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Healthy Soil for a Prosperous India

A Roadmap for Sustainable Soil Management

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List of Abbreviations

ABY	Atal Bhujal Yojana
ACZ	Agroclimatic zone
AIoT	Artificial Intelligence of Things
ATMA	Agriculture Technology Management Agency
CRM	Crop Residue Management
CSO	Civil Society Organisations
CSR	Corporate Social Responsibility
CRP	Community Resource Person
DoAFW	Department of Agriculture and Family Welfare
DSR	Direct Seeding Rice
ESG	Environment, Social and Governance
FMCG	Fast Moving Consumer Goods
FPO	Farmer Producer Organisation
GR	Green Revolution
KPI	Key Performance Indicator
KVK	Krishi Vigyan Kendra
MIDH	Mission on Integrated Development of Horticulture
MoAFW	Ministry of Agriculture and Farmers' Welfare
MoJS	Ministry of Jal Shakti
MoRD	Ministry of Rural Development
NGO	Non-Governmental Organisations
NMNF	National Mission on Natural Farming
NPK	Nitrogen, Phosphorous, Potassium
NREGS	National Rural Employment Guarantee Scheme
NRLM	National Rural Livelihood Mission
PDS	Public Distribution System
PKVY	Paramparagat Krishi Vikas Yojana
PMDS	Pre-monsoon drying and sowing
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PM-PRANAM	Programme for Restoration, Awareness, Nourishment and Amelioration of Mother Earth
PROM	Phosphate rich organic matter
PSB	Phosphate Solubilizing Bacteria
R&D	Research and Development
RAD	Rainfed Area Development
RKVY	Rashrtiya Krishi Vikas Yojana
SALT	Sloping Agriculture Land Technology
SHC	Soil Health Card
SHG	Self Help Group
SOC	Soil Organic Carbon
SRLM	State Rural Livelihood Mission

Executive Summary

Context

Soil - a critical and strategic national asset - is foundational to life. It directly supports our nutritional security, environmental sustainability and livelihood security. Soil health is intricately connected to 11 out of 17 global sustainable development goals[1]. Unfortunately, decades of human activity considering soil just as a "physicochemical bed" (as opposed to a "living biological entity"), ignoring its intricate link to biodiversity and ecosystems around it, and focusing solely on reductionist Key Performance Indicators (KPIs) such as yield has led to severe unintended consequences on soil health (Elizabeth T. Alori, Bernard R. Glick, and Olubukola O. Babalola 2017), (Ann Raeboline Lincy Eliazer Nelson, Kavitha Ravichandran, and Usha Antony 2019).

The soil on 96-120 million hectares out of India's 328 million hectares of land, particularly in forests, croplands and pastures, is already classified as 'degraded' (NAAS 2010)(Space Application Centre, ISRO 2021). Besides, about half of the cultivable land in India is deficient in Soil Organic Carbon (SOC), and most soils are low in significant macro and micronutrients (Das et al. 2021). The deteriorating soil condition necessitates India to transform its approach to managing this national asset and scaling healthy soil at speed. As soil health transcends multiple national outcomes, government departments, jurisdictions, and disciplines, the action for soil needs concerted and coherent effort by all.

Recognising the importance of healthy soils, the Indian government has implemented several national schemes such as the Soil Health Card (SHC) Scheme, to provide access to soil data for better decision-making, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) to promote water use efficiency in irrigation, Rashtriya Krishi Vikas Yojana (RKVY) to train farmers in organic farming, etc. The honourable Prime Minister Shri Narendra Modi has identified a five-pronged strategy for sustainable soil management. It prioritises making soils chemical-free, enhancing soil organic matter, maintaining soil moisture, mitigating the impact of low groundwater, and arresting soil erosion (PIB, 2022).

Co-created with over 110 regional experts from close to 65 organisations via regional consultations across diverse sectors and stakeholders including the government, civil society, private sector, academia, farmers etc., this Roadmap for Healthy Soils in India builds upon the Prime Minister's foresight.
It frames an ambitious shared vision for India's soil, identifies initiatives and strategies to translate the shared vision into collective action, and identifies specific roles for the various stakeholders in the ecosystem.

Indo-German development cooperation project 'Soil Protection and Rehabilitation for Food Security in India (ProSoil)' is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and development (BMZ) in partnership with the National Bank for Agriculture and Rural Development (NABARD) in the Indian states of Maharashtra and Madhya Pradesh. The project is part of a larger global programme under BMZ's Special Initiative "Transformation of Agricultural and Food Systems".

ProSoil collaborated with knowledge partner The Council on Energy, Environment and Water (CEEW), one of Asia's leading not-for-profit policy research institutions, for the development and co-creation of this roadmap through extensive consultations.

> ***The deteriorating soil condition necessitates India to transform its approach to managing this national asset and scaling healthy soil at speed.***

[1] SDGs 1 (End Poverty), 2 (Zero Hunger), 3 (Good Health and Wellbeing), 5 (Gender Equality), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 9 (Industry Innovation and Infrastructure), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 13 (Climate Action), and 15 (Life on Land)

The Council uses data, integrated analysis, and strategic outreach to explain - and change - the use, reuse, and misuse of resources.
The Sustainable Food Systems (SFS) team at CEEW seeks to catalyse the transformation of India's food system through a holistic, systems-based approach. The team's work is guided by the 30-30-30 by 2030 agenda, which envisions a 30% shift in food production towards sustainable approaches, a 30% shift towards sustainable and healthy consumption choices, and a 30% shift in value addition to sustainable supply chains.

Vision and Goals of the National Roadmap for Sustainable Soil Management

The *'Amritva'* (immortality) of our *'maati'* (soil) must get rejuvenated in the *'Amrit Kaal'*. The roadmap envisions that by the completion of *'Amrit Kaal'*, i.e., India's vision for development for 2047, India's entire soil - a critical national asset:

- becomes regenerative and has a thriving soil biodiversity,
- while ensuring nutritional security, climate change mitigation, and sustainable and resilient livelihoods.

It aims to achieve the vision

- via concerted and coherent action of multiple stakeholders in the water-land-food-health nexus.
- by capitalising on modern science and technology and valuable traditional knowledge.

Adequate baseline data on soil health is crucial to set achievable intermediate milestones as a way forward to the vision and goals of the National Roadmap. Further, given India's agroecological and socioeconomic diversity, the baseline data and the targets must be region-specific.

The roadmap proposes a placeholder interim milestone of achieving 50% of the 2047 target by 2030. This translates to about 131 million hectares (under forest cover, pastures and grazing lands, agricultural land) of regenerative and healthy soil in India. As a preliminary strategy, the proposal is to target 50% of the degraded (~40 mha) and undegraded land (~91 mha[2]) so that the focus is not only on restoring degraded land but also protecting undegraded land and elevating its capability.

Actioning the National Roadmap

As healthy soil influences multiple national outcomes, actioning this roadmap needs coherent effort across various departments of the union and state governments, Civil Society Organisations (CSOs), research institutes, farmers' organisations, private sector, development financial institutes, philanthropies etc. The following are four key initiatives/pathways, along with the roles of various stakeholders in achieving the shared vision of the roadmap.

Meri Maati Abhiyaan (MMA)

Based on the success of national movements like the 'Swacchha Bharat Abhiyaan' (Clean India Mission), the central government may institute and drive the healthy soil agenda by launching a 'Meri Maati Abhiyaan' (My Soil Mission). This multi-stakeholder movement will have the following key pathways:

- **Mainstream action and convergence for soil across relevant government departments:** Integrate soil health KPIs into all the relevant departments' mandates, foster coordination across government departments on healthy soil, and enhance soil-related personnel and technological capacities. The roadmap also recommends reporting soil status in the annual national budget to draw adequate attention to this critical national asset among the *Pancha Bhuta*.

  a. **Proposed stakeholders:** Ministry of Agriculture and Farmers' Welfare (MoAFW), Ministry of Jal Shakti (MoJS), Ministry of Animal Husbandry, Dairying and Fisheries (MoAHDF), Ministry of Health and Family Welfare (MoHFW), Ministry of Environment, Forest, and Climate Change (MoEFCC), Ministry of Mines, Ministry of Corporate Affairs (MCA), respective state governments departments, district collectorates, etc.

[2] The target of 50% for undegraded lands will be revised as soon as baseline data becomes available. The need of baseline data and the prerequisites for achieving that have been discussed at the end of this section.

- **Establish soil as a critical national asset and treat 'soil security' as a national issue:** Mainstream and expand the natural capital accounting and ecosystem services to include soil health. The Ministry of Statistics and Programme Implementation (MoSPI) implemented the System of Environmental-Economic Accounting-Ecosystem Accounting (SEEA EA), which covers soil partially and needs to be actively mainstreamed for policymaking in India.

  Additionally, inspired by the Water Act of 1974, the roadmap proposes introducing a National Soil Act to safeguard and rejuvenate Indian soil.

  a. **Proposed stakeholders:** MoAFW, MoSPI, MoJS, respective state government departments, Members of Parliament, CSOs working on soil agenda.

- **Enable convergence for soil action between government and CSOs:** Build a platform to improve coordinated action on soil health between grassroots organisations and local governments. It will prevent duplication and foster synergies.

  a. **Proposed stakeholders:** Local government bodies, Donor agencies, and CSOs.

- **Procure local and diverse produce in government programmes to enhance crop and soil biodiversity:** Procure and distribute 'diverse' local produce via mid-day meals, the Integrated Child Development Services (ICDS) Scheme , the Public Distribution System (PDS), government canteens and railways.

  a. **Proposed stakeholders:** Food Corporation of India (FCI), Ministry of Consumer Affairs, Food and Public Distribution, Ministry of Women and Child Development, Ministry of Education (MoE), Indian Railways, and other state government agencies.

- **Facilitate context-specific technology adoption across India:** Improve awareness and accessibility to context-suited technologies and interventions for healthy soil based on the agroecological and socio-economic contexts via adequate capacity building of the extension workers.

  The establishment of community seed banks can be used to promote the use of indigenous seeds. Lead farmers who are early adopters of sustainable practices may be incentivised to demonstrate context-specific technologies and foster peer-to-peer learning.

  a. **Proposed stakeholders:** Research institutions, Farmers collectives, Agri extension workers, Krishi Vigyan Kendras (KVKs), National Institute of Agricultural Extension Management (MANAGE), Lead farmers, etc.

- **Formulate, align, and institutionalise soil health KPIs:** To drive consensus on defining "healthy soils" and identifying the relevant indicators to measure it.

  a. **Proposed stakeholders:** soil scientists, research institutions, and international organisations.

Making 'Meri Maati Abhiyaan' a People's Movement

Make soil action a people's movement to inspire and empower communities to act towards healthy soil.

- **Recognise and create soil champions and promote aspirational 'Soil Jobs' in the rural economy:** To engage the agricultural community in the MMA, the government can incentivise local practitioners who champion the healthy soil agenda. Furthermore, it is expected to create aspirational jobs such as 'Soil Stewards', who become first-mile actors coordinating local efforts between various government departments and CSOs, and championing soil initiatives such as running field experiments, collating best practices, guiding Community Resource Persons (CRPs), creating audio-visual content for healthy soil practices. A Soil Steward in every gram panchayat can generate 2.5 lakh aspirational jobs for the rural youth.

  a. **Proposed stakeholders:** Ministry of Rural Development (MoRD), MoAFW, Ministry of Labour and Employment.

- **Strengthen people's cultural and emotional connection with soil:** Instil a sense of belonging and responsibility in communities towards healthy soils via cultural, historical, and inspiring storytelling. It will also inspire the youth to consider farming as an aspirational career option.

    a. **Proposed stakeholders:** Ministry of Information and Broadcasting (MIB), Digital Media (Public Broadcast channels like Doordarshan, All India Radio etc.)

