

Zero budget natural farming practices on yield of crops (Maize + soybean and Pea + coriander) in mid hill of Sikkim Himalayas

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Summary

Natural Farming (NF) is an alternative low-input, climate-resilient farming practice that have emerged to reduce input costs and higher yields for farmers from locally available inputs by eliminating the use of chemical fertilizers and improving soil fertility. In this article, it was physico-chemically characterized the different formulations (jeevamrit, ghanjeevamrit and beejamrit) for different parameters and found that it varies at different interval days. This present article mainly focused on the different cropping system of the natural farming and also evaluating the economics of the returns with the conventional farming system. Therefore, the cropping system practiced are Maize and soybean during kharif season followed by vegetable pea and coriander during the rabi season. Result for the different natural farming practices in soybean + maize intercropping revealed that the maximum sole yield was recorded under AI-NPOF packages with 26.1 q/ha followed by complete natural farming with 21.4 q/ha whereas other treatments remained non-significant. In intercropping, the yield was found to be maximum under complete natural farming with (35.9 q/ha). The system BC ratio was highest under AI-NPOF Packages (1.82) followed by complete natural farming (1.20). In the pea-coriander system, the higher sole yield was recorded under AI-NPOF package with (70 q/ha) followed by complete NF (61.4 q/ha). The intercropping yield and vegetable pea equivalent were highest under complete NF. The result indicated that in natural farming, the vegetable-based cropping system was profitable in comparison to the maize based in terms of the net returns.

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Introduction

The agriculture in India where the green revolution was popularized has severely affected the soil health to a great extent¹. The liberal usage of fertilizers and inorganic substances has significantly raised the production and yield while creating the bad soil health. With this application, there has been a rise in the intake of the N, P and K from 0.07 million tons to more than 25.95 million tons. Due to the heavy dosage application of fertilizers, there has been an imbalance in soil health where the soil flora has greatly been affected (Khadse et al. 2019). Moreover, the effect of the green revolution has always left its harmful footprints in the agricultural era. The monocropping system practiced in India has also encouraged the application of fertilizers and pesticides in a higher quantity causing considerable damages in the soil flora and fauna^{2, 13}. A chemical free and climate resilient method of farming given by scientist Subash Palenkar in order to end the problems arising after green revolution by introducing natural farming was done in the year 2006. To get the better of the problems related to soil health and production, the introduction of

the organic and natural farming was introduced initially by the farmers in some pockets of the country. The natural farming is also known as Bharatiya Prakritik Krishi Paddhati Programme (BPKP) which mainly focuses at promoting traditional indigenous practices which lessens the external expenses. It is therefore based on farm biomass recycling by using the biomass mulching, use of the liquid concoction prepared from cow dung-urine and botanicals formulations. It then will reduce the dependency on external purchased inputs and will ultimately help to wave off the credit burden of small margin farmers. These farming were innovative and eco friendly that was easily accepted by many³. Most of the researchers along with scientist accepted and claimed that the natural farming can be a good alternative to chemical farming that will directly help in the sustainable development⁴.

The primarily goal of natural farming is to maximize the yield of the farm by optimizing the production factors such as labor, soil and other equipments and avoiding the use of the non-natural inputs such as fertilizers in order to maximize the production potential. Moreover, the natural farming aims to improve and preserve the soil quality whereas the conventional farming ruin in every case. Among the important steps in natural farming are the crop diversity conservation, no tillage and water shed management. Further in 2015-16, the Government of

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Andhra Pradesh implemented a Zero budget farming program to enhance the farmer's welfare and conserve the environment. Zero Budget Natural Farming is the form of farming that witnesses the natural growth of the crops without adding the fertilizers and pesticides or any other synthetic products. The main aim of the natural farming is to minimize the cost of production to almost zero and to bounce back to the pre-green revolution farming system^{5, 14, 15}. Further it can be regarded as the farming system wherein the financial outlay to purchase any essential inputs such as seeds, fertilizer, pesticides and insecticide are totally waved off. In spite of the natural farming's infant stages, many farmers have accepted the concept in a very positive manner, adding on the labor and production costs have significantly decreased by 14-15%⁶.

