Agriculture and Allied Sciences. 2021;7(2):34-38.
2. Sanjay-Swami. Soil health management under organic production system. International Journal of Chemical Studies. 2020;8(2):330-339. Doi: https://doi.org/10.22271/chemi.2020.v8.i2e.8789
3. Bordoloi P. Productivity enhancement of Maize (*Zea mays*) through liming under rain-fed condition of North East India. International Journal of current microbiology and applied sciences. 2020;(Special issue 11):2875-2881.
4. Arunachalam A, Pandey HN. Microbial C, N and P along a weeding regime in a valley cultivation system of northeast India. Tropical Ecology. 2003;44(2):147-154.
5. Sanjay-Swami. Soil health management under organic production system. Soil and Water Conservation Today. 2020;15(3):4.
6. Sanjay-Swami. Women in Hill Agriculture: Protecting soil health through organic recycling. In: *Women in Agriculture* (The Invisible Partners in Development), eds. Rathore, S. and Sharma, P., Jaya Publishing House, New Delhi; c2019. p. 153-168. ISBN: 978-93-87 590-98-4.
7. Bordoloi P. Organic waste management: Boon for doubling Farmers' income in Meghalaya. Journal of Plant Health Issues. 2021;2(2):036-039.
8. Bordoloi P. Vermicompost and integrated nutrient management approach for yield enhancement of capsicum (*Capsicum annuum* L.) under hill agro ecosystem of Meghalaya, North East India. Journal of Krishi Vigyan. 2021;10(1):309-313.
9. Bhatnagar RK, Palta RK. Earthworm, vermiculture and vermicomposting, Indian Agricultural Research Institute, New Delhi; c2004.
10. Bordoloi P, Balasubramanian D, Arunachalam A, Arunachalam K, Garkoti S. Agricultural waste management for sustainable crop Production: A case study in Arunachal Pradesh. Biodiversity Conservation-The Post-Rio Scenario in India. Assam University, Silchar; c2007.
11. Malla G. Innovative measures for mitigating negative effects of climate change on hill agriculture in Nepal. Journal of Hill Agriculture. 2014;5(2):87-91.
12. Greg EE, Anam BE, William MF, Duru EJC. Climate change, food security and agricultural productivity in African - issues and policy directions. International Journal of Humanities and Social Science. 2011;1(21):205-223.
13. Drinkwater L, Wagoner P, Sarrantonio M. Legume-based cropping systems have reduced carbon and nitrogen losses. Nature. 1998;396(6708):262-265.
14. Pimentel D, Hepperly P, Hanson J, Douds D, Seidel R. Environmental, energetic, and economic comparisons of organic and conventional farming systems. Bio Science. 2005;55:573-582.
15. Reganold JP, Glover JD, Andrews PK, Hinman HR. Sustainability of three apple production systems. Nature. 2001;410(6831):926-930.
16. Sanjay-Swami. Vermicomposting: Transforming garbage into gold. CPGS-AS Extension Bulletin No. 2018-19/05, School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University, Umiam-793 103, Meghalaya; c2019.
17. Bertora C, van Vliet PCJ, Hummelink E, Willem van Groenigen J. Do earthworms increase N_2O emissions in ploughed grassland? Soil Biology & Biochemistry. 2007;39(2):632-640.
18. Rizhiya E, Bertora C, van Vliet PCJ, Kuikman P, Faber J, Willem van Groenigen J. Earthworm activity as a determinant for N_2O emission from crop residue. Soil

Biology & Biochemistry. 2007;39(8):2058-2069.
19. Kumar M, Hazarika S, Choudhury BU, Ramesh T, Verma BC, Bordoloi LJ. Liming and integrated nutrient management for enhancing maize productivity on acidic soils of Northeast India. Indian J Hill Farming. 2012;25(1):35-37.
20. Sanjay-Swami, Singh S. Effect of nitrogen application through urea and *Azolla* on yield, nutrient uptake of rice and soil acidity indices in acidic soil of Meghalaya. Journal of Environmental Biology. 2020;41(1):139-146. DOI: http://doi.org/10.22438/jeb/41/1/MRN-1133
21. Bordoloi P. Productivity enhancement of Maize (*Zea mays*) through liming under rain-fed condition of North East India. International Journal of current microbiology and applied sciences, 2020;(Special issue 11):2875-2881.
22. Yadav OS, Sanjay-Swami. Performance of tomato (*Solanum lycopersicum* L.) in acid soil under integrated nutrient management with biochar as a component. International Journal of Current Microbiology and Applied Sciences. 2019;8(05):793-803.
23. Bordoloi P, Islam M. Effect of integrated nutrient management on productivity of rice (*Oryza sativa* L.) and soil fertility status under rain-fed condition of Meghalaya. Journal of Krishi Vigyan. 2020;9(1):176-179.
24. Bordoloi P. Lime application for higher productivity of potato (*Solanum tuberosum* L.) and managing soil acidity in Ri-Bhoi District of Meghalaya. Indian Res. J. Ext. Edu. 2021;21(2-3):202.
25. Bharadwaj KKR. Recycling of crop residues, oil cakes and other plant production in agriculture. Recycling of crop, animal, human and industrial waste in agriculture. H. L. S. Tandon (Ed.) Fertilizer Development and Consultation Organization, New Delhi; c1995. p. 9-27.
26. Anonymous. Handbook of Area, Production and Yield of Principal crops in Meghalaya, Directorate of Economics and Statistics, Govt. of Meghalaya; c2019.
27. Shah, Lawrence Eugene, Lake Brennan, Ilten Éadaoin. Vermicomposting to sequester carbon, enrich soil and improve livelihoods. Jaya Organic Yojana: Land Use: Agriculture, Forestry, Waste Management; c2018.
28. Bharadwaj KKR. Recycling of crop residues, oil cakes and other plant production in agriculture. Recycling of crop, animal, human and industrial waste in agriculture. H. L. S. Tandon (Ed.) Fertilizer Development and Consultation Organization, New Delhi; c1995. p. 9-27.
29. Shah, Lawrence Eugene, Lake Brennan, Ilten Éadaoin. Vermicomposting to sequester carbon, enrich soil and improve livelihoods. Jaya Organic Yojana: Land Use: Agriculture, Forestry, Waste Management; c2018.