- **Sensitise children and youth on healthy soil:** Include educational content on healthy soil, its importance and management in school and college curriculums. Also, enable practical exposure via visits to farmer field schools, for farming and agricultural courses, etc. Additionally, schools and colleges can organise campaigns on healthy soils and empower children to become change agents and ambassadors of soil health, fostering a sense of environmental and social responsibility.

    a. **Proposed stakeholders:** MoE, Schools, Colleges, CSOs.

- **Strengthen local governance and leadership for bioresource governance and soil action:** Embed healthy soil in the mandate of local governance bodies and structures such as the Gram Panchayat Development Plan (GPDP) and Water Security Planning and Biodiversity Management Committee.

    a. **Proposed stakeholders:** Ministry of Panchayati Raj, MoRD, Village panchayats, CRPs, KVKs, Ministry of Mining, Public Works Department, Union and State Government regulatory bodies.

> *A Soil Steward in every GP can generate 2.5 lakh aspirational jobs for the rural youth.*

Recalibrate incentives for value chain actors to achieve healthy soil

Aligning economic incentives for farmers, CSOs, and the private sector to promote a shared commitment towards healthy soil.

- **Incentivise farmers to adopt healthy soil management practices:** Leverage prevailing government support for farmers to encourage and incentivise the adoption of sustainable soil management practices. For example, linking cash transfer (PM KISAN) for healthy soil management activities or targeted direct benefit transfer to farmers reducing the chemical fertiliser use (PM PRANAM scheme).

    a. **Proposed stakeholders:** MoAFW, CSOs, Bureau of Energy Efficiency, Insurance companies, Financial institutions.

- **Incentivise the private sector to promote healthy soils:** Institute tax incentives and low-interest loans to incentivise private entities to invest in low-cost soil testing, research and development for equipment design, and innovation in citizen science for soil health mapping. Besides this, market regulators can work with private companies in the food, agriculture, and FMCG sectors to incorporate soil health into their Environmental, Social and Governance (ESG) reporting. Union and State Governments can also encourage Corporate Social Responsibility (CSR) investments in healthy soil by promoting it as a significant agenda.

    a. **Proposed stakeholders:** MCA, MoAFW, Ministry of Commerce and Industries, Corporates, Confederation of Indian Industries, Investors, Advisory and Consultancy firms, Credit rating agencies.

- **Align philanthropic community to focus on healthy soil:** Establish a donor alignment platform for philanthropic organisations to embed healthy soil in their food, agriculture and land-use initiatives.

    a. **Proposed stakeholders:** Philanthropies, organisations shaping philanthropic agendas.

Soil Innovation and Evidence Generation

Targeted evidence is critical to guide the scale-up of context-appropriate solutions for healthy soils. Fostering innovation and regular evidence and learning agenda in soil practices, inputs, funding, and governance would help healthy soil strategies be more effective.

- **Enable data and evidence ecosystem for healthy soil:** Develop a national database to capture successful soil management practices, including Indigenous Traditional Knowledge (ITK). It will help disseminate information on practices, techniques, materials, and geographies, with additional features like dashboards for soil priority maps. In addition, relevant government stakeholders can ensure the incorporation of the latest soil data across departments into the Agri Stack to harmonise soil health data in the country.

  a. **Proposed stakeholders:** MoSPI, Ministry of Tribal Affairs, Ministry of Panchayati Raj, Research Institutions, Local communities, MoAFW, MoJS.

- **Establish mechanisms to strengthen knowledge co-creation and exchange between researchers, extension workers, and farmers on soil health:** Create Agroecological Learning Centres (ALC) within KVKs to facilitate knowledge exchange regarding soil and agroecological practices. This is expected to enhance bottom-up innovation and promote the adoption of locally suited soil management practices.

  a. **Proposed stakeholders:** MoAFW, Extension officers, Farmer Field Schools, KVKs.

- **Support infrastructure for soil evidence generation:** To tailor soil health strategies to local conditions, the government may invest in decentralised soil testing laboratories or Biolabs to provide farmers with quick and varied quality tests on soils, seeds, pest control and water. This can be complemented by capacity building and trainings for farmers and extension workers in soil self assessment using lean methods, such as observing soil self-assessment using lean methods such as observing soil texture, compaction, and fauna presence.

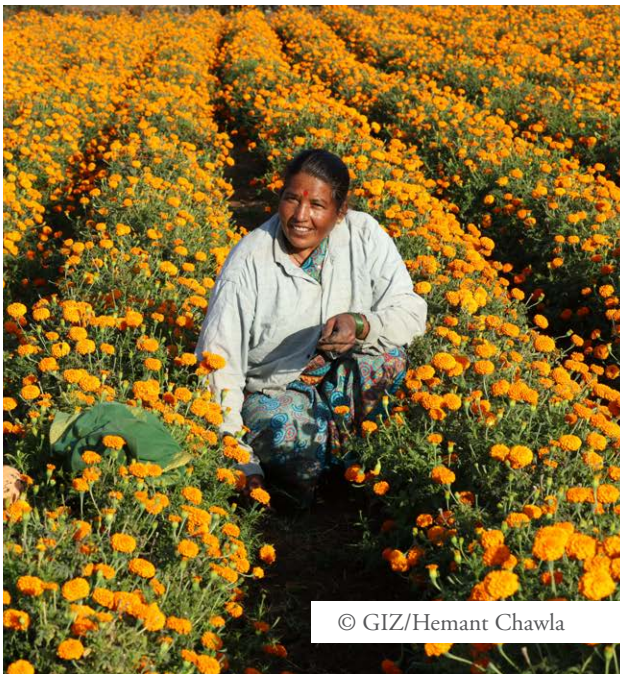
  a. **Proposed stakeholders:** Indian Council of Agricultural Research (ICAR), MoAFW, Investors, Research institutions, soil scientists, CSOs, lead farmers, extension officers etc.

- **Support innovation and entrepreneurship towards healthy soils:** Dedicated funds from the Atal Incubation Centres (AIC) and privately supported incubation centres is expected to promote innovative services by start-ups working in the field of soil health. These funds can aid entrepreneurs in building scalable and sustainable enterprises, particularly in developing context-relevant inputs, equipment and services for soil improvement, including bio inputs.

  Additionally, incentivising research and development for soil-related technology, tools and machines that alleviate human drudgery and reduce labour costs associated with soil health management practices.

  a. **Proposed stakeholders:** Investors, Startups, Private sector agencies, and Agri-businesses

Indian soils need our attention. This roadmap is the first systematic bottom-up effort to collectively envision and act towards healthy soils in India.



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01

Context

Soil, a critical national asset, forms the basis for sustaining life and health as it is the foundation of nutritional security, environmental sustainability and the security of livelihoods. Unfortunately, soil degradation has become one of the most significant risks to India's jobs, growth and sustainability. The Green Revolution (GR) paradigm considering soil as a 'chemical bed' (as opposed to a 'biological entity') and focusing solely on yields as the Key Performance Indicator (KPI) has led to severe unintended consequences on soil health (Alori et al. 2017), (Nelson et al. 2019). Almost half of the cultivable land in India is now deficient in Soil Organic Carbon (SOC), and most Indian soils are low in significant macro and micronutrients (Das et al. 2021). Annual rates of soil loss in India are about 15 tonnes per hectare, which is higher than sustainable rates of 5 to 12 tonnes per hectare. As eroded soil seeps into water reservoirs, it further impacts crop productivity and water quality. Deteriorating soils have increasingly made our food systems vulnerable to climate variability and associated risks (Wijerathna-Yapa and Pathirana 2022).

Furthermore, there is a connection between soil health, nutrition security and water quality. Research indicates that 3–6% of Soil Organic Matter (SOM) in agricultural soils is fundamental to ensuring food and nutritional security[3]. A positive correlation exists between SOM and the nutrient supply systems of soil, making it essential for plant, animal and human health (Lal 2020). Increasing SOM by just 1% can improve the soil's water-holding capacity by up to 20,000 gallons per acre (Bhadha et al. 2017). Additionally, soil can act as a significant filter of water-borne pollutants. Soil rich in organic matter can decompose the chemicals and contaminants that enter through excessive use of fertilisers. Therefore, the solution to address water pollution from agricultural sources is increasing SOM (Day 2015).

The official data on the soil status is also alarming. According to the latest land use data by MoAFW from 2021, India's total land area is 328 million hectares. ISRO's recent estimates state that about 96 million hectares out of 328 million hectares of the country's soil is already classified as 'degraded land' (Space Application Centre, ISRO 2021), of which 79.85 million hectares fall under the targeted land areas (forest cover, pastures, other grazing lands, and agricultural land) for restoration or prevention of degradation. This highlights the need for an urgent action in the form of a paradigm shift towards sustainable soil health management in India.

Taking note of soil's importance in the country's sustainable development, the State and the Union have taken a proactive stance in addressing soil health management. The honourable Prime Minister Narendra Modi has identified a five-pronged strategy to save the soils - making soils chemical-free, enhancing soil organic matter, maintaining soil moisture, mitigating the impact of low groundwater, and arresting soil erosion (PIB 2022). Through schemes such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) promoting water use efficiency in irrigation, Rashtriya Krishi Vikas Yojana (RKVY) training farmers in organic farming, Soil Health Card (SHC) Scheme providing access to soil data for better decision making, the Union and State are also active in promoting soil health management through policy instruments. In 2023 Azadi Ka Amrit Mahotsav or the celebration of the 75th anniversary of India's Independence, also focused on soils with the slogan Meri Maati Mera Desh (My Soil My Country) (PIB 2023). The NITI Aayog has provided policy support, knowledge on best practices, and evidence for robust policymaking on sustainable soil management in India.

In 2023 Azadi Ka Amrit Mahotsav or the celebration of the 75th anniversary of India's Independence, also focused on soils with the slogan Meri Maati Mera Desh (My Soil My Country) (PIB 2023).

[3] Conscious Planet Inc. 'Soil Revitalization Global Policy Draft', 2022. https://drive.google.com/file/d/1foB0PDpO7zYt_rigQWMY7o4MLMrFq7MB/view?pli=1.

While numerous success stories are emerging in various regions, sustainable soil management practices are yet to be adopted in scale, with less than 5% of the farmers practising mulching and about 1% of the farmers practising cover cropping (Gupta et al. 2021). Well-intended regional or local efforts remain fragmented and divergent, highlighting the need for coherent and collective action at scale to promote soil health. Further, given that diverse landscapes (farmlands, forest areas, grasslands, wastelands etc.) fall under different jurisdictions, there is a need for concerted efforts through a multi-departmental program involving the Ministry of Environment and Forests, the Ministry of Agriculture and Farmers' Welfare, and the Ministry of Chemicals and Fertilizers. Therefore, a national-level roadmap with a multi-stakeholder approach involving policymakers, practitioners, and enabling agencies across food, health, agricultural, rural development, and environmental ministries is essential.

This roadmap identifies the key enabling factors (or success factors) that catalysed the scale-up of key soil health management practices in different regions, and the actions required by public, private and non-governmental actors in creating this enabling environment.

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02

Developing the National Roadmap

The process deployed in developing this roadmap focuses on participative learning from the collective experiences of relevant stakeholders in scaling various soil health management practices and systems in their specific contexts. The roadmap development process consists of four steps. The first two steps were executed via a series of three regional (Himalayan Region, Gangetic and North Region, and Central and South Region) stakeholder consultations in India.

Step 1: Co-discovering context-specific learnings, particularly identifying the key success factors that enabled the scale-up of popular soil health management practices. For identifying the relevant success factors, the scalability framework by Agarwal et al., 2023, was used.

Step 2: Co-envisioning India's 'Soil Mission' and chalking out various actionable areas to be implemented by different stakeholders.

