JUST AGRICULTURE
multidisciplinary e-Newsletter

Rapid Soil Organic Carbon Augmentation with Natural Farming-Concept and Benefacting Role of KVKs

Neeraj Kumar[1], Sarang Monga[2], Komalpreet Kaur[2] and Rajesh K. Rana[3]*

[1]Young Professional-1, ICAR-ATARI Ludhiana, Punjab
[2]Senior Research Fellow, ICAR-ATARI Ludhiana, Punjab
[3]Principal Scientist, ICAR-ATARI Ludhiana, Punjab

ARTICLE ID: 65

Abstract

The availability of the carbon component in the soil has a major impact on the productivity/ efficiency of agricultural systems. Natural farming enhances carbon sequestration by capturing and storing atmospheric carbon in the soil. This approach employs various practices like cover cropping, reduced tillage, and application of bio-formulations, which increase soil organic matter and improve physio-chemical properties of soil. Natural farming rapidly increases soil carbon storage, lowers greenhouse gas emissions, and improves agricultural and ecological resilience against climate change and global warming by creating a robust soil ecosystem. It also promotes environmental and economic sustainability by reducing dependency on artificial and expensive inputs. Last but not the least, the pivotal role played by the 42 KVKs of Punjab, HP, J&K, Uttarakhand and Ladakh in building capacity of the farmers, spreading awareness and conducting demonstrations on the farmers' field for promotion of natural farming in this zone is appreciable. Overall, natural farming presents a superior strategy for mitigating climate change by rapidly building-up soil organic carbon for higher soil health and agricultural productivity.

Introduction

Soil organic carbon (SOC) plays critical role not only in improving the soil health but also by contributing to various environmental, agricultural, and socio-economic benefits. Soil health greatly dependents on Soil Organic Matter (SOM) which is a major sink (of carbon) and source of soil carbon. SOC is an indicator of soil fertility as it physically enhances soil properties (including the water holding capacity, stores soil nutrients more efficiently, and boosts microorganisms' health and population. SOM is derived from decomposed plant and

JUST AGRICULTURE
multidisciplinary e-Newsletter

animal residues, as well as from the microbial biomass. Its' composition varies from recently available plant biomass (such as stubbles) to well decayed materials over hundreds of years. Despite wide variations in the estimates, 58% of SOM is often assumed to be soil carbon (Pribyl, 2010).

Significance of Soil Organic Carbon

Soil organic carbon being one of the most important factors responsible for soil health and crop productivity has very diverse scope and very high imperativeness to agricultural and general sustainable development (Fig. 1).

- **Soil Fertility and Crop Production:** SOC is a key source and facilitator of essential nutrients like nitrogen, phosphorus, and sulphur. It also improves soil properties by decreasing bulk density and enhancing porosity & water holding capacity, resulting in better root and plant growth.
- **Climate Change Mitigation:** SOC acts as a significant carbon sink. Increasing SOC levels in soils help sequester atmospheric CO_2 and in mitigating climate change. Proper management of SOC with natural farming can reduce emission of greenhouse gases, contributing to our climate sustainability goals.
- **Environmental Sustainability:** High SOC levels support a diverse range of soil organisms essential for nutrient cycling and pest control in addition to the soil health. Organic carbon helps even in the detoxification of pollutants and heavy metals in the soil enhancing soil and environmental health.
- **Positive Economic and Social Impact:** In a country like India, where agriculture is a primary livelihood for millions. Improved soil health through higher SOC can lead to better livelihood of smallholder farmers reducing poverty in rural areas (Rana et al., 2018).
- **Soil and Water Conservation:** Natural farming practices enhance soil's water-holding capacity, reducing water stress on plants and supporting continuous biomass production, which contributes to ongoing carbon sequestration. By maintaining ground cover and improved soil structure, natural farming minimizes soil erosion, which is crucial for retaining carbon-rich topsoil.

