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Influence of organic sources of nutrient for profitable and soil-supportive cowpea (*Vigna unguiculata* L.) farming under hilly agricultural system of North Easten India

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Abstract
A technology was demonstrated in different location of District Ri-Bhoi of Meghalaya to showcasing the technology of organic nutrient management in cowpea (*Vigna unguiculata* L.) by comparing with the local farmer's practice during the year 2021-22. The technology demonstrated i.e., FYM @ 5 t/ha + Neem cake @ 400 kg/ha+ vermicompost @ 5 t/ha + Rhizobium 10 kg/ha + PSB10 kg/ha recorded significantly higher yield *i.e.,* 12.8 q/ ha and benefit cost ratio of 2.02 followed by farmers practice i.e., 8.6 q/ha of yield with benefit cost ratio of 1.45 from the farmers field which was done through imbalance fertilizer application. Regarding the soil parameters also seen a significant increase of soil nutrients in the harvesting stage of crop compare to the soil collected from the plot before the treatment as well as with the plot from Farmers practice. Furthermore, extension gap of 4.2 q/ha, technology gap of 2.2 q/ha and the technology index of 14.66 achieved from the result of the Treatments shows the feasibility and suitability of the demonstrated technology in the Field level among the Farmers under Hilly Agricultural System of North Easten India.

Keywords: FLD, vermicompost, cowpea, organic farming, hilly agricultural system of North Easten India

Introduction
The agriculture practices of North East India are mostly organic in nature and it forms the basis for socio-economic development of the region. The cultivation of crop is practicing generally by using imbalance fertilizer application through organic inputs mostly in rain-fed condition with indigenous knowledge system from ages which is achieved by wisdom (Bordoloi, 2021a, Bordoloi, 2021b and Sanjay-Swami, 2020) [4, 5, 19, 20]. The development achieved through green revolution in other parts of India is not influenced in this region, as a result modernization of agriculture is lacking behind as compare to the irrigated areas of the country. So, the use of chemical fertilizers, adoption of machinery and other modern agricultural technology is very less in this region. As a result of imbalance fertilizer application along with the problem of soil acidity has resulted very low yield of crop and deterioration of soil health also observe in this region (Bordoloi, 2020, Bordoloi, 2021c and Bordoloi and Islam, 2020 and Sanjay-Swami and Singh, 2020) [6, 7, 8, 12, 20].
Various studied had been done on Organic Farming which results high yields and good soil health. The application of Lime along with organic fertilizers shows various successful results for crop cultivation with good soil health (Bordoloi, 2021d) [9]. Good soil physical and chemical health and high productivity of crops also achieved from application of organic fertilizer in complete dose in North East India (Rajkhowa *et al*., 2019, Kumar *et al*. 2020 and Bordoloi, 2021f) [17, 16, 11] but the challenges which hampers the progress of organic farming should be resolved (Bhuyan, 2021, Bordoloi *et al*. 2020 and Babu *et al*., 2015) [3, 6, 7, 12, 2].
Among other vegetable crop Cowpea is a famous crop cultivated in Ri-Bhoi district of Meghalaya. Nonetheless the yield achieved from the vegetable crop is less due to the imbalance fertilizer application. Considering the above in view this technology is demonstrated in the Farmers Field of Ri-Bhoi district to showcase the technology which comprises of organic fertilizer in cowpea for improved crop yield and positive effect on soil nutrient status for sustainable development of Hill Agriculture in North Eastern Region of India.

Materials and Methods

The technology demonstration as FLD was done during the year 2021-22 in selected villages of District Ri-Bhoi of Meghalaya namely Umeit, Nongpoh, Thadnongiew, Mawbri and Nonglakhiet with the altitudes in between 835 to 915 amsl. The district is falls in North Latitudes 25.15/ and 26.15/ and East Longitudes 91.45/ and 92.15/ and the total geographical area of the district is 2378 sq. km (Anonymous, 2011) [1]. Moreover, the study area is a humid subtropical area with average annual rainfall is recorded in the range of 1000 mm to 2500 mm. The soil was sandy loam and acidic. For the Technology, the Treatments included were T_1: FYM @ 5 t/ha + Neem cake @ 400 kg/ha+ Vermicompost @ 5 t/ha + Rhizobium 10 kg/ha + PSB @ 10 kg/ha and T_2: Farmers Practice (10 q/ha FYM) i.e., imbalance fertilizer dose. The selected Farmers were given training about the soil health along with complete package and practice of Cowpea crop before the implementation of the programme in their areas.