Via a National-Level Conference on the 4-5 December 2023 held in New Delhi, step 3 has been executed and step 4 has been initiated:

Step 3: Consolidating the regional inputs to co-create the first draft of the Roadmap for Healthy Soils in India, and

Step 4: Fine-tuning the roadmap along with the relevant institutions.

Annexure I provides details on each of the steps mentioned above.

> ***The first two steps were executed via a series of three regional (Himalayan Region, Gangetic and North Region, and Central and South Region) stakeholder consultations.***

03

Emerging contours of sustainable soil management in India

Sustainable soil health management entails ensuring and enhancing soil health, fertility, and resilience in an environmentally sound, economically viable, and socially responsible manner over the long term. It involves adopting a wide variety of soil management practices and systems. In the following paragraphs, we discuss some of the most popular soil health management practices followed across India. It is important to note that the practices focus only on one aspect of agriculture, while systems are more holistic concerning the overall agriculture or most aspects concerning it. While most the practices remain at the margins, the following are worthy of mention given the traction they receive or their claimed potential:

3.1 Practices

A. Crop-related practices

i. Cover cropping

Integrating cover crops into farming systems is crucial for sustainable soil health management. Cover crops can be rotated or intercropped with other crops and sown when primary crops are not grown. Some cover crops are specifically chosen for their ability to capture and retain nutrients in the soil. Examples of such cover crops are green gram, black gram, Indian mustard, etc. Cover cropping is practised by 1 to 2 million farmers across India.

Applicable regions: *All, especially green revolution belts.*

Soil benefits: *Adds organic matter to the soil, supplies nitrogen.*

Problems Addressed: *Weed and pest infestation, water erosion, nutrient depletion.*

ii. Crop Rotation

Crop rotation is a cropping pattern in which two or more crops are sequentially planted on the same plot of land. Simple rotation involves two to three crops, while complex rotation can involve a dozen or more. Around 12 to 15 million farmers across India are practising some form of crop rotation.

Applicable regions: *All, especially green revolution belts (Gupta et al. 2021).*

Soil benefits: *Build soil structure, decrease soil run-off.*

Problems Addressed: *water erosion, weed and pest infestation, nutrient depletion, soil salinisation.*

iii. Pre-Monsoon Dry Sowing (PMDS)

PMDS is a system of sowing, tilling, and tending the land wherein crops are grown in the non-farming season to keep the soil under green cover throughout the year (Institute for Development Studies, Andhra Pradesh 2021). In this system, pulses, millets, and oilseeds are pelletised with wood ash and other inoculants and spread out in the fields. The coated pellet protects the seed, allows moisture retention and provides a favourable condition for germinating.

Applicable Regions: *Andhra Pradesh, especially semi-arid and rainfed regions (Gupta et al. 2021)*

Soil benefits: *Conserves soil moisture and reduces wind and soil erosion.*

Problems Addressed: *Long crop duration, weed infestation (Apmas n.d.)*

B. Soil amendments

i. Application of Amirthakaraisal/ Jeevamrutham

Amirthakaraisal is an organic preparation combining fresh cow dung, cow's urine, jaggery and water. This extract can then be used for seed treatment (TNAU Agritech Portal 2014). It enhances microbial activity in the soil, helps improve soil fertility, and prevents water pollution caused by synthetic fertilisers[4].

Applicable regions: *Mostly all*

Soil benefits: *Soil fertility, soil texture[5].*

Problems Addressed: *Lack of microbial diversity*

ii. Slurry Application

Bio-slurry is a nutrient-rich by-product of biogas as a natural fertiliser. The efficacy of bio-slurry application can also be enhanced by combining the application with organic fertilisers or other beneficial ingredients[6]. An example is the Bio-PROM Model, under which high-grade rock phosphate, bio-slurry, and bio-inoculants are co-composted into a very fine-sized matter that can be used as an alternative to chemical fertilisers (BAIF 2023).

Applicable regions: *Mostly all*

Soil benefits: *Reduction of soil pH and improvement in soil organic carbon[7].*

Problems Addressed: *Soil fertility, Cost of production*

[4] GIZ - CEEW Regional consultation conducted in Mumbai, 20th November 2023
[5] GIZ - CEEW Regional consultation conducted in Mumbai, 20th November 2023
[6] GIZ - CEEW Regional consultation conducted in Delhi, 8th November 2023
[7] GIZ - CEEW Regional Consultation, Delhi, 8th November 2023

iii. Tank Silt Application

Tank silt is fine soil particles transported through surface runoff and erosion deposited as sediments in rainwater harvest tanks. After decomposition, these particles transform into nutrient-rich soil amendments, which can be applied on farmland (Srinivasan et al. 2021).

Applicable regions: *Rainfed agricultural lands (Dhan foundation, n.d.) and dry arable land (Srinivasan et al. 2021).*

Soil benefits: *improves water holding capacity of the soil, reduces soil bulk density, increases soil organic carbon, and improves nutrient retention of soil*

Problems Addressed: *Soil fertility, Water use efficiency*

iv. Mulching

It is the practice of covering the soil surface with organic materials (e.g. plant residues, straw, hay, groundnut hulls, leaves and compost, peat, wood products, sawdust, and animal manure), or synthetic materials (paper, polyethene, wax-coated papers, aluminium, steel foils, and asphalt spray emulsions, etc.). Around 5 million farmers across India practise some form of mulching.

Applicable regions: *Mostly rainfed regions (Gupta et al. 2021)*

Soil benefits: *retains soil moisture, prevents soil runoff, increases soil organic carbon and increases soil productivity (Yu et al. 2021)*

Problems Addressed: *Water loss from the soil surface, Weed growth*

v. Biochar application

Biochar is a soil amendment made from the thermochemical decomposition of biomass (e.g. wood chips, agriculture and forest waste, etc.). Biochar has a highly porous structure which improves the physical characteristics of soil such as soil structure, and soil porosity, and its negative charge helps retain nutrients in the ground (Tan et al. 2020), (Jien and Wang 2013), (Layek, Narzari, Hazarika, Das, Rangappa, Devi, Balusami et al. 2022).

Applicable regions: *All (Mohan et al. 2018) (Mankasingh, Choi and Ragnarsdottir 2011)*

Soil benefits: *Retains soil nutrients, facilitates carbon sequestration of soil, improves soil structure, reduces soil erosion.*

Problems Addressed: *Water pollution.*

vi. Phosphate Solubilising Bacteria (PSB)

PSBs are strains of bacteria such as Pseudomonas, Bacillus, and Micrococcus, that are capable of solubilising insoluble soil phosphate into releasing soluble phosphorous ions absorbable by plant roots. PSBs mixed with a substrate applied to soil increase phosphorous availability. This in turn also supports the root growth of plants (Alori, Glick and Babalola 2017).

Applicable regions: *Eastern Himalayan regions (Panda, Rahman and Panda 2016), Coastal and Island regions (Desouza, Nair and Chandramohan 2000), (Pati et al 2021).*

Soil benefits: *Increase phosphate availability in soils.*

Problems Addressed: *Cost of cultivation, Soil contamination (PSB can enhance removal of toxic metals by plants from contaminated soil.) (Yuan et al. 2022)*

C. Tech-based practices

i. Crop residue management

Crop Residue Management options can be classified as in-situ and ex-situ management options. In-situ crop residue management involves the incorporation of crop residues through mulching or decomposing using a consortia of microbes. Baling and transporting straw from the field is a feasible ex-situ option when alternate, practical and economically viable usage methods are identified (DoAFW 2023). Research suggests that incorporating crop residue in soil improves soil infiltration rate, reduces soil temperature fluctuations, and increases Soil Organic Matter (SOM) concentration (Mirzaei et al. 2021).

Applicable regions: *Paddy-wheat cropping systems (DoAFW 2023)*

Soil benefits: *Reduces average cultivated land burnt, reduces the use of herbicides and pesticides[8], enhances soil organic matter.*

Problems Addressed: *Crop residue burning and associated air pollution*

> ***Baling and transporting straw from the field is a feasible ex-situ option when alternate, practical and economically viable usage methods are identified (DoAFW 2023).***

[8] GIZ - CEEW Regional consultation conducted in Guwahati, 23rd November 2023

ii. Zero Tilling

Zero tillage is an agricultural practice in which crops are grown without disturbing the soil. Zero tillage eliminates pre-planting tillage operations and often involves precision planting, wherein farmers can use specialised equipment such as no-till seed drills to plant seeds directly into untilled soil. Zero tillage is often practised with other soil health practices such as cover cropping and mulching (Baeumer 1974). Around 1.76 million hectares of land across India was already under no-till agriculture in 2008 (Erenstein 2009).

Applicable regions: *Rice/wheat-growing regions in the Indo-Gangetic Plains (Raju 2012) (CGIAR 2023).*

Soil benefits: *Retains soil moisture, reduces soil erosion, maintains natural soil structure.*

Problems Addressed: *Wind and water erosion, cost of cultivation.*

D. Sustainable agricultural systems

i. Direct Seeded Rice (DSR)

Usually practised for rainfed and deepwater systems, DSR is a planting technology under which rice seeds are directly sown into the soil instead of transplanting. There are two types of DSR technology – Wet seeding, in which pre-germinated seeds are broadcasted into puddled or levelled fields without standing water and dry seeding, wherein seeds are sown into dry soil surface and then incorporated into the soil by ploughing or harrowing. Generally, under the DSR system, a minimum water saving of 18% can be achieved without compromising on crop yield (Deb, Kumar and Srivastava 2023).

Applicable regions: *Paddy cultivating regions, especially water-stressed areas (Kaur and Singh 2017).*

Soil benefits: *Improved soil structure (Kaur and Singh 2017).*

Problems Addressed: *Water use efficiency, long crop duration, labour costs (as it eliminates transplanting of seedlings).*

ii. Sloping Agriculture Land Technology (SALT)

Sloping Agriculture Land Technology (SALT) is a system designed for sloping lands like hills or mountains, in which dense hedgerows of fast-growing perennial shrubs or nitrogen-fixing species are planted along contour lines to help trap sediments and transform the sloping land into terraced land (ICIMOD 2019). The advantage of SALT farming is that it can be duplicated readily by farmers, takes less time, and is economically feasible and ecologically sound. Besides, SALT farms can easily convert to forest land if left unfarmed (FOCUS IFAD n.d.)

Applicable regions: *Slopy and hilly regions (Panwar et al. 2017).*

Soil benefits: *Prevents soil erosion and increases soil fertility through nitrogen fixation.*

Problems Addressed: *Soil erosion, declining crop yield, water use efficiency, water logging.*

iii. Natural Farming

A local low-input farming system that advocates the complete elimination of synthetic chemical agro-inputs by substituting it for formulations of natural and locally sourced inputs such as cow dung, cow urine, jaggery, and pulse flour. Natural farming includes mulching, cover cropping, and symbiotic intercropping. It is being practised in over 650,000 hectares across 11 states in India, with Andhra Pradesh as a forerunner. As of 2019, 580,000 farmers have adopted Zero Budget Natural Farming (ZBNF). Other forerunners are Gujarat, Madhya Pradesh, Kerala, and Chhattisgarh (Kumar 2020).

Applicable regions: *All (particularly rainfed and tribal regions), (DoAFW n.d.)*

Soil benefits: *Improve soil organic matter, stimulate microbial activity, and increase soil protection from soil-borne diseases.*

Problems Addressed: *Soil infertility, nutrient depletion, water pollution caused by chemical fertilisers, pest infestation, nutrient depletion, high cost of production.*

04

Vision and Goals of the National Roadmap for Sustainable Soil Management

The *'Amritva'* (immortality) of our *'maati'* (soil) must get rejuvenated in the *'Amrit Kaal'* (Immortal Age). The roadmap envisions that by the completion of *'Amrit Kaal',* i.e., India's vision for development for 2047, India's soil - a critical national asset:

- becomes regenerative and has thriving soil biodiversity,
- while ensuring food and nutritional security, climate change mitigation, and sustainable and resilient livelihoods.