JUST AGRICULTURE
multidisciplinary e-Newsletter

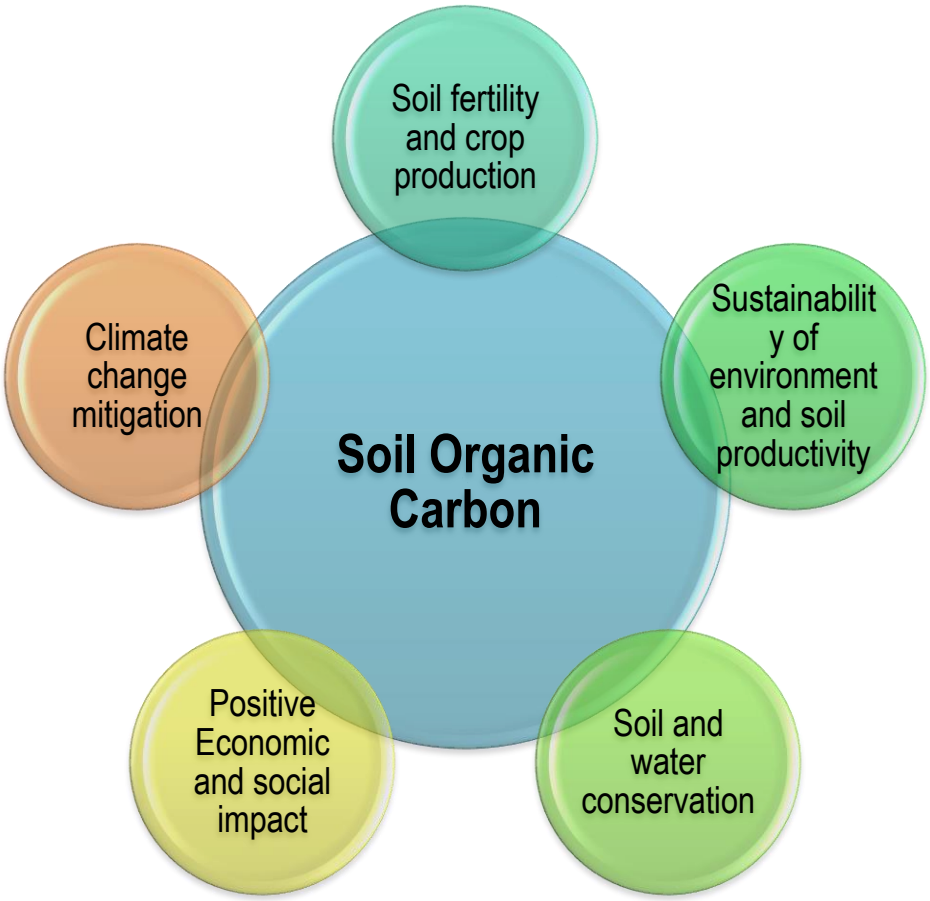

Fig. 1: Advantages of improved Soil Organic Carbon

Challenges and Management Practices

Over the years, intensive farming and improper soil management have led to a decline in SOC levels and resultant soil degradation in many parts of India (Benbi et al., 2009). To address this, eco-friendly agricultural practices especially, natural farming play great role in augmentation of SOC through application of bio-formulations (such as Jeevaamrit, Ghanjeevaamrit and Beejamrit etc.), mulching, reduced tillage, crop rotation, multiple cropping, and cover crops etc. Application of these bioformulations, contributes to carbon sequestration. Bio-mulching provides additional organic material into the soil, which is crucial for increasing soil carbon stocks. Reduced tillage minimizes soil disturbance, preserving existing organic carbon and fostering conditions that enhance carbon accumulation. Crop rotation diversifies soil microbes, improves soil structure and also promotes better carbon retention. Permanent soil cover, through mulching or cover crops, protects the soil from erosion and helps maintain carbon levels too. Together, these practices build a robust carbon cycle

JUST AGRICULTURE
multidisciplinary e-Newsletter

within the soil, collectively enhancing its capacity to sequester carbon and contributing to climate change mitigation (Singh et al., 2022; Sood et al., 2024).