As matter of fact, Sikkim being an organic state, the usage of the chemical fertilizers and any other synthetic products are strictly banned. The practices of the natural farming can prove to be more beneficial as the application of the liquid formulation as the insecticides and pesticides will help more to outshine the practices of

organic farming in the state. Therefore, a trial experiment was laid out at the research farm, ICAR Sikkim centre to evaluate the natural farming practices in different agro ecology. Under natural farming, the intercropping with the legumes crops is considered to be essential components as it helps in increasing the crop productivity and soil fertility through atmospheric fixation. The main cropping system includes the maize based cropping system during the Kharif and vegetable based during the Rabi season.

Materials and Methods

The natural farming experiment was started during the year 2020-2021 at the ICAR Research farm, Sikkim centre, Tadong Gangtok. The experiment was designed to evaluate the yield of the different crop grown under two different seasons. There were two different crops i.e. soybean and maize under Kharif seasons followed by vegetable pea and coriander under Rabi seasons. The experiment was laid out in completely Randomized Design. The below table depicts the different treatments as per the seasons (Table 1).

Table 1. The treatment details of the natural farming experiment under study

S. no.	Treatment	Kharif crops (Soybean + maize)	Rabi crops (Vegetable pea + Coriander)
T ₁	Control	Sole crop (Soybean) (No addition of any inputs except labour for operations including weeding)	Sole crop (Vegetable pea) (No addition of any inputs except labour for operations including weeding)
T ₂	Complete NF	Soybean + Maize (intercrop) Beejamrit + Ghanjeevamrit @ 250 kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month + Wheat straw as mulch @ 5t/ha + Whapasa (irrigation in alternate furrows at noon)	Vegetable pea + Coriander (Intercrop) Beejamrit + Ghanjeevamrit @ 250 kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month + soybean straw as mulch @ 5 t/ha + Whapasa (irrigation in alternate furrows at noon)
T ₃	NF-1 (Without-Beejamrit + Ghanjeevamrit + Jeevamrit)	Soybean + Maize (intercrop) Mulching (wheat straw as mulch @ 5 t/ha) Whapasa (irrigation in alternate furrows at noon)	Vegetable pea + Coriander (Intercrop) Mulching (Soybean straw as mulch @ 5 t/ha) Whapasa (irrigation in alternate furrows at noon)
T ₄	NF-2 (Without-crop residue mulching)	Soybean + Maize (intercrop) Beejamrit + Ghanjeevamrit @ 250 kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month + Whapasa (irrigation in alternate furrows at noon)	Vegetable pea + Coriander (Intercrop) Beejamrit + Ghanjeevamrit @ 250 kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month + Whapasa (irrigation in alternate furrows at noon)
T ₅	NF-3 (Without intercropping)	Sole crop (Soybean) Beejamrit + Ghanjeevamrit @ 250 kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month + Wheat straw as mulch@5t/ha + Whapasa (irrigation in alternate furrows at noon)	Sole crop (Vegetable pea) Beejamrit + Ghanjeevamrit @ 250 kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month + soybean straw as mulch @ 5 t/ha + Whapasa (irrigation in alternate furrows at noon)
T ₆	NF-4 (Without-Whapasa, irrigating in alternate rows and	Soybean + Maize (intercrop) Beejamrit + Ghanjeevamrit @ 250kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month + Wheat straw as mulch @ 5 t/ha	Vegetable pea + Coriander (Intercrop) Beejamrit + Ghanjeevamrit @250 kg/ha + Jeevamrit @ 500 lit/ha/irrigation twice in a month +

	during noon)		soybean straw as mulch @ 5t/ha
T ₇	AI-NPOF package	Sole crop (Soybean), details of manures and quantity to be applied should be given (Example) FYM-quantity used /ha VC-quantity used /ha Neem cake-quantity used /ha	Sole crop (Vegetable pea), details of manures and quantity to be applied should be given (Example) FYM-quantity used /ha VC- quantity used /ha Neem cake- quantity used /ha

Jeevamrita /Jeevamruta

Water	250 lit.
Cow dung	10 kg
Cow urine	10 lit.
Jaggery	1-2 kg
Pigeon pea flour	2 kg
A handful of undisturbed soil	150 g

Preparation of Jeevamrit

The Jeevamrit preparation was done at ICAR, Research farm Sikkim centre Tadong Gangtok. It was prepared in a plastic drum of 250 liters capacity where all the components mentioned were added and stirred thoroughly. Firstly, the adding of 10 kg of fresh cow (indigenous) dung with 10 liters of indigenous cow urine was done followed by addition of 2 kg of Jaggery, 2 kg pulse flour (besan, Chickpea flour) along with 150 g of soil from undisturbed bunds/ forest in 200 litres of water was mixed thoroughly. The prepared liquid was then kept under shade covering with gunny bag/ cotton cloth/ plastic mosquito net. Further the Stirring of the mixture for 5-10 minutes for twice a day i.e morning and evening with wooden stick was carried on. Jeevamrit is ready for application at 9th day and it can be applied up to 12th day from its preparation. The recommended dose is 200 liters of Jeevamrit is sufficient for one acre of land.