It aims to achieve the vision

- via concerted and coherent action of multiple stakeholders in the water-land-food-health nexus.
- by capitalising on modern science and technology, and valuable traditional knowledge.

To scale sustainable and healthy soils in India, we must focus on both restoring degraded land, preventing land degradation and elevating the soil health of non-degraded land. Secondly, to ensure the necessary momentum to achieve the Vision 2047, we must identify concrete and ambitious milestones at reasonable intervals until 2047, e.g. 2030 and 2040. However, given the lack of sufficient baseline information on soil health, a critical precursor to setting milestones will also be to define what soil health means, build consensus on the indicators for assessing soil health, and enable precise baseline data. Therefore, while investing in baseline discovery, at this point we will have to start with a placeholder interim target for 2030.

As we think of the placeholder interim target, we must differentiate between productive and unproductive land because some land classes are naturally unproductive (dunes, periglacial, etc.). While dune stabilisation has found early success at the pilot level, such land classes remain challenging to transform and are not a target for the 2030 vision. Thus, it is necessary to define and scope the 'total land' in India and the land classes that should be aimed at under this roadmap. According to the latest land use data by MoAFW from 2021, India's total land is 328 million hectares. Out of this, 306 million hectares are under-utilised. Two land use classes - 'Barren and Unculturable Land' (16.6 million hectares) and 'Area put to Non-Agricultural uses' (27.7 million hectares) (Directorate of Economics and Statistics, MoAFW n.d.) - should further be excluded because these land types include lands which are extremely difficult to transform (dunes, periglacial, etc.) and land under built area, respectively. Thus, the 'total land' to be targeted under this roadmap should include a) the area under forest cover (71 million hectares), b) pastures and other grazing lands (10 million hectares) and c) agricultural land[9] (180 million hectares). The total area under these classifications is 262 million hectares (Directorate of Economics and Statistics, MoAFW n.d.).

Out of this, the total land degraded is 79.85 million, which is 30 per cent of the entire land that cuts across the land types included in this roadmap (Space Applications Centre, ISRO 2021). The three major[10] causes of land degradation in the above-targeted land are:

- **Water Erosion:** This refers to loss of soil cover due to surface runoff or rainfall, and the area it affects, as per the Degraded and Wastelands of India Report by NAAS, is 73 million hectares (NAAS & ICAR 2010). However, the total land degraded due to water erosion as per ISRO's estimates is 36 million hectares (Space Applications Centre, ISRO 2021)[11].
- **Vegetation degradation:** This refers to biomass or vegetative cover loss due to deforestation or overgrazing. The total land under degradation due to vegetation degradation is 30 million hectares, according to the Land Degradation and Desertification Atlas of India report by ISRO (Space Applications Centre, ISRO 2021).

[9] Agricultural land includes culturable wastelands, land under misc. crops, fallow land and net sown area
[10] Wind erosion which majorly is limited to unproductive land classes (sand dunes, periglacial, etc.) in Western Rajasthan, Gujrat and Ladakh, which are not being targeted for 2030
[11] In this bulleted list, the figures from the two reports are provided as a review of the prominent data sources in the literature. The figures are not for the purpose of mapping the trends over time

- **Soil Salinity/Alkalinity:** Saline soils are majorly found in irrigated areas. It refers to the water-soluble salt present in the soil. The main causes of high soil salinity are excess irrigation and indiscriminate use of fertilisers. India's total land with high soil salinity/alkalinity is 1.04 million hectares[12], according to the report by ISRO (Space Applications Centre, ISRO 2021). On the other hand, the NAAS report shows that land degradation due to highly sodic, acidic, and alkaline conditions is 10.3 million hectares (NAAS & ICAR 2010)[13].

This roadmap proposes a placeholder interim 2030 target of 50 per cent of the total land (under forest cover, pastures and other grazing lands and agricultural land) - 131 million hectares - to achieve regenerative and healthy state of the soil. As a preliminary strategy, the proposal is to target 50% of the degraded (~40mha) and undegraded land (~91mha[14]), so that we focus not only on restoring degraded land but also protecting the undegraded land and elevating its capability. Such a roadmap for scaling sustainable soil will help India deliver on multiple international commitments and domestic programmes linked with the food, land, and water nexus. Some relevant national/international plans/commitments are listed below:

- India has committed to restoring 26 million hectares at UNCCD COP in 2019 (MoEFCC 2022).
- India's pledge under its Nationally Determined Contributions includes creating an additional carbon sink of 2.5 to 3 billion tonnes through increasing forest and tree cover by 2030 (GOI 2015). To achieve this, increasing tree cover and area under forests remain key levers (FSI 2019).
- India's National Action Plan for Climate Change aims to bring 33% of the country's geography area under forests and tree cover (GoI 2008). As of 2020-21, the land covered under forests and tree cover in India is 24.62% (FSI 2021).
- India's outcome budget 2023-24 aims to bring 4.1 million hectares of land under crop residue management (MoF 2023).
- In 2022, India officially committed to becoming carbon neutral by 2070 (MoEFCC 2022). Sustainable soil management can play a critical role in helping India achieve its net zero target.
- To promote natural farming, the Union government has targeted to support 10 million farmers by FY 2026-27 (MoF 2023), covering approximately 10 million hectares of land[15].
- The concept of Land Degradation Neutrality (LDN) has been adopted as part of the 2030 Agenda for Sustainable Development and is enshrined in Target 15.3: "by 2030, combat desertification, and restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world".

Delivering successfully on the roadmap will require effective prioritisation of geographies/landscapes to be targeted under the roadmap out of 262 million hectares under forest cover, pastures and other grazing lands and agricultural land, and prioritisation of the initiatives relevant therein. The 'soil action' in different regions may be prioritised by assessing its potential feasibility/risks and impact.

Feasibility or risks

- **Technical feasibility:** Driven by the specific causes of soil degradation, the specific agroecological context and applicable solutions, the feasibility of 'soil action' in different regions will vary.
- **Risk to national priorities, particularly nutrition security and livelihoods:** E.g. initiatives such as scaling natural or organic farming or shifting to bio-inputs, which may reduce crop yields initially, pose low risks to nutrition security if targeted in the regions where land productivity is already low (e.g. significant portions of rainfed and tribal regions).
- **Alignment with domestic programmes and international commitments:** Regions that the Union and State Government target for other land-focused initiatives, such as the National Mission on Natural Farming and commitment to restore 26 million hectares of land under UNCCD, can be prioritised.

[12] Close to 2.6 million hectares of degraded land under saline soil is in the unproductive/barren salt marsh area of Gujarat. It has not been considered in this calculation because barren land is not being considered in this roadmap.
[13] As per the report, the area under alkaline, sodic and acidic soil is 2.63 million hectares, 2.60 million hectares and 5.08 million hectares respectively
[14] The target of 50% for the undegraded land will be revised as soon as baseline data becomes available. The need of baseline data and the prerequisites for achieving that have been discussed at the end of this section.
[15] Average land size per farmer has been taken as one hectare

Scale of Impact

Interventions on land degraded to higher levels can create more impact in restoring ecosystems, incrementing land productivity, livelihood generation, etc.

Additionally, soil assessments can be done in regions currently identified as non-degraded to holistically study soil health, including the levels of micro and macro-nutrients, land capability classification , soil biodiversity, etc. The regions that show a declining trend must be focused on through relevant interventions.

Further, given India's agroecological and socioeconomic diversity, the roadmap may be segmented into a manageable number of regional-focused components, and the baseline and the targets must be region-specific. Potential segmentation includes the following: coastal and island regions, Ghats (Western and Eastern), Plateau, Plains (IGP + Brahmaputra), northeastern hills, and Himalayan (Eastern and Western) region. Each component is integral to scaling a holistic and sustainable approach to soil management.

Given that multiple land classes are involved that are governed and/or impacted by and are essential for different ministries, this roadmap must become a multi-ministerial effort, involving the Ministry of Agriculture and Farmers' Welfare (MoAFW), Ministry of Rural Development (MoRD), Ministry of Panchayati Raj, Ministry of Fisheries, Animal Husbandry and Dairying Ministry of Forest, Ministry of Chemicals and Fertilizers, Environment and Climate Change, Ministry of Jal Shakti, Ministry of Cooperation, etc.

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[16] The land capability classification divides the land into two broad categories: Land suitable for cultivation and Land unsuitable for cultivation. Land suitable for cultivation is further categorised in: a) Land that contains highly productive soil and can sustain cropping throughout the year, b) moderately fertile land that can sustain

05

What can help achieve success in Vision 2030?

Many soil management practices (discussed in section 3) have scaled up in diverse regions of India, and they offer us learnings on "what" led to their scaling up. The roadmap builds upon these lessons to ensure that these 'success factors' can be activated nationally via public, private and non-governmental actors. The following is a summary of the identified success factors:

5.1 Enabling context-relevant technologies at scale

Technology (including traditional and modern soil management practices and systems, soil testing and various relevant digital and ICT technologies) that are appropriate for the agro-ecological, socio-economic, and cultural context of users of soil (e.g. farmers and farm workers.) see accelerated adoption. Developing or tailoring such technologies and ensuring awareness about them along with availability, accessibility, and affordability are crucial for scaling sustainable soil in India. The following can drive the successful development and adoption of context-relevant technology at scale:

- **Scaling innovation for every context:** Identifying traditional and novel ways of addressing key soil challenges must happen quickly across India's various agroecological, socio-economic, and cultural contexts. For example, the development of new machines and implements like the Happy Seeder for not just large but smallholder farmers, formulation of effective biostimulants like Jeevamrutam or Beejamrutam using locally available ingredients and livestock, simple and fast methods of monitoring and evaluation for soil biodiversity, etc.

  The NDDB has scaled up the demand and use of bio-slurry in farming by designing and making bio-slurry-applicators available and suitable for the region and smallholder farmers. However, beyond conventional research, development, and innovation; scaling innovation for every context will primarily require:

  a. Rethinking farmer/soil user as a potential innovator and identifying and validating solutions developed by them and co-creating new solutions. This will require enabling the proximity of innovators to the context-specific problems and the users during the innovation process.

  b. Capitalising on all available knowledge, including modern technology-based innovation and indigenous/traditional knowledge.

An example of the above two is the Andhra Pradesh Community-Managed Natural Farming Programme (APCNF), which includes bottom-up, context-specific innovations in its program design. The Community Resource Persons (CRPs) in APCNF have been trained to encourage, track, document and support the innovations being attempted by APCNF farmers across the state.

- **Scaling adoption in every context:** Given the diversity in agroecological, socio-economic, and cultural contexts in India, context-specific solutions and strategies will need to be implemented to drive awareness of issues and access to know-how, inputs, and various types of equipment and services. Using contextually appropriate awareness generation modules (preferably audio-visual content) coupled with contextually relevant dissemination approaches (e.g. peer-to-peer networks, lead farmers networks, locally popular digital platforms, local festivals, SHGs, KVK functionaries, etc.) will be critical. Innovative ways of encouraging the production of local AV content documenting ITK, particularly by local youth and the elderly, can accelerate awareness generation at scale while fostering a strong connection with the community. Similarly, access to contextually relevant inputs, equipment, and services can be accelerated by encouraging innovative business models, particularly those supporting decentralised development/ production.