Soil Organic Carbon Sequestration with Natural Farming

Carbon sequestration refers to the process of capturing and storing atmospheric carbon dioxide (CO_2) in various carbon sinks (such as soil, vegetation) of the global carbon cycle. Natural farming practices, which emphasize sustainable and regenerative techniques, play a significant role in carbon sequestration. The sequestration of soil organic carbon is dependent on the availability of nitrogen in order to maintain a healthy carbon-nitrogen ratio. Carbon sequestration through natural farming is an important approach not only for successful chemical free farming but also to mitigate climate change by capturing atmospheric carbon dioxide (CO_2) and storing it in the soil and biomass. Natural farming, which emphasizes minimal soil disturbance, organic inputs and biodiversity, significantly enhances SOC levels. Inclusion of Agro-forestry options in natural farming set-up has resulted in faster carbon sequestration and longer carbon locking/ storage at one hand and enhancement in quality attributes of food crops on the other (Keprate *et al*., 2024). As an important initiative of the Government of India, application of all principles of natural farming have been promoted through uniform capacity building of farmers (Rana *et al*., 2023). Detailed process of carbon sequestration through natural farming has been depicted in Fig. 2 and elaborated below:

- **Minimal Soil Disturbance:** Intensive soil tillage oxidises the soil carbon**.** Natural farming often involves minimal or zero tillage, which reduces soil disturbance (Singh et al., 2022). This helps to maintain the soil structure and reduces the release of stored carbon back into the atmosphere. It not only conserves soil organic carbon but also create conditions for establishment of healthy mycorrhiza. Mycorrhiza has been assigned paramount significance in the functioning of natural farming.
- **Organic Matter Addition:** Natural farming relies on organic inputs such as Jeevaamrit, Ghanjeevaamrit and Beejamrit in addition to application of crop residues in the form of mulch material. These organic materials decompose slowly, increasing the soil organic carbon content with the help of healthy soil microbial population. In fact, ideal population of microbes is promoted by the application of organic matter as discussed above. Planting cover crops especially during summer season, helps protect the soil from excessive soil temperature, check soil erosion, ensure additional organic matter, and resultant enhanced carbon storage in the soil.

JUST AGRICULTURE
multidisciplinary e-Newsletter

- **Plant Biodiversity and Agroforestry:** Integrating trees and shrubs with crops and livestock in farming systems, as promoted in natural farming, increases biomass above and below ground (Keprate et al., 2024). Trees and perennials sequester carbon in their own biomass and contribute to long-term carbon storage. Natural farming encourages growing a variety of crops, which improves soil health and increases resilience of the system to pests and diseases**.** Casting of earthworms and microbes not only add to soil porosity but also enhance soil fertility tremendously (Singh et al., 2022). Diverse plant species contribute to different root structures and organic matter inputs, further enhancing the level of carbon sequestration.
- **Enhanced Soil Biology:** Natural farming practices enhance soil microbial activity by providing a steady supply of organic matter and enabling conditions for the growth of various microbes. Soil microbes play a crucial role in the decomposition of organic material, leading to the formation of stable forms of SOC that can remain in the soil for longer periods. The presence of beneficial fungi in the form of mycorrhizae, which form symbiotic relationships with plant roots, helps in the efficient uptake of nutrients and enhances the sequestration of carbon in the soil.
- **Reduction of Chemical Inputs:** Natural farming nearly eliminates or significantly reduces the use of synthetic fertilizers and pesticides, which are energy-intensive to produce and apply. This not only reduces carbon emissions (carbon footprints) associated with their production but also fosters healthier soils with higher levels of soil organic carbon. The healthy soil systems regenerate nutrients by themselves and we need not externally supply them. Contrary to the general belief, maintenance of high soil organic carbon through natural farming has also enhanced the economics of even the highly inputs intensive high-tech agriculture (Thakur et al., 2024a; 2024b; Rana et al., 2024).
- **Long-Term Sustainability:** Natural farming can be particularly effective in regenerating degraded lands by rebuilding SOC and subsequently restoring the soil health, which enhances the land's capacity to sequester carbon over time. Land management practices that incorporate carbon sequestration and prevent various forms of land degradation are the basis of natural farming. Simultaneously, no use of chemical inputs ensures ecological sustainability and restriction on the use of external inputs helps resource poor farmers against financial distress and resultant indebtedness.