Application of Jeevamritha

It was generally applied to the crops twice a month in the irrigation water or as a 10% foliar spray. The preparation was stored up to a maximum of 15 days and used in the field either through spray or mixing with irrigation water.

Preparation of Beejamritham

The ingredient required to prepare beejamritham are local cow dung, cow urine, lime and soil. The cow dung was properly mixed with soil and lime which was further dipped in the cow urine for 12 hours. The cow dung was then removed from the cow urine which was squeezed and the urine was added with 50g of lime. It is basically used for the seed treatment by mixing with hand or coat the seeds well before sowing. In case of leguminous seeds, dipping them and drying is recommended.

Acchadana-Mulching

In the present experiment, the mulch material used were the crop residue of the previous sowing. Such as, the soybean and maize mulch was used for the vegetable pea and coriander cropping and the pea residue for maize and soybean cropping. It was used to protect the topsoil and promotes aeration and water retention in the soil.

Result and Discussion

The data for the soil properties after the harvest is presented in the table 2 below. After the analysis of the soil sample, the result revealed that the highest pH level was observed in case of the T₇ (AI-NPOF packages) with 5.49 followed by T₂ (complete natural farming) with 5.31

and 5.27 in case of T₅ (NF-3). Whereas the lowest pH was recorded in T₁ (control). However, it was found that all the treatment was found to be significant. Likewise, it was also recorded that the SOC% were maximum in case of T₇ (AI-NPOF packages) with 1.01% followed by T₂ (complete natural farming) with 0.97% and T₅ (Natural farming-3(NF-3)). The lowest SOC % was found in T₁ (Control). Further it was found that all the treatments were non-significant in comparison to T₇. The present findings have been confirmed by many previous studies⁷⁻⁹. It was revealed that the application of the organic manures to the soil will definitely influence the soil properties especially SOC% and the microbial count. It was stated that the no tillage will not increase the SOC% of the soil which in the present study was reported in case of complete natural farming¹⁰. The MCB were found to be maximum in case of T₇ with the highest count of 502.5 mg/kg similarly the count in T₂ was 425.38 mg/kg followed by 402.56 mg/kg in case of T₅.

Likewise, the lowest MCB count was observed in T₁. The treatments were found to be non-significant in comparison with T₇. The finding comes with an agreement with the present study as it states that the application of 100% organic manure helps in the increases of the microbial population as reported in present study¹¹. Different organic manure with different concentration affects the microbial count in a soil. The application of the FYM will help to increase the microbial population significantly¹². The available Nitrogen content was found to be highest in (T₇) AI-NPOF with 389.46 kg/ha followed by 327.81 kg/ha in case of complete natural farming(T₂) followed by natural farming-3(T₅) with 319.71kg/ha.

Similarly, the available Phosphorous content in the soil was found to be maximum in T₇ (AI-NPOF) with 16.69 kg/ha followed by T₂ completed natural farming with 12.98 kg/ha and 12.62kg/ha in T₅ (Natural farming-3). T₇ (AI- NPOF packages) had the maximum available potassium which was 437.83 kg/ha followed by 419.49 kg/ha in case of T₂ (complete natural farming) and 407.38 kg/ha in T₅ (Natural Farming-3). Similarly, the lowest amount of potassium was observed in T₃ (NF-1(without Beejamrit + Ghanjeevamrit + jeevamrit) with 395.03 kg/ha. The dehydrogenase was found to be maximum in T₇ with 56.37 µg TPF produced g⁻¹ hr⁻¹) followed by T₂ with 41.81 and 38.17 µg TPF produced g⁻¹ hr⁻¹) respectively in case of T₅. The lowest dehydrogenase activity was recorded in T₃ with 32.47 µg TPF produced g⁻¹ hr⁻¹). The bulk density was found to be maximum in T₃ (NF-1 without Beejamrit + Ghanjeevamrit + jeevamrit) with 1.36 µg/m³ followed by T₄ (NF-4 without wapasa, irrigation in alternative rows during noon) and T₆ (NF-4 without wapasa, irrigation in alternative rows during noon) with 1.35 µg/m³. Whereas the minimum bulk

density was recorded in case of T₇ (AI-NPOF) packages with 1.29 µg/m³. Pareek and Yadav 2011 reported that enzyme activity was significantly increased by the application of the organic manure to the soil. Likewise,