5.2 Institutionalising 'soil action' in communities

Instituting and capacitating communities to make them self-reliant in decision-making and action towards better soil outcomes is another key success factor for scaling and sustaining soil action. The following enables institutionalising 'soil action' in communities:

- **Creating Community Leaders who Drive Sustainable Soil Management Agenda:** Making local influencers the soil champions is one way to do this. For instance, spiritual organisations like Art of Living are capitalising on the network of their spiritual teachers/trainers with the community's respect to promote ecologically suitable farming practices. Alternatively, those with traditional/indigenous knowledge or modern soil management expertise can be capacitated to become soil champions.
- **Strengthening and leveraging social capital:** Community institutions, informal and formal networks, etc., can help embed soil action in the community. Women's Self-Help Groups (SHGs) have been engaged by multiple CSOs and Union and State government programmes for driving the adoption of a variety of interventions and systems targeting soil management, such as crop rotation, natural farming, bio input production, village level seed banks, etc. Engineer and educator Sonam Wanghchuk's SECMOL Alternative Institute created an inter-village competition around an "ice-stupa" (an artificial glacier) to embed this water harvesting method in the Ladakh region.

> ***For instance, spiritual organisations like Art of Living are capitalising on the network of their spiritual teachers/trainers with the community's respect to promote ecologically suitable farming practices.***

5.3 Institutionalising 'soil action' in the Union and the State governments

Embedding 'soil action' within the existing policies, schemes, implementation plans or department missions by including sustainable soil management-related goals and strategies

can enable sustained government support at the Union and State level towards 'soil action' at scale. For instance, the Odisha government's decision to include finger millet or ragi in public procurement at MSP and distribution of ragi under the Public Distribution System (PDS) enabled crop diversification and millet production at scale. However, a suitable multi-departmental institutional structure will be critical to enable coordinated action of multiple relevant departments towards sustainable soil management.

For example, the Odisha Millet Mission (OMM) has established a high-powered steering committee led by the Principal Secretary (Agriculture) comprising senior officers from relevant departments for coordinated decision-making.

Discovering/creating 'soil action' championing officers and leveraging them will be critical to piloting or scaling the policy mentioned above. The success of OMM started with the championship of district collector Malkangiri, Odisha, to pilot the OMM in his district.

Similarly, in Meghalaya, the state leadership mandated that Village Employment Committees set up under National Rural Employment Guarantee Scheme (NREGS) have a Natural Resource Management Committee (NRMC). The NRMC promotes participatory planning of natural resource management activities under the NREGS. Thus, the NRMC helps with better utilisation of funds, promotes convergence across different state government initiatives, and generates community awareness.

In the Union government, leadership in the NRLM has been championing agroecology-based approaches and has launched large-scale initiatives such as Deen Dayal Antyodaya Yojana - Mahila Kisan Sashaktikaran Pariyojana.

Such initiatives promote convergence across different departments, promote local governance by encouraging participatory planning, and thus lead to more concerted efforts for natural resources management, in this case. Thus, institutionalising soil action at the State and the Union level will provide the necessary framework, resources, and regulations to support effective soil action by providing continuity and long-term commitment to soil action.

5.4 Making 'Soil Action' Financially Viable

Any actor, whether the user of soil (e.g. farmer, kitchen gardener, potter, etc.) or any other value chain actor having an indirect effect on soil management (e.g. input/service provider, the buyer of farm produce, Union and State governments, etc.) will adopt/promote sustainable soil management and continue doing the same only if it is financially viable. They have access to suitable financing to support necessary investments. The following can make 'soil action' financially viable at scale:

- **Recalibrating government support towards water-energy-food-health-ecosystems nexus:** For farmers, the economics of sustainable soil management are particularly influenced at scale by the Union and State government policies (e.g. subsidies on various forms of fertilisers and power, effective MSP on various crops, etc.). Therefore, it would be critical to harmonise various direct or indirect financial incentives/supports provided to farmers and other users of soil towards making sustainable soil management financially viable and unsustainable behaviour unviable. PM-PRANAM is being seen as a great starting point in this direction, which also has the potential to make soil action financially viable for the Union and the State governments by reducing expenditure on chemical fertilisers.
- **Enabling diverse incentives and sources of financing towards sustainable soil management:** Making diverse market-based incentives, such as carbon credits and soil health-linked green credits available and accessible can enable sustainable behaviour at scale. Ensuring legislation, particularly strengthening and enforcing existing ones, that penalise actions that harm soil health can also drive behaviour change at scale. Effectively diversifying funding sources to include funds available under CSR and climate financing and re-directing some of the unspent funds under national and state schemes can further address the gap in the funding required for scaling sustainable soil management across India.

> ***The economics of sustainable soil management are particularly influenced at scale by the Union and State government policies***

06

Actions Required by Stakeholders

Mainstreaming the sustainable soil agenda needs concerted and convergent actions from various stakeholders, including, but not limited to, the Union and State government departments, CSOs, research institutes, farmer organisations, private sector, development financial institutes, etc. Through the three regional consultations, we have identified four initiatives and mapped out the roles of relevant stakeholders.

6.1 Meri Maati Abhiyaan (MMA)

Given the scale of the challenge and the need for everyone's contribution in addressing the soil challenges, we need a multistakeholder 'movement' endorsed by the State and the Union for healthy soils. Similar to the 'Swacchha Bharat Abhiyaan', the Union and the State governments can institute and drive the Meri Maati Abhiyaan.

Mainstream action and convergence for soil across the relevant Union and State government ministries

a. **Elevate Healthy Soil as a key goal for relevant ministries by including soil health KPIs in ministry's mandate, programmes, and reporting**

Proposed stakeholders: MoAFW; MoJS; Ministry of Animal Husbandry, Dairying and Fisheries; Ministry of Health and Family Welfare; MoEFCC; Ministry of Mines; Ministry of Corporate Affairs; respective state governments departments, etc.

Relevant ministries and departments must integrate soil health as a Key Performance Indicator (KPI) within their mandates and operational framework. It will ensure concerted engagement of respective ministries towards sustainable soil management. For example, including soil health KPIs within the mandate of the Department of Fertilizers would promote the judicious use of chemicals. Similarly, incorporating soil health KPIs in the operational framework of irrigation departments of state governments would promote interventions to avoid excessive flooded irrigation.

Budgets are a reflection of the Union and State governments' priorities. Reporting the status of natural assets like soil in the national and state budgets would draw adequate attention to the problem, facilitate resource allocation, and encourage collaboration for soil health initiatives across various ministries.

b. **Ensure convergence within the state and with non-state actors towards healthy soil via suitable institutional structures**

Proposed stakeholders: Union and State Government ministries, administrative bodies such as district collectorates to ensure coordination of various government activities.

Given that the soil health impacts and gets impacted by multiple factors (fertilisers, groundwater pumping, livestock), various Union and State government ministries need to ensure coordinated action. Establishing multi-stakeholder platforms at different administrative levels can bring representatives of multiple ministries, farmers, KVKs, CSOs and other stakeholders together to address the soil health challenges at the local level.

c. **Foster personnel and technological capacities towards soil action across relevant Union and State government departments**

Proposed stakeholders: Union and state departments of agriculture, Directorate of Extension, Indian Council of Agriculture Research (ICAR), Indian Institute of Soil Science, State Agricultural Universities (SAUs), and Agriculture Technology Management Agency (ATMA)

Ensuring skilled human resources in the academia and Union and State government departments is critical to plan and operationalise soil management strategies at the ground level. Extension workers, SRLM/NRLM functionaries, and ATMA officials can be sensitised and trained on the importance of soil health in addition to data collection, management and reporting skills.

Training for the extension workers must focus on the importance of soil and the relevant management practices, as the current focus lies entirely on technology transfer for crop production. The National Institute of Agricultural Extension Management (MANAGE), with the support of their regional set-ups and other state-level extension education institutes, can ensure regular knowledge updates, particularly covering emergent context-specific insights, to extension workers and KVKs. Similarly, local waste management authorities can be trained and equipped with adequate infrastructure to turn wet waste into compost for farmers.

Adequate human capital in academia and the Union and State government departments can also be ensured to provide last-mile delivery of soil management practices to farmers. The current ratio of 1 extension officer for every 1162 farmers, as opposed to the recommended ratio of 1:750, further highlights the issue (Nandi and Swamikannu 2019).

Establishing soil as a critical national strategic asset and treating 'soil security' as a national issue

a. Mainstreaming and expanding natural capital accounting and valuation of ecosystem services in India to deeper coverage of soil

Proposed stakeholders: MoAFW, MoSPI, MoEF&CC, National Remote Sensing Centre (NRSC).

MoSPI, in close collaboration with MoEFCC and NRSC, has developed the System of Environmental-Economic Accounting - Ecosystem Accounting (SEEA EA). The SEEA EA can show human/anthropogenic impact on ecosystem services over time in a way that is compatible with traditional national accounts and comparable across countries. SEEA EA covers soil under the valuation of forest and cropland. While actively mainstreaming SEEA EA for policy making in India, we need to enhance the understanding and coverage of soil health issues within SEEA EA. MoSPI can also deepen the soil coverage in its annual report on India's environmental accounts, "EnviStats India".

b. Introducing a National Soil Act

Stakeholders involved: Members of Parliament and CSOs working on the soil agenda

Following the model of the Water (Prevention and Control of Pollution) Act, 1974, a National Soil Act can address the restoration and conservation of soil resources, aiming to prevent or mitigate soil erosion and degradation.

Enable convergence for soil action between the CSOs and the local government bodies

a. Develop a platform for grassroots organisations to enable coordinated soil action

Proposed stakeholders: Local government bodies, Donor agencies, and CSOs

Establish a platform that can help CSOs working on soil and allied sectors (Agriculture, Water and Sanitation, Health, Public Works, etc.) to synergise amongst themselves, prevent duplication of efforts, and improve their coordination with public institutions within the jurisdictions (Gram Panchayats, blocks, districts, etc.) they work in.

Procure local and diverse produce in the Union and State Government programmes to enhance crop biodiversity on agricultural land.

Proposed stakeholders: Food Corporation of India; Ministry of Consumer Affairs, Food and Public Distribution; Ministry of Women and Child Development; Ministry of Education; Indian Railways, and other state government agencies.

Plant diversification above the soil is directly linked to biodiversity in the soil (Cappelli et al 2022). To promote biodiversity-rich soils, the Union and the State governments can procure local and diverse food groups under the PDS starting with millets, pulses, fruits, and vegetables.

This locally procured produce can also be included in various Union and State government programs including Anganwadi, mid-day meals, government and railway canteens. This will encourage the cultivation of local, resource-efficient crops more suited to the local climate while improving the food and nutritional security of the consumers.

Facilitate context-specific technology adoption in diverse contexts across India.

Proposed stakeholders: Research institutions, Farmers collectives, Agri extension workers, KVKs, National Institute of Agricultural Extension Management (MANAGE), and regional and state-level extension education institutes

a. **Ensure dissemination of context-specific technologies**

Extension services are one of the primary conduits of information delivery to the farmer. Government extension systems at different levels (ATMA, KVK, etc.) and research institutions can enable awareness, affordability, and accessibility of tools/equipment and farming methods designed/modified for each agroecological and socioeconomic context. Awareness programmes, technical manuals developed in regional languages, and field demonstrations can further facilitate this initiative. But more importantly, this will require equipping agri-extension personnel with context-specific scientific knowledge on soil health.

b. **Seed Banks**

Indigenous seeds can support below-ground biodiversity and soil health (Devra et al. 2011) (IUCN 2023) due to their superior nutrient retention capability, lower fertiliser/pesticide requirements, and adaptability to the local terrain (Joshi 2021) Establishing community seed banks can help gather, revive, and propagate ethnic varieties at the local level, providing local farmers easy access to indigenous seeds.

c. **Encourage peer-to-peer learning and demonstration of successful practices by lead farmers**

Proposed stakeholders: Lead farmers and farmers' collectives.