JUST AGRICULTURE
multidisciplinary e-Newsletter

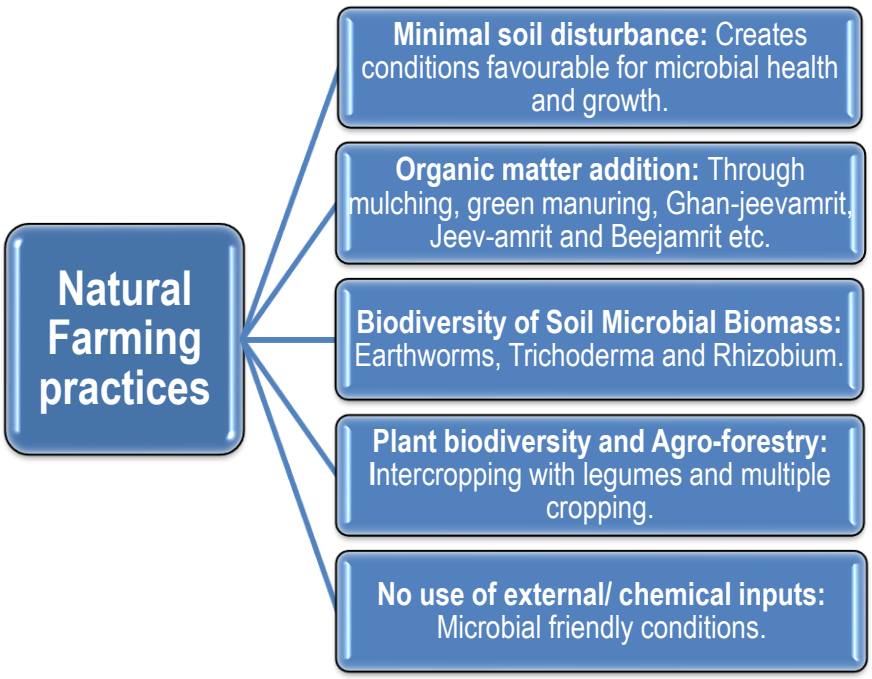

Fig. 2: Factors influencing rapid carbon sequestration through Natural Farming practices

Initiatives of the Government of India

Realising the imperativeness of Natural Farming in restoring human and ecological health the Government of India (GOI) made concerted efforts through various initiatives to popularise and to ensure higher adoption of this regenerative method of doing agriculture in India. It started with the launch of Paramparagat Krishi Vikas Yojna (PKVY) in 2015-16 followed by Bhartiya Prakriti Krishi Paddhati (BPKP) in 2019-20. PM of India emphasised on mass promotion of Natural Farming on 10th July 2022 and afterwards the BPKP included important project "Out-scaling of Natural Farming through KVKs" in order to ensure food security along with harmony with nature. Natural farming promotion in 5 km wide corridors along the river Ganga was another important decision under this initiative. Subsequently, the GOI announced National Mission on Natural Farming in early 2023 for which draft guidelines were formulated in December 2023.

Role of KVKS

Natural Farming was promoted through 425 KVKs of India through the flagship program of Government of India (GOI) under the name "Out-scaling of Natural Farming Through KVKs" during 2022-23 and 2024-25. Organising trainings for farmers on natural

JUST AGRICULTURE
multidisciplinary e-Newsletter

farming, organising awareness programs on natural farming and conducting natural farming demonstrations on farmers' fields were the main mandated activities under this program.

In ICAR Zone-1 under the jurisdiction of ICAR-ATARI Ludhiana 42 KVKs of Himachal Pradesh (13), Jammu & Kashmir (8), Ladakh (4), Punjab (5), and Uttarakhand (12) implemented this flagship program of GOI on natural farming. The project funding started in 2022-23 and lasted till 2023-24 as the project was supposed to be implemented in mission mode right from 2024-25 under new funds flow mechanism. Hence, whatsoever progress KVKs made during 2024-25 was only out of their left-over funds during 2023-24. The overall total of the project output has been presented in the Table 1.