Table 2. Effect of different natural farming practices on soil properties after harvesting of last crop (Gangtok)

*T₁=Control; T₂=Complete Natural farming (NF); T₃=NF-1

the increase of the dehydrogenase activity was maximum when the incorporation of the vermicompost followed by FYM, the findings are in agreement with the present one.

recorded under complete T₂ (Complete NF) with

Treatment	pH	SOC%	MCB (mg/kg)	Av. N (kg/ha)	Av. P (kg/ha)	Av. K (kg/ha)	Dehydrogenase (µg TPF produced g ⁻¹ hr ⁻¹)	Bulk density (µg/m ³)
T ₁	5.03	0.93	297.9	287.5	10.59	380.58	28.58	1.37
T ₂	5.31	0.97	425.38	327.81	12.98	419.49	41.81	1.31
T ₃	5.07	0.94	370.56	306.67	11.84	395.03	32.47	1.36
T ₄	5.09	0.94	378.72	307.67	11.99	397.59	35.39	1.35
T ₅	5.27	0.96	402.56	319.71	12.62	407.38	38.17	1.34
T ₆	5.18	0.95	385.93	318.53	12.15	402.51	37.82	1.35
T ₇	5.49	1.01	502.5	389.46	16.69	437.83	56.37	1.29
Sem ±	0.58	0.25	1.45	2.58	4.27	1.72	1.58	0.21
LSD (P=0.05)	1.63	0.76	4.72	7.48	12.82	4.89	4.78	0.62

(without Beejamrit + Ghanjeevamrit + Jeevamrit); T₄=NF-2 (without crop residue mulching); T₅= NF-3 (without intercropping); T₆= NF-4(without wapasa, irrigation in alternative rows during noon); T₇=AI-NPOF Package.

From the below table 3, the result for the different natural farming practices in soybean +maize intercropping revealed that the maximum sole yield was recorded under (T₇) AI-NPOF packages with 26.1 q/ha followed by (T₂) complete natural farming with 21.4q/ha whereas other treatments remained non-significant. Similarly, the lowest yield was recorded in T₁ (control) with 16.2 q/ha. In case of intercropping, the yield was found to be maximum under complete Natural farming (T₂) with 35.9 q/ha followed by T₆ (NF-4) with 33.2 q/ha. There was no yield in case of T₁ (Control), T₅ (NF-3 (without - intercropping) and T₇ (AI-NPOF packages) respectively. Maximum system equivalent yield was

38.7q/ha which was statistically at par with T₄ and T₆ but other treatments were found to be non-significant. The system gross returns were found to be maximum in T₂ (Complete NF) with 148 Rs/ha) which was statistically at par with T₃ but significantly higher than other treatment expect T₄ and T₆ which were significant. Similarly, the system cost of cultivation was found to be highest in T₂ (Complete NF) with 67.5 Rs/ha. Highest system cost of cultivation was recorded under T₂ (Complete NF) which was statistically at par with T₄ (NF-2 without crop residue mulching) but remained significantly higher than other treatments. In case of system net returns the T₂ (Complete NF) were found to be significantly higher than other treatments. The system BC ratio was found to be highest under T₇ (AI-NPOF Packages) with 1.82 followed by T₂ (Complete natural farming) with 1.20 whereas all other treatments remained non-significant

Table 3. Effect of different natural farming practices on productivity and profitability of crops in soybean + maize intercropping system