Farmers must be encouraged to use tools and technologies for soil management to reduce time and manual labour. Demonstrating successful practices by the youth and the lead farmers in the villages through field demonstrations and audio-visual tools can facilitate this.

Formulate, align and institutionalise soil health KPIs.

Proposed stakeholders: Soil scientists, research institutions, and international organisations.

a. **Drive consensus on the definition of "healthy soil" and indicators to measure it**

Since soil has physical, chemical and biological properties and soil science is still emerging, there is a need to build consensus on the definition and key indicators of "healthy soil." New-age science shows biology's critical and foundational role in soil health (FAO 2020). Scientists, policymakers, and agricultural experts play an important role here. Adopting standardised and consistent KPIs for soil would ensure concerted action.

6.2 Making 'Meri Maati Abhiyaan' a People's Movement

Make soil action a people's movement to inspire and empower communities to engage and act towards healthy soils. Through adaptive governance structures, this strategy emphasises promoting soil health awareness among children and youth, creating dignified job opportunities in soil health, and fostering grassroots involvement of communities.

Recognise and create soil champions and promote aspirational 'soil jobs' in the rural economy.

Proposed stakeholders: MoRD, MoAFW, Ministry of Labour and Employment, respective state government ministries etc.

a. Recognising and incentivising local practitioners (farmers and others) and influencers implementing or promoting healthy soil practices

It is important for people, especially the agricultural community, to 'feel' a part of the 'soil movement' in the country, where they voluntarily take up sustainable practices.

To accomplish this, the Union and the State governments can identify and incentivise lead farmers who have successfully implemented soil management practices to disseminate the importance of soil health within the local community. Field demonstrations in local languages and farmer field schools can also help encourage a voluntary uptake of sustainable soil-related practices. Additionally, interventions in input supply chains can be explored to incentivise farmers to adopt healthy soil practices.

b. Create and scale the aspirational jobs of 'Soil Stewards' across Indian villages

While lead farmers generate awareness of successful soil management practices, there will remain a significant need for research, support, coordination, and relationship management functions/roles for making MMA an effective people's movement. The lead farmers, local CRPs, and other local government functionaries cannot just deliver these demanding roles. This creates an opportunity to carve out an 'aspirational' job of a 'Soil Steward' for local youth (men or women). Such youth, potentially graduates, can become the Points of Contact (PoC) of the local government to champion and coordinate all the soil-related activities in the Gram Panchayat, from running field experiments to collating best practices to guiding CRPs to creating audio-visual content.

They can be evolved into a national cadre/community of Soil Stewards. With one Soil Steward per Gram Panchayat, this roadmap can generate 250k+ jobs for rural youth.

Strengthening the community's cultural/emotional connection with soil

a. Featuring success stories and documentaries highlighting historical ties with the land.

Proposed stakeholders: MoAFW, Ministry of Information and Broadcasting, respective departments at the state level, Digital Media, Public Broadcast channels like Doordarshan, All India Radio, etc.

This fosters a sense of belonging and responsibility, promoting sustainable soil practices. The rural youth can be encouraged to take up farming as a career option by showcasing case studies of successful farming practices and demonstrating farming as a profitable enterprise. Taking up farming as a career option would reduce the diversion of agricultural land, leaving the productive land fallow (reducing in quality in the long run), and even check migration from agricultural settings.

The community's affection for their natural resources, especially soil, must be revived and fostered to develop a sense of belonging and responsibility to promote sustainable soil practices. Documentaries highlighting the ties of the community with their lands, featuring success stories of the community, etc., can help achieve this.

b. Engaging spiritual institutions

Proposed stakeholders: Spiritual institutions, local communities, etc.

Spiritual institutions, such as the Isha Foundation, which led a global movement for saving soil, can play an important role in fostering a sense of environmental stewardship and promoting a holistic connection to nature, contributing to the overall well-being of soil health.

Sensitise children and youth on Healthy Soil via educational institutions

Proposed stakeholders: Ministry of Education, National Council of Educational Research and Training (NCERT), Education departments at the central and state government level, Schools, Colleges, CSOs.

Children and youth play a crucial role in nation-building. Through children, many houses and the community in general can be influenced.

a. **Include content on the importance of "healthy soil" in school and college curricula**

   'Sustainable soil management', its importance and linkages with the economy, environment, society and SDGs can be included in the curriculum[17].

b. **Institute visits to farmer field schools, gardening periods, etc. for exposure and practical agricultural knowledge, especially soil management**

   In addition to the curriculum, practical sessions on soil health and related practices can be organised in schools and colleges. Practitioners in agriculture or soil management can conduct these sessions. School gardens and community agriculture zones can be leveraged to provide a hands-on experience to the children.

c. **Conduct school/college level campaigns on healthy soil.**

   Schools and colleges can conduct campaigns on healthy soil, akin to initiatives like the Swachh Bharat Abhiyaan. These efforts would empower students to be flagbearers of change and ambassadors of healthy soil, instilling a sense of environmental and social responsibility.

Strengthen and expand local governance and leadership for local bioresource governance and soil action

Proposed stakeholders: Ministry of Panchayati Raj, MoRD, Ministry of Mining, respective state government ministries, MoEFCC, Village panchayats, CRPs, Agri Extension departments, Public Works Department, Union and State level regulatory bodies, legislators, and media.

Local governance must be strengthened to ensure sustained action towards soil health. This involves embedding soil health in the local governance agenda. This can be achieved by integrating soil health into the mandates and plans of the established local governance initiatives, including the Gram Panchayat Development Plan (GPDP) and water security planning and biodiversity management committee.

Based on the local socio-political context, a new local institution for governing soil can be established for targeted action. Meghalaya's Village Natural Resource Management Committee (VNRMC), established under a community-led landscape management project, is an example of such an institution. The VNRMC directly executes projects related to natural resource management and has three village community facilitators (VCF) to support the implementation (Meghalaya Basin Management Agency 2020).

6.3 Recalibrate incentives for value chain actors to achieve healthy soil

By aligning the economic incentives for farmers, CSOs, and the private sector towards achieving healthy soil, this strategy aims to promote a shared commitment towards achieving soil health outcomes.

[17] In a review meeting on the implementation of NEP 2020, there were suggestions that the secondary schools with science labs must engage with the farmers to help them create awareness about the quality and health of the soil through soil testing.

Incentivise farmers to adopt soil management practices

Proposed stakeholders: MoAFW and the ministries of agriculture in states, Ministry of Chemicals and Fertilizers, CSOs, Bureau of Energy Efficiency, insurance companies, and financial institutions.

a. **Leverage Union and State government support for farmers to encourage the adoption of sustainable soil management.**

Farmers can be incentivised to adopt soil management practices through increased financial Incentives such as increased cash transfer (under the PM KISAN scheme) or targeted direct benefit transfer to those farmers who reduce chemical fertiliser usage (under the PM PRANAM scheme).

The Union Government can create additional incentives by linking carbon credit and the National Green Credit scheme towards soil health.

Incentivise the private sector to promote healthy soils

a. **Incentivise through tax incentives and low-interest loans**

Proposed stakeholders: Private sector institutions, agricultural ministries at the Union and State levels, Ministry of Commerce, Confederation of Indian Industries.

As the private sector plays an important role in providing a variety of inputs and services to farmers, they can be incentivised to promote soil health. Mechanisms including tax incentives and low-interest loans, can be explored to promote the private sector to develop low-cost soil testing, invest in research and development for equipment design, and innovate on citizen science for soil health mapping, etc.

b. **Incorporate soil health outcomes in the Environmental, Social, and Governance (ESG) reporting of corporations in the food, agriculture and FMCG sectors**

Proposed stakeholders: Ministry of Corporate Affairs, investors, advisory and consultancy firms, credit rating agencies

To enhance private sector engagement towards healthy soils, relevant companies can integrate soil health into their business evaluations and ESG reporting. Integrating soil health into ESG reporting requirements through regulatory bodies like the Securities and Exchange Board of India (SEBI) can help foster the private sector's commitment to healthy soil. Additionally, the Union and State could nudge CSR investments towards healthy soil by showcasing soil as an influential agenda for the government.

Align philanthropic community to focus on healthy soil

a. **Establish a donor alignment platform.**

Proposed stakeholders: Philanthropies and organisations shaping philanthropic agendas

While reasonable philanthropic resources are going into the agriculture sector, these are often diffused between multiple schools of thought and focus areas in agriculture. A donor alignment platform would be a collaborative space for philanthropies to align their efforts towards the common goal of soil health, thereby preventing diffused efforts. It can also facilitate coordinated funding from multiple donors for more synergistic outcomes.

6.4 Soil Innovation and Evidence Generation

Targeted evidence generation is critical to support the scale-up of context-appropriate solutions for healthy soil. Fostering innovation and regular evidence and learning agenda in soil practices, inputs, funding, and governance would help further healthy soil strategies more effectively.

Enable data and evidence ecosystem for targeted intervention

a. Develop a national database documenting soil management practices

Proposed stakeholders: MoSPI, MoAFW, Ministry of Tribal Affairs, Ministry of Panchayati Raj and respective state government ministries, research institutions, and local communities, space agencies, etc.

A crowd-sourced but moderated, national-level database may capture successful field, landscape, and system-level approaches/initiatives for soil management, including Indigenous Traditional Knowledge (ITK) across India. Information on the Package of Practices, techniques employed, required materials/equipment, and suitable geographies can be accessible through a user-friendly database.

In addition to information on practices, dashboards can provide soil priority maps to identify areas facing severe land degradation to facilitate targeted resource allocation. One such example of a knowledge system initiative is the Asian Soil Information Systems, put together by the Global Soil Partnership in its Regional Implementation Plan (2016)[18].

b. Harmonise and integrate data from multiple sources on various soil-relevant disciplines

Proposed stakeholders: MoAFW, MoJS, Ministry of New and Renewable Energy, and respective state-level ministries.

Harmonise and integrate data on soil (degradation, desertification, fertility etc.) across multiple existing institutions that are currently working in isolation, such as ICAR, SAUs, NBSS-LUP, ISRO, and Soil Survey of India.

The information from these datasets could be integrated to create a bio-indicators based soil index linking physicochemical properties with biological properties to assess soil health. Digital tools like AI/ML/IoT can be leveraged in the creation of the soil index.

Agri Stack can incorporate the latest harmonised dataset to ensure easy access to soil information to all stakeholders, from soil scientists to FPOs.

Establish mechanisms to strengthen knowledge co-creation and exchange between researchers, extension workers, and farmers on soil health.

a. Set up and strengthen local knowledge exchange institutions for bottom-up and peer-to-peer knowledge transfer.

Proposed stakeholders: MoAFW and respective state government ministries, Extension officers, Farmer Field Schools, and KVKs.

The Union and State governments can facilitate such a knowledge exchange by creating block-level institutions such as Agroecological Learning Centres (ALCs) to disseminate farmers' knowledge of soil and agroecological practices. ALCs can also collate and communicate bottom-up innovations to the research community.

Local knowledge exchange institutions can also facilitate the co-creation of region-specific soil health management strategies by involving the local communities in designing and implementing initiatives tailored to their unique environmental and cultural contexts. This can help in adopting soil management practices suited to their local needs.

b. Support infrastructure for soil evidence generation

Proposed stakeholders: MoAFW and respective state government ministries, ICAR, SAUs, private investors, research institutions, soil scientists, etc.

c. Enable decentralised soil testing through Biolabs

Invest in decentralised soil testing laboratories to inform soil health strategies based on the local conditions. The Union and the State governments can invest in localised lab facilities to provide a variety of quality tests on soil, seeds, pest control and water. This would empower farmers to make swift decisions.