Table 1: Overall total of the project output during 2022-23, 2023-24 and 2024-25

State	No. of Natural Farming KVKs	Training Programs		Awareness Programs		No. of Demonstrations
		No.	Farmers Trained	No.	Participants	
Himachal Pradesh	13	107	4210	164	6425	201
J & K	8	85	3460	232	18875	174
Ladakh	4	41	1829	82	3415	73
Punjab	5	43	1747	52	2926	55
Uttarakhand	12	86	3467	176	9183	142
Total	**42**	**362**	**14713**	**706**	**40824**	**645**

State wise overall total of the project output in above Table might indicate distorted picture due to variable number KVKs implementing natural faming project, hence, KVK wise, year wise, state/ UT wise and component wise average output of the project was estimated and presented in the Fig. 3 to 7 below.

State/ UT wise average (per KVK) number of natural farming training organised during 2022-23 was quite modest vis-à-vis 2023-24 in all the states and UTs of India falling under ICAR-Zone-1. However, the output during 2024-25, so far, was subjected to the availability of left over funds from the previous financial year (Fig. 3).

JUST AGRICULTURE
multidisciplinary e-Newsletter

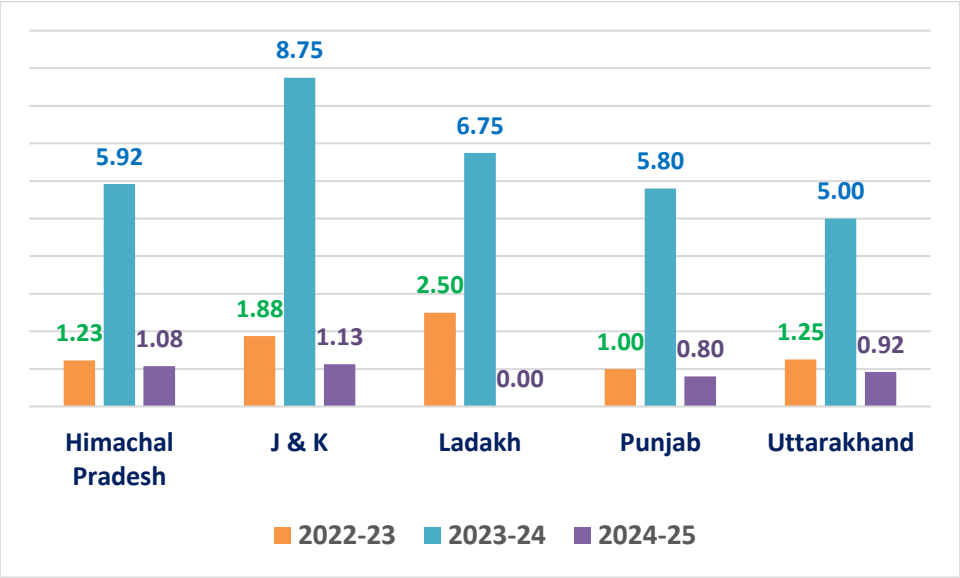

Fig. 3: Average No. of training programs conducted per KVK

The state and KVK wise average number of farmers trained under the program under discussion more or less mimic the number of training programs organised per KVK as the norms for organising natural farming trainings under the project were uniform for all the KVKs (Rana et al., 2023) (Fig. 4).