Treatment	Sole Yield (q/ha)	Intercrop Yield (q/ha)	Soybean Equivalent Yield (q/ha)	System Equivalent Yield (q/ha)	System Gross Return (Rs/ha) × 1000	System Cost of Cultivation (Rs/ha) × 1000	System Net Return (Rs/ha) × 1000	System B: C ratio
T ₁ : Control	16.2	0.0	0.0	16.2	62.0	29.6	32.355	1.09
T ₂ : Complete NF	21.4	35.9	17.3	38.7	148.3	67.5	80.789	1.20
T ₃ : NF-1 (without Beejamrit + Ghanjeevamrit + Jeevamrit)	18.6	31.3	15.1	33.7	129.1	58.9	70.205	1.19
T ₄ : NF-2 (without - crop residue mulching)	19.2	32.7	15.8	35.0	134.0	62.0	71.943	1.16
T ₅ : NF-3 (without intercropping)	20.4	0.0	0.0	20.4	78.1	36.7	41.366	1.13
T ₆ : NF-4	19.6	33.2	16.0	35.6	136.4	68.1	168.345	1.00

(without Whapasa, irrigating in alternate rows and during noon)	-							
T ₇ : AI-NPOF package	26.1	0.0	0.0	26.1	99.9	35.4	64.492	1.82
SEm±	0.71	-	-	1.10	6.23	1.38	2.26	0.04
LSD (P=0.05)	2.18	-	-	3.16	18.8	4.87	6.11	0.12

According to the table 4 presented below, the result concluded with the maximum sole yield which was recorded under T₇ (AI-NPOF package) with 70q/ha followed by T₂ (Complete NF) with 61.4 q/ha. Whereas the lowest yield was recorded in T₁ (control) with 56.29q/ha. The intercropping yield and vegetable pea equivalent were found to be highest under T₂ (Complete NF). The treatments such as T₇ (AI-NPOF packages), T₅ NF-3(without intercropping) and T₁ (Control) did not yield as the yield was 0.0. With references to the system equivalent yield, maximum was recorded under T₂ (complete NF) which was statistically at par with T₃ (NF-1; without Beejamrit + Ghanjeevamrit + Jeevamrit) and T₄ (NF-2 without crop residue mulching but significantly

higher than other treatments expect T₆ (NF-4 without wapasa, irrigation in alternative rows during noon). In case of system gross return, the maximum return was noticed under T₂ (complete NF) which was significantly higher in comparison to other treatments but remained at par with T₃, T₄ and T₆. System cost of cultivation was recorded to be maximum in T₆ which was statistically higher than other treatments expect T₄ which was found to be significant. The system net return was found to be highest in complete NF. The maximum B: C ratio was noticed under AI-NPOF packages followed by complete NF which was significantly higher than other treatment but remained at par with T₆.

Table 4. Effect of different natural farming practices on productivity and profitability of crops in vegetable pea + coriander intercropping system

Treatment	Sole Yield (q/ha)	Intercrop Yield (q/ha)	Vegetable Pea Equivalent Yield (q/ha)	System Equivalent Yield (q/ha)	System Gross Return (Rs/ha) × 1000	System Cost of Cultivation (Rs/ha) × 1000	System Net Return (Rs/ha) × 1000	System B: C ratio
T1: Control	56.2	0.00	0.0	56.2	168.6	43.4	125.1	2.88
T2: Complete NF	61.4	5.12	17.1	78.5	235.4	51.1	184.2	3.60
T3: NF-1 (without Beejamrit + Ghanjeevamrit + Jeevamrit)	58.6	4.10	13.7	72.3	216.8	46.8	169.9	3.63
T4: NF-2 (without crop residue mulching)	59.2	4.42	14.7	73.9	221.8	48.4	173.3	3.58
T5: NF-3 (without intercropping)	60.4	0.00	0.0	60.4	181.2	47.1	134.0	2.85
T6: NF-4 (without Whapasa, irrigating in alternate rows and during noon)	59.6	4.87	16.2	75.8	227.5	51.4	176.0	3.42
T7: AI-NPOF package	70.0	0.00	0.0	70.0	210.0	45.2	164.8	3.64
SEm±	2.01	-	-	2.10	6.98	1.35	6.87	0.08
LSD (P=0.05)	5.78	-	-	6.34	21.7	3.87	20.1	0.22