[18] "Report of the Third Asian Soil Partnership Workshop: Towards a Regional Implementation Plan for Asia" (Rome: FAO, 2016), https://www.fao.org/3/br396e/br396e.pdf.

d. Support farmers' capacity building on soil self-assessment

Besides setting up local labs, enable farmers and extension workers to self-assess soil quality using lean methods like observing texture, compaction, and fauna presence.

Support innovation and entrepreneurship towards healthy soils

Proposed stakeholders: Ministry of Micro, Small and Medium Enterprises, Ministry of Commerce, Department for Promotion of Industry and Internal Trade, State-level Ministries of Commerce, Investors, Startups, Private sector agencies, agri-businesses, Ministry of Science and Technology, Department of Scientific and Industrial Research

a. Support entrepreneurs enabling context-relevant inputs, equipment, and services for healthy soils

Initiatives like the Atal Incubation Centres (AICs) and privately supported incubation centres can have dedicated funds for soil-focused startups. They can support entrepreneurs to build scalable and sustainable enterprises focusing on soil health, including tools/machinery for bio inputs, etc.

b. Incentivise research and development for soil-related technology

Encourage the development of tools/machines for labour-intensive soil health management practices. Technology startups and R&D institutions must be encouraged to develop tools and machines to reduce human drudgery and labour costs.

2023	2025	2028	2030
Initiative 1: Meri Maati Abhiyaan			
Mainstreaming soil action and enabling convergence across relevant Union and State government ministries	Elevating Soil Health as a key goal for relevant Union and State government ministries via including soil health KPIs in ministries' vision and mission statement, reports/assessments, programmes, and schemes **Stakeholders involved: Ministry of Agriculture and Farmers' Welfare; Ministry of Jal Shakti; Ministry of Animal Husbandry, Dairying and Fisheries; Ministry of Health and Family Welfare; Ministry of Environment, Forest, and Climate Change; Ministry of Mines; Ministry of Corporate Affairs; respective state governments departments, etc.** Foster personnel and technological capacities towards soil action across relevant Union and State Government ministries. **Stakeholders involved: Ministry of Agriculture at the Union and State levels, Directorate of Extension, Indian Council of Agriculture Research, Indian Institute of Soil Science, State Agricultural Universities, Agriculture Technology Management Agency, etc.**	Ensure convergence within the state and with non-state actors towards healthy soils via suitable institutional structures. **Stakeholders involved: State government departments and administrative bodies such as district collectorates**		

	2023	2025	2028	2030
Establishing soil as a critical national strategic asset and treating 'soil security' as a national issue	Mainstreaming and expanding natural capital accounting and valuation of ecosystem services in India to deeper coverage of soil **Stakeholders involved: Ministry of Agriculture and Farmers' Welfare, Ministry of Statistics and Programme Implementation, Ministry of Jal Shakti, respective state government departments**		Introducing a National Soil Act **Stakeholders involved: Members of parliament, Members of Legislative Assembly, CSOs working on the soil agenda**	
Enable convergence for soil action between CSOs and the local government	Develop a platform for grassroots organisations to enable coordinated soil action **Stakeholders involved: Local government bodies, Donor agencies, and CSOs**			
Procure local and diverse produce in the Union and State government programmes to enhance crop biodiversity on agricultural land.		Procure local and diverse produce in the Union and State government programmes to enhance crop biodiversity on agricultural land **Stakeholders involved: Food Corporation of India, Ministry of Consumer Affairs, Food and Public Distribution, state governments' procurement agencies, etc.**		
Facilitate context-specific technology adoption in diverse contexts across India	Ensure dissemination of context-specific technologies **Stakeholders involved: Research institutions, farmers' collectives, agriculture extension workers, KVKs, National Institute of Agricultural Extension Management (MANAGE), other regional and state-level extension education institutes** Encourage peer-to-peer learning and demonstration of successful practices by lead farmers **Stakeholders involved: Lead farmers, Farmers' collectives**	Seed Banks **Stakeholders involved: Research institutions, farmers collectives, agriculture extension workers, KVKs, National Institute of Agricultural Extension Management(MANAGE), other regional and state-level extension education institutes**		
Formulate, align and institutionalise soil health KPIs	Drive consensus on "healthy soil" definition and indicators to measure it Stakeholders involved: Soil scientists, research institutions, and international organisations			

2023	2025	2028	2030
Initiative 2: Making 'Meri Maati Abhiyaan' a People's Movement			
Recognise and create soil champions and promote aspirational 'Soil Jobs' in the rural economy	Encouraging adoption of soil health practices by recognising and incentivising local practitioners (farmers and others) and influencers implementing or promoting the best practices **Stakeholders involved: Ministry of Rural Development, Ministry of Agriculture and Farmers' Welfare, Ministry of Labour and Employment, respective state government ministries, etc.** Create and scale the aspirational jobs of 'Soil Stewards' across Indian villages **Stakeholders involved: Ministry of Rural Development, Ministry of Agriculture and Farmers' Welfare, Ministry of Labour and Employment, respective state government ministries, etc.**		
Recognise and create soil champions and promote aspirational 'Soil Jobs' in the rural economy	Featuring success stories and documentaries highlighting historical ties with the land **Stakeholders involved: Ministry of Information and Broadcasting, Digital Media (public broadcast channels like Doordarshan, All India Radio etc.)** Engaging spiritual institutions **Stakeholders involved: Spiritual institutions, local communities etc.** Include content on the importance of "healthy soil" in school and college curricula. **Stakeholders involved: Ministry of Education, National Council of Educational Research and Training (NCERT), Education departments at the central and state government level, Schools, Colleges, CSOs**		

	2023	2025	2028	2030
Sensitise children and youth on Healthy Soil via educational institutions	Institute visits to farmer field schools, gardening periods, etc. in schools for exposure and practical agricultural knowledge especially soil management **Stakeholders involved: Ministry of Education, Schools, Colleges, CSOs** Conduct school/college level campaigns on healthy soil **Stakeholders involved: Ministry of Education, Schools, Colleges, CSOs**			
Strengthen and expand local governance and leadership for local bioresource governance and soil action		Strengthen and expand local governance and leadership for local bioresource governance and soil action **Stakeholders involved: Ministry of Panchayati Raj, MoRD, and respective state government ministries, MoEFCC, Village panchayats, CRP, Agriculture Extension Department, Ministry of Mining, Public Works Department, Union and State Government regulatory bodies, legislators, and the media**		
Initiative 3: Recalibrate Incentives for Value Chain Actors to Focus on Healthy Soils				
Incentivising farmers to adopt soil management practices	Leverage the Union and the State government support for farmers (subsidies, etc.) to encourage adoption of sustainable soil management **Stakeholders involved: Ministry of Agriculture and Farmers' Welfare and respective state government ministries, Ministry of Chemicals and Fertilizers, CSOs, Bureau of Energy Efficiency, Insurance companies, Financial institutions**			
Incentivise the private sector to promote healthy soils	Incentivise through tax incentives and low-interest loans **Stakeholders involved: Private players, Ministry of Agriculture and Farmers' Welfare, Ministry of Commerce, Confederation of Indian Industries**	Incorporate soil health outcomes in the Environmental, Social, and Governance (ESG) reporting of corporates in food, agriculture and the FMCG sector **Stakeholders involved: Ministry of Corporate Affairs, Investors, Advisory and Consultancy firms, Credit rating agencies**		

	2023	2025	2028	2030
Align philanthropic community to focus on healthy soils	Establish a donor alignment platform **Stakeholder involved: Philanthropies and organisations shaping philanthropic agendas**			
	Initiative 4: Soil Innovation and Evidence Generation			
Enabling data and evidence ecosystem for targeted intervention	Develop a national database of soil management practices **Stakeholders involved: Ministry of Statistics and Programme Implementation, Ministry of Agriculture and Farmers' Welfare, Ministry of Tribal Affairs, Ministry of Panchayati Raj and respective state government ministries, Research Institutions, Local communities, etc.**	Harmonising and integrating data from multiple sources on various soil-relevant disciplines **Stakeholders involved: Ministry of Agriculture and Farmers' Welfare, Ministry of Jal Shakti, Ministry of New and Renewable Energy, and respective state-level ministries.**		
Establish mechanisms to strengthen knowledge exchange and co-creation between research and extension institutions and farmers	Setting up and strengthening local and traditional knowledge exchange institutions for upward (bottom-up) and lateral (peer-to-peer) knowledge transfers **Stakeholders involved: Ministry of Agriculture and Farmers' Welfare and respective state government ministries, Extension officers, Farmer Field Schools, KVKs, State-level Ministries of Agriculture**			
Infrastructure for evidence building	Enable decentralised soil testing through Biolabs **Stakeholders involved: Ministry of Agriculture and Farmers' Welfare and respective state government ministries, Indian Council of Agricultural Research, State Agricultural Universities, Private investors, Research institutions, soil scientists, etc.** Capacity building on self-assessment **Stakeholders involved: CSOs that engage with local communities, lead farmers, extension officers etc.**			

	2023	2025	2028	2030
Support innovation and entrepreneurship towards healthy soils	Incubation centres for rural entrepreneurs to enable access to context-relevant inputs, equipment and services **Stakeholders involved: Ministry of Micro, Small and Medium Enterprises, Ministry of Commerce, Department for Promotion of Industry and Internal Trade, State level Ministry of Commerce, Investors, Startups, Private sector agencies, and Agri-businesses** Incentivise Research and Development for soil-related technology **Stakeholders involved: Ministry of Science and Technology, Department of Scientific and Industrial Research, Investors, Startups, Private sector agencies, and Agri-businesses**			

07

Mainstreaming Soil in National Policies

This section aims to identify government policies at the Union level influencing soil health and suggest potential linkages (as indicated in the literature) to enhance actions towards healthy soil. The policies shortlisted are from four departments - the Ministry of Agriculture and Farmers' Welfare (MoAFW), the Ministry of Jal Shakti (MoJS), the Ministry of Chemicals and Fertilisers (MoCF), and the Ministry of Rural Development (MoRD). Annexure 2 provides a detailed methodology for the shortlisting exercise.

7.1 Policies of Department of Agriculture and Farmers' Welfare (DoAFW) linked with Soil Health

National Mission on Natural Farming (NMNF)

(FY 2023-24 Budget Allocation – INR 459 crore) (MoF 2023)

The scheme creates an enabling structure for the adoption of natural farming by promoting integrated agriculture-animal husbandry models utilising on-farm resources and dissemination of best practices.

Linkages with Soil:

- NMNF promotes bio-inputs instead of chemicals, intending to improve soil aeration and fertility.
- Provides for regular soil testing to track changes in soil health (DoAFW 2022).

Recommendations:

- Through this mission, the Union government needs to promote research and studies for developing standards and protocols for biofertilisers and biopesticides and conducting field trials and demonstrations. It can also establish a few facilities, monitor production, and check its efficacy (Khurana & Kumar 2022).
- The government can promote time-tested interventions like producing phosphate-rich organic manure as biogas slurry, green manuring, utilising crop residue for organic cultivation, and using field trials to measure their impact.

Agriculture Infrastructure Fund (AIF)

(FY 2023-24 Budget Allocation – INR 500 crore) (MoF 2023)

The scheme aims to mobilise investment in agriculture infrastructure through long-term debt financing in viable projects for post-harvest management infrastructure and community farming assets through incentives and financial support.

Linkages with Soil:

- Concessional loans and credit support are provided for organic input production, bio-stimulant production and precision agriculture. These activities positively impact soil health, and the incentives under this scheme can promote their uptake (MoAFW 2020).

Rashtriya Krishi Vikas Yojana (RKVY)

(FY 2023-24 Budget Allocation - INR 7,150 crore) (MoF 2023)

RKVY is an umbrella scheme with missions like Soil Health and Fertility, Rainfed Area Development, Paramparagat Krishi Vikas Yojana, Per Drop More Crop, National Project on Agro-forestry, Crop Diversification Programme, etc. The scheme aims to make farming remunerative, promote agri-entrepreneurship, and strengthen supply chains (MoAFW 2017).