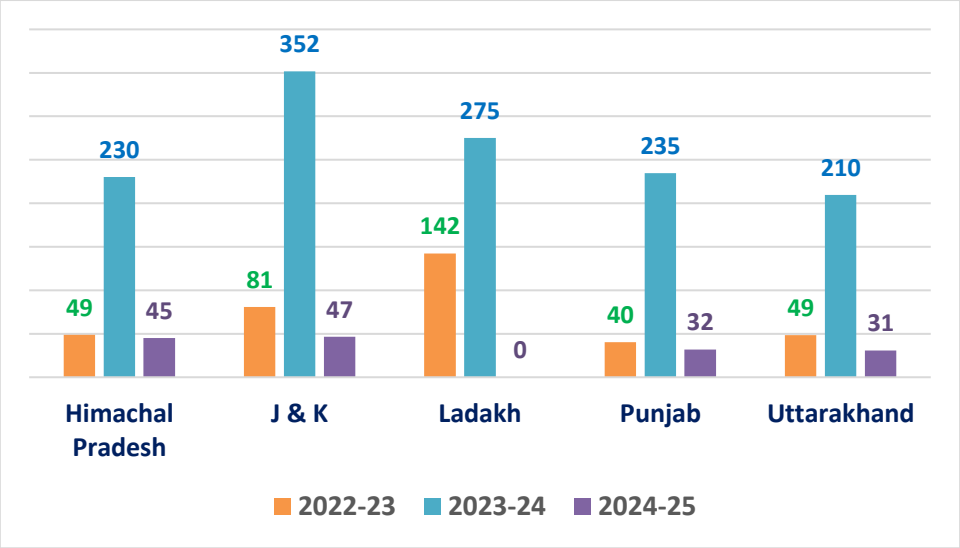

Fig. 4: Average No. of farmers trained on Natural Farming per KVK

Invariably the Natural Farming KVKs in all the states and UTs organised greater number of awareness programs during 2022-23 vis-à-vis 2023-24 as higher emphasis was given on awareness programs during initial year of the project. The per KVK performance on number of awareness programs by the KVKs of J&K was the best followed by Ladakh,

JUST AGRICULTURE
multidisciplinary e-Newsletter

Uttarakhand, Himachal Pradesh and Punjab (Fig. 5). KVKs were not supposed to conduct awareness programs during 2024-25 hence, there is no output on this aspect.

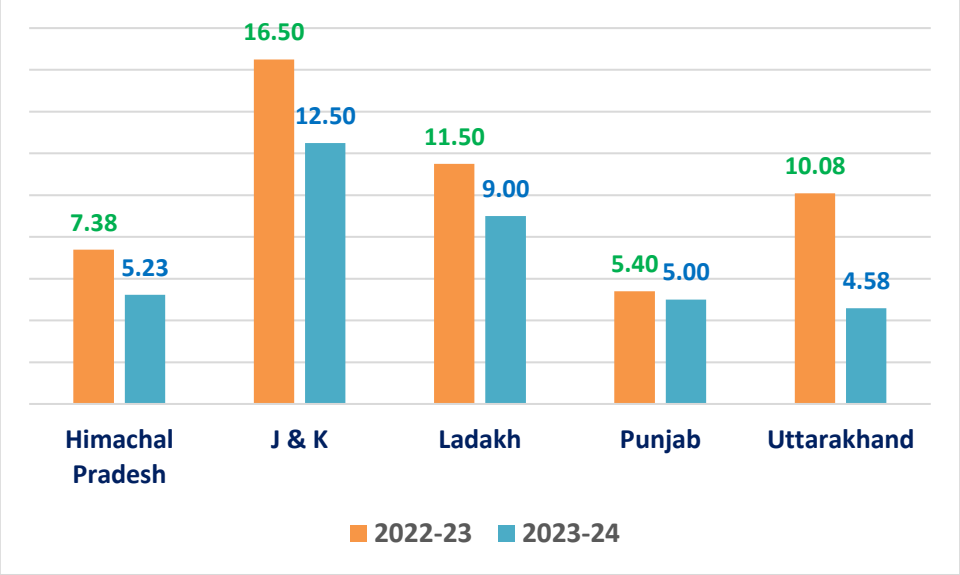

Fig. 5: Average No. of awareness programs organised per KVK

The state/ UT wise average number of participants per KVK in the awareness programs on natural farming had more or less same trend except the state of Punjab that had higher number of participants per awareness program compared to the state of Himachal Pradesh (**Fig. 6**).