Conclusion

The practices and application of the natural farming can be a positive element in the agriculture sector as far as

the conservation and preservation of the agro-ecology is concerned. The application of the cow and botanical extract can be considered to be a new game changer in

the organic farming system as well. The liquid concoction used as the remedy for the major insect pest will be dominance aspects in the farming system where the total discard of the in organic product is done. Further it can be concluded that the application jeevamrit and beejamritham in the field can be a very useful component as they efficiently and naturally works as a seed treatment along with the insect-pest repellent. Moreover, the preparations of these products are easy to prepare with less inputs within a short frame of time. Natural farming is found not popular among the farmers in Sikkim. Although the state is an organic one, the certain certain practices prescribed in natural farming, such as *Jeevamritha*, *Beejamritha* and other plant protection materials. Mulching and different irrigation techniques (*Wapasa*) can be introduced. There is always scope for tweaking and innovation in these practices like *Ghanajeevamritha* in Sikkim. It is also evident that there is significant reduction in the cost of cultivation of all the crops, although crop yield may/may not be higher as compared to conventional farming. Further, the observed of better soil health in terms of light texture, presence of earthworms, moisture retention, etc. in natural farming plot can be experienced. Thus, natural farming may not look as yield enhancing farming practices, but would definitely increase farmers' income through cost reduction and long-term sustainability.

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Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript

References

1. Chandel RS, Gupta M, Sharma S, PL Verma & Chandel A. 2021. Impact of Palekar's natural farming on farmer's economy in Himachal Pradesh. *Indian Journal of Ecology*, 48: 873-878.
2. Elizaer NAR, Ravichandran K & U Antony. 2019. The impact of the green revolution on the indigenous crops of India. *Journal of Ethnic Food*, 6:1-11.
3. Khadse A, Rosset PM, Morales H & Ferguson BG. 2017. Taking agroecology to scale: the zero budget atural farming peasant movement in Karnataka. *Indian Journal of Peasant Studies*, 45:9-12.
4. Khadse A, & Rosset PM. 2019. Zero Budget Natural Farming in India—from Inception to Institutionalization. *Agroecology and Sustainable Food Systems*, 37:1-24.
5. Krishnakumar S, Saravanan A, Natarajan SK, Veerabadran V & Mani S .2005. Microbial population and enzymatic activity as influenced by organic farming. *Research journal of biological sciences*, 1:85-88.
6. Meena VS, Maurya BR, Bohra JS, Verma R, Meena MD. 2013. Effect of concentrate manure and nutrient levels on enzymatic activities and microbial population under submerged rice in alluvium soil of Varanasi. *Crop Research International Journal*, 45(3): 1-9.
7. Ministry of Commerce (2021). Agriculture in India: Information about Indian Agriculture and its Importance. <https://www.ibef.org/industry/agriculture-india>
8. Nagavani AV, Subbain P. 2015. Effect of organics and inorganic on soil microbial population and enzymatic activity in maize-maize cropping system. *Progressive Agriculture*, 15(1): 9-14
9. Palekar S. 2005. The Philosophy of Spiritual Farming Amravati: Zero Budget Natural Farming Research, Development and Extension Movement. Amravati.
10. Pareek N & Yadav BL. 2011. Effect of organic manure on soil physic-chemical properties, soil microbial biomass and yield of mustard under irrigation of different residual sodium carbonate water. *Journal of the Indian soil science*, 59:335-342
11. Poeplau C & Don A. 2015. Carbon sequestration in agricultural soils via cultivation of cover crops-a meta-analysis. *Agriculture Ecosystems and Environment*, 200: 33-41
12. Tripathi S & Tauseef S. 2018. Zero Budget Natural Farming, for the sustainable Development Goals. Andhra Pradesh.
13. Haldhar SM, Jat GC, Deshwal H, Gora JS & Singh D. 2017. Insect pest and disease management in organic farming. Book 'Towards Organic Agriculture' edited by B. Gangwar and N. K. Jat. Today & Tomorrow's Publishers, New Delhi, Page: 359-390, ISBN: 81-7019.
14. Bana RS, Dawar Rakesh, Haldhar SM, Godara S, Singh A, Bamboriya SD, Kumar V, Ishra AK & Choudhary M. 2022. Natural farming: Is it safe to march ahead? *Journal of Agriculture and Ecology*, 14: 01-11.
15. Sarangthem I, Haldhar SM, Mishra LK & Thakuria D. 2023. The book of abstract: international conference on natural farming for revitalizing environment and resilient agriculture (NF-RERA, 2023). Pub: College of Agriculture, CAU, Imphal, pp: 374, ISBN: 978-81-947184-4-4.