For the result, the periodical data of growth parameters and yields were recorded. From all the plot of demonstration periodical soil sample analysis was done. For the analysis and for conclusion of the study the benefit cost ratio was done. The technology gap, extension gap and technology index were calculated by the formula given by Samui *et al.,* (2000) as follows

Technology Gap = Potential yield – Demonstration Yield (q/ha)

Extension Gap = Demonstration Yield – Farmers Yield (q/ha)

Technology Index = Potential Yield – Demonstration Yield/ Potential Yield x 100

Results and Discussion

Economics Analysis

From the Table 1 it is seen that the T_1: FYM @ 5 t/ha + Neem cake @ 400 kg/ha+ vermicompost @ 5 t/ha + Rhizobium 10 kg/ha + PSB10 kg/ha had resulted higher yield of 12.8 q/ ha followed by T_2: Farmers Practice (10 q/ha FYM) i.e., 8.6 q/ha at 5% level of significance. A total of 148.84% yield improvement was recorded in T_1. Some similar studies were also recorded higher crop yield by using organic treatments in Farmers field. The satisfactory B:C ratio is achieved in T_1 (2.02) as compare to T_2 (1.45). This type of similar results was achieved by Kumar *et al*., (2015) [15]. The yield and suitable benefit cost ratio reveals that the Technology is economically viable in the Farmers Field of North Eastern hilly Region of India.

Gap Analysis

The gap analysis was done for study the feasibility of the Technology in the farmer's field. From the Table1, it is observed that the Technology gap is 2.2 q/ha which shows the farmer's cooperation for doing the demonstration in the Farmers Field with satisfactory result. From the Table 1 it is also seen that the Extension Gap is 4.2 q/ha which tells the requirement of trained the farmers to reduce the gap for increase the productivity in a higher level. Moreover, the technology index achieved is 14.66 which shows the feasibility and suitability of the technology at the farmers' field and suitability of the Technology. Similar results also recorded in the region by earlier studies (Bordoloi, 2021 and Kumar *et al.,* 2015) [14, 15]. From the results of the gap analysis, it is concluded that the Technology is suitable for the hill agro-ecosystem of North Eastern India.

Soil Analysis

From the Table 2 it is seen that in the T_1: FYM @ 5 t/ha + Neem cake @ 400 kg/ha+ vermicompost @ 5 t/ha + Rhizobium 10 kg/ha + PSB10 kg/ha, a total of 124.87% increase in available Nitrogen is achieved as compared to T_2: Farmers Practice (10 q/ha FYM). For Phosphorus and Potassium also 171.07% and 134.29% increase was recorded which was significantly higher as compared to T_2. Some similar results were also recorded by Bordoloi, 2022 [41].

Table 1: Effect of Organic Nutrients on Productivity and Economics of Cowpea crop

Area (ha.)	Av. Yield (q/ha.)		% increase	Econ. of demo. (Rs./ha.)				Econ. of check (Rs./ha.)				Technology gap (q/ha)	Extension gap (q/ha)	Technology Index
	Demo	Check		GC	GR	NR	BCR	GC	GR	NR	BCR			
1	12.8	8.6	148.84%	38,000	76,800	38,800	2.02	35,343	51,600	16,257	1.45	2.2	4.2	14.66

Table 2: Effect of Organic Nutrients on Soil Nutrient Status of Cowpea Cultivation

pH		Organic Carbon (kg/ha)		Available Nitrogen (kg/ha)		Available Phosphorus (kg/ha)		Available potassium (kg/ha)	
Demo.	Check	Demo.	Check	Demo.	Check	Demo.	Check	Demo.	Check
4.56	5.21	1.29	1.02	389.35	311.80	18.92	11.06	192.20	143.12
Percent Increase (%)		126.47		124.87		171.07		134.29	

Conclusion

Organic cultivation of vegetable crop in the North Eastern hilly region of India is a successful way for the Farmers of this region for economic upliftment and for entrepreneurship development. As vegetable cultivation is getting priority among other crop cultivated in this region, so doing of organic vegetable production would be helpful for maintain the economic viability and environmental sustainability of hill agro-ecosystem of North East India. This type of technology of Organics if adopt properly can improve the productivity of vegetable crops and also helpful for mainlining the sustainability of soil. Moreover, this type of successful demonstration plays important role for motivating the farmers to adoption of new technology for profit maximization. Further researches are required urgently in organic farming to overcome the various challenges of Organic Farming for more profitable and soil-supportive vegetable Farming under Hilly Agricultural System of Meghalaya, North East India.

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