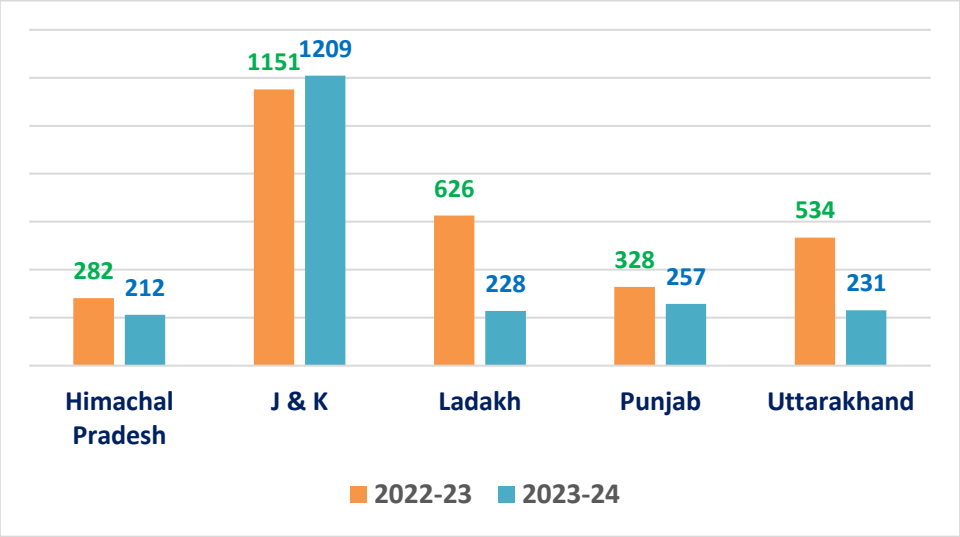

Fig. 6: Average No. of participants in awareness programs on natural farming per KVK

Conducting natural farming demonstrations on farmers' fields was another significant mandate of the project implementing KVKs. The natural farming KVKs of J&K conducted the

JUST AGRICULTURE
multidisciplinary e-Newsletter

highest number of per KVK demonstrations followed by the KVKs of Ladakh, Himachal Pradesh, Uttarakhand and Punjab. Ovrall, the number of demonstrations conducted during 2023-24 was higher than the 2022-23 (Fig. 7). KVKs had no mandate of conducting natural farming demonstrations during 2024-25.

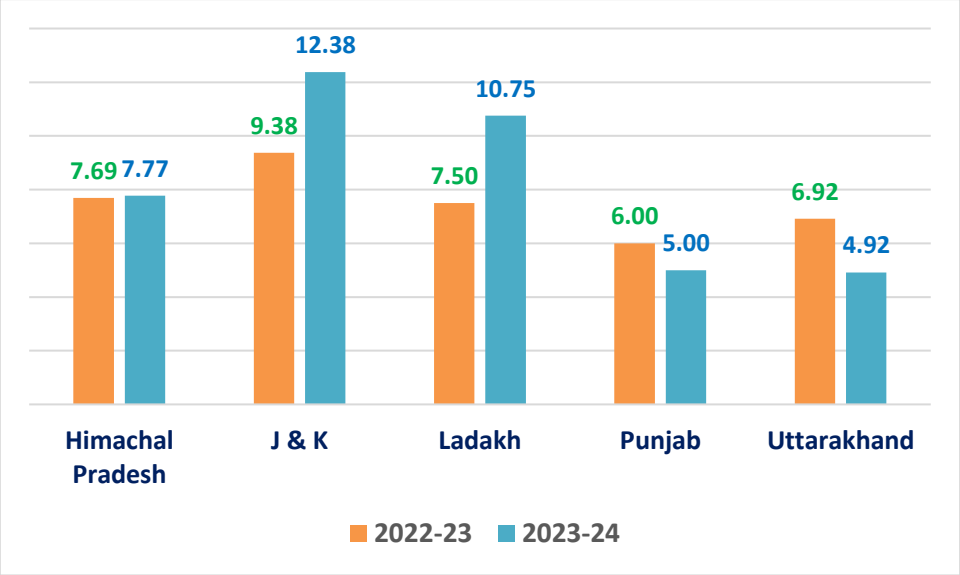

Fig. 7: Average No. of demonstrations conducted on natural farming per KVK

Conclusion

Carbon sequestration through natural farming provides a multifaceted solution to overcome a wide range of environmental challenges. By enhancing soil organic carbon and promoting sustainable land use practices, natural farming plays a crucial role in reducing atmospheric CO_2 levels. At the same time, it improves soil health, biodiversity, water conservation, food security, and sustainable livelihoods. Carbon sequestration through natural farming enhances soil organic matter, which provides a richer food source for soil microbes, thereby boosting their population and activity. This increase in microbial diversity and abundance improves soil health and nutrient cycling. This holistic approach not only addresses climate change and soil degradation but also contributes to a more resilient and equitable agricultural system for the future. Taking due cognisance of the role of natural farming in socio-economic sustainability especially of the small and marginal Indian farmers, the Government of India took pertinent measures to promote it during recent past through a series of initiatives, out of which "Out-scaling Natural Farming through KVKs" was the most prominent. The efforts of 42 natural farming KVKs of this zone, in building farmers' capacity, enhancing awareness, and organizing

JUST AGRICULTURE
multidisciplinary e-Newsletter

on-field demonstrations has been particularly fruitful in promoting natural farming. Hence, the role of Natural Farming in the promotion of soil organic carbon has not only been recognized in the academic world but it has also been duly understood and implemented by the Indian policy makers.

References:

Benbi D K and Brar J S (2009) A 25-year record of carbon sequestration and soil properties in intensive agriculture. Agronomy for sustainable development 29: 257-265.

Pribyl D W (2010) A critical review of the conventional SOC to SOM conversion factor. Geoderma. 156 (3-4): 75-83.

Keprate A, Bhardwaj D R, Sharma P, Kumar D and Rana R K (2024) Biomass Partitioning, Carbon Storage, and Pea (Pisum sativum L.) Crop Production under a Grewia optiva-Based Agroforestry System in the Mid-Hills of the Northwestern Himalayas. Sustainability. 16: 7438. https://doi.org/10.3390/su16177438

Rana R K and Singh R (2018) Restoring human and environmental health through creative natural farming practices. In, Agri-Innovators: The Torch Bearers of Brighter Agriculture, Singh R, Rana R K, Chahal V P and Singh A K (Eds.), Ludhiana ICAR-ATARI: 19-24.

Rana R K, Sheoran P, Keshava, Singh R, Singh R K and Gautam U S (2023) Training Manual for Uniform Out-scaling of Natural Farming through KVKs. ICAR-ATARI, Zone-I, Ludhiana, Punjab: 30p.

Rana R K, Sheoran P, Jaryal N and Monga S (2024) Natural Farming Going Beyond the Boundary of Zero Budget-Inspiring Tale of an ARYA Entrepreneur. Just Agriculture 5 (1): 201-209

Singh M, Rana R K, Monga S and Singh R (2022) Organic and Natural Farming- A Critical Review of Challenges and Prospects. Bhartiya Krishi Anusandhan Patrika 37(4): 295-305. DOI: 10.18805/BKAP569

Sood P, Yadav D S, Kumar R, Chauhan N, Kumar V, Kumar N, Singh J, Rana R K and Sheoran, P (2024) Natural Farming: Imperativeness of Farmers' Perspective for Brighter Future. ICAR-Agricultural Technology Application Research Institute, Zone-1, PAU Campus, Ludhiana- 141 004, Punjab, India. Pp:28.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Thakur R, Thakur S, Kaur T and Rana R K (2024a) Protected Cultivation of Flowers through Natural Farming. In, Inspiring Tales of Entrepreneurs' Journey to Success. ICAR, New Delhi: 103-107.

Thakur S, Thakur R, Rana R K and Kaur T (2024b) Protected Cultivation of Yellow-Red Coloured Bell Peppers through Natural Farming. In, Inspiring Tales of Entrepreneurs' Journey to Success. ICAR, New Delhi:108-113.