Following are the Mission-wise linkages with soil:

- Soil Health and Fertility (DoAC 2008)
  - Assist farmers with soil health testing and distributing soil health cards.
  - Establish soil testing laboratories and strengthen existing soil test laboratories.
  - Encouraging terracing, gully control measures, check dams, diversion drains, etc.
  - Reclaiming problem soils by providing monetary assistance for inputs required for treating the soil.
- Rainfed Area Development (RAD)
  - RAD promotes soil productivity through crop diversification and crop rotation and increasing soil cover (mulching) periods, which is essential to enhance the soil's organic matter.
  - Developing location-specific innovations and enhancing farmers' knowledge and management skills towards regenerative integrated farming systems (MoAFW n.d.).
- Paramparagat Krishi Vikas Yojana
  - Promotes using organic fertilisers and crop rotation through subsidies.
  - Encourages, via subsidies, the use of natural inputs like neem cakes to increase soil fertility (Department of Administrative Reforms and Public Grievances 2017).
- Per Drop More Crop
  - Promotes drip irrigation, which prevents loss of nutrients due to surface run-off in flood irrigation (MoAFW 2023)
- National Project on Agroforestry (DoAFW 2016)
  - Promotion and adoption of agroforestry prevents soil erosion, helps retain soil moisture, and enriches the soil with organic matter.
  - Under the scheme, it is mandatory for a farmer to have a soil health card to track the nutrient status of the soil.
- Crop Diversification Program
  - The programme aims to shift paddy and tobacco farmers to diversify their crops by alternating with leguminous crops to restore soil fertility, which takes fewer nutrients from the soil (PIB 2020).

Recommendations from the literature:

- Soil health and Fertility
  - Include some qualitative indicators such as 'improvement in production/productivity from the adoption of recommendations', 'time taken from a collection of samples to the issuance of soil health card', etc.
  - Aim to strengthen linkages of Soil Test Labs with research institutions like ICAR and State Agriculture Universities. This can improve the quality of services and reduce the time taken to provide test results, etc (NITI Aayog 2020).
- Paramparagat Krishi Vikas Yojana
  - Provide monetary incentives to the farmers adopting organic farming in the initial 3-5 years to support them during the transition.
  - Establish organic input shops and build the capacity of farmers on the technical front.
  - Encourage Eco-agritourism in organic farming clusters to supplement the income from organic farming (NITI Aayog 2020).
- Per Drop More Crop
  - Simplify the application process and ensure farmers receive timely maintenance and repair services. This will help include more smallholder farmers in the subsidy allocation process for drip irrigation.
  - Explore ways to reduce the cost of installation of irrigation equipment to encourage more farmers to adopt this technology (Tripathy et al., 2023).

Mission on Integrated Development of Horticulture (MIDH)

(FY 2023-24 Budget – INR 994 crore) (MoF 2023)

The scheme aims to augment farmers' income and improve nutritional security by encouraging horticulture. Furthermore, it focuses on the efficient use of water and improving productivity by providing high-quality planting material.

Linkages with Soil:

- Provides financial support for soil solarisation, which can kill unwanted pathogens in the soil.
- Promotes precision farming, which regulates the number of inputs required and keeps the soil health indicators in check.
- Monetary incentive of Rs. 10,000 per hectare is transferred to organic farmers who cultivate vegetables (MoAFW 2014).

Formation and Promotion of 10,000 FPOs Scheme

(FY 2023-24 Budget – INR 955 crore)

The scheme enables the formation of Farmer Producer Organisations and assists in establishing market linkages for their produce, which increases the income of the members.

Linkages with Soil:

- Assistance forming FPOs in regions with prevalent organic and natural farming.
  These FPOs help create market linkages for organically produced crops, increasing the uptake of organic farming. (MoAFW 2020)

7.2 Policies of DoAFW linked with Agriculture but not with Soil Health

Pradhan Mantri Fasal Bima Yojana (PMFBY)

(FY 2023-24 Budget – INR 1.36 lakh crore) (MoF 2023)

The scheme aims to provide security against natural disasters leading to loss of crops by insuring farmers' produce at a subsidised premium rate. Moreover, it encourages farmers to adopt innovative practices, diversify their crops and stabilise farmer incomes to ensure their continued farming. (MoAFW 2020)

Pradhan Mantri Kisan Samman Nidhi (PM KISAN)

(FY 2023-24 Budget – INR 6 lakh crore) (MoF 2023)

Under this scheme, Rs. 6,000 are provided annually to supplement the financial needs of all landholding farmers' families in procuring various inputs to ensure proper crop health and appropriate yields commensurate with the anticipated farm income as well as for domestic needs (MoAFW 2020).

7.3 Policies of Ministry of Jal Shakti

Pradhan Mantri Krishi Sinchayee Yojana

(Command Area Development, *Har Khet Ko Paani* and Accelerated Irrigation Program)

(FY 2023-24 Budget Allocation – INR 8.59 thousand crore) (MoF 2023)

The scheme focuses on improving irrigation efficiency, providing an assured supply of water to every farm field and bringing the cultivable area under assured irrigation. It also promotes the adoption of precision irrigation by attracting private investment.

Linkage with Soil:

- Creating and rejuvenating traditional water storage systems like Jal Mandir, Khatri, Zabo, Eri, Ooranis, Dongs and Katas to prevent surface runoff and soil erosion (Ministry of Jal Shakti 2017).

Recommendations:

- In some of the developed command areas, the water table is rising to 0.3 metres due to misuse of water for irrigation. This poses a risk of water logging and decreases soil fertility. Canal lining prevents seepage and improves the water table in problematic areas (NITI Aayog 2020).

Namami Gange Mission

(FY 2023-24 Budget Allocation – INR 4000 crore) (MoF 2023)

The Vision for Ganga Rejuvenation constitutes restoring its 'wholesomeness' by ensuring "Aviral Dhara" (Continuous Flow), "Nirmal Dhara" (Unpolluted Flow"), Geologic and Ecological Integrity of the river.

Linkages with Soil:

- The programme involves desilting ponds, kunds and other water bodies and constructing embankments that prevent flooding and soil erosion.
- It also promotes afforestation, which helps in maintaining soil organic matter and soil moisture.
- The mission has initiated a programme of organic farming on a 5-kilometre stretch along both sides of the Ganga (Ministry of Jal Shakti 2020).

Atal Bhujal Yojana

(FY 2023-24 Budget Allocation – INR 1000 crore) (MoF 2023)

This convergence scheme is implemented in states where groundwater has reached critical depths. It aims to change behaviour at the ground level through awareness and capacity building to enable sustainable groundwater management.

Linkage with Soil:

- The scheme promotes mechanisms of micro-irrigation (sprinkler and drip), which are better than flood irrigation for soil health as it prevents waterlogging and nutrient leaching (Ministry of Jal Shakti 2020).

7.4 Policies under the Department of Fertiliser linked with Agriculture and Soil Health

Nutrient-Based Subsidy

(FY 2023-24 Budget – INR 44,000 crore) (MoF 2023)

The policy makes fertilisers affordable for farmers. The subsidy on fertiliser is given to manufacturers/importers based on the nutrient contents of the fertiliser. The subsidy is provided for nutrients like Phosphorus (P), Potash (K), Nitrogen (N) and Sulphur(S) as well as micronutrients Zinc (Zn) and Boron (Br).

Linkage with Soil:

- By subsidising fertilisers, the policy enables farmers to balance nutrients in the soil. Still, it leads to excessive use as well, which deteriorates soil health. (DoF n.d.)

Recommendation:

- Improve SHC services to enable 'prescription-based fertiliser consumption' and subsidise only the prescribed amount (Chander et al. 2020)

Urea Subsidy

(FY 2023-24 Budget – INR 131 crore) (MoF 2023)

The scheme's main objective is to reduce the costs the farmers pay for urea by subsidising the urea manufacturers.

Linkage with Soil:

- Judicious use of urea adds much-needed nitrogen to the soil but can lead to crop damage if used in excess.
- The disproportionate subsidy on urea incentivises its excess use, which deteriorates soil health.

Recommendations:

- Currently, fertiliser subsidies in India are concentrated in seven states.

The recommendation is to ensure an equitable distribution of subsidies among other states, considering their respective soil requirements (K.V. et al. 2018).

- Gradually increase urea prices under the current fixed price regime, with the aim of eventually including urea under the Nutrient-Based Subsidy Scheme (Comptroller and Auditor General of India 2015).

PM PRANAM

The scheme aims to reduce the use of chemical fertilisers by incentivising states to adopt alternative fertilisers and ensure the balanced use of fertilisers.

Linkage with Soil:

- Under the scheme, 50% of the fertiliser subsidy saved by a State/UT in a particular financial year by way of reduction in consumption of chemical fertilisers (Urea, DAP, NPK, MOP) compared to the previous 3 years average consumption, will be passed on to that State/UT as a grant. This aims to encourage optimal fertiliser use and maintain ideal soil health via nutrient management.
- Moreover, the scheme also encourages the use of alternative fertilisers (PIB 2023).

7.5 Policies under the Department of Rural Development linked with Agriculture and Soil Health

National Rural Employment Guarantee Scheme

(FY 2023-24 Budget – INR 6 lakh crore) (MoF 2023)

The scheme aims to accomplish the dual objective of natural resource management by constructing productive and conservation assets and reducing poverty by providing 100 days of employment per family at minimum wage.

Linkages with soil:

- Permissible works under the scheme include water and soil conservation works that support agricultural activities. For example, constructing bunds, checking dams and trenches to prevent soil erosion, building infrastructure for bio-input manufacturing, etc. (MoRD 2005)

Recommendations:

- Ensuring the successful completion of soil conservation projects (as a large proportion of soil conservation projects remain incomplete) (Jain et al. n.d.)

National Rural Livelihood Mission

(FY 2023-24 Budget – INR 14.13 thousand crore) (MoF 2023)

The mission reduces poverty by making access to gainful self-employment and skilled wage employment possible through SHGs, Livelihood Collectives, etc.

Linkage with soil:

- The Mahila Kisan Sashaktikaran Pariyojana under NRLM has made significant changes in the use of new scientific knowledge and practices which intend to revive age-old traditional knowledge, recycle biomass, and restore soil fertility.
- Encourages adoption of non-chemical weed, pest and disease management practices which includes, but is not limited to – preparation and uses of indigenous bioresources like Agnayastram, Neemastram, or Brahmastram.
- Encourages adoption of the soil enrichment practices, composting (NADEP, vermicomposting, etc.) to convert cow dung into composts, green manuring, green leaf manuring, Azolla preparation and use of bioresources like Jeevamruth/Ghanjeevamruth and use of local materials like tank silt, biogas slurry etc. (MoRD n.d.).

Pradhan Mantri Krishi Sinchayee Yojana (Watershed Component)

(FY 2023-24 Budget – INR 2,200 crore)

The scheme aims to increase the area under irrigation. It aims to integrate the development of rainfed areas using the watershed approach towards soil and water conservation, regeneration of groundwater, arresting runoff, providing livelihood options and other natural resource management activities.

Linkage with Soil:

- The scheme enables effective management of runoff water and improved soil and moisture conservation activities such as ridge area treatment, drainage line treatment, rainwater harvesting, in-situ moisture conservation, and other allied activities on a watershed basis (MoRD 2021).

Recommendations:

- There is a need to manage watershed structures frequently. The scheme can ensure regular cleaning and maintenance of water channels every 2nd or 3rd year, to prevent siltation and flooding.

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08

Conclusion

India has taken numerous steps towards ensuring soil health and sustainable soil management. Soil health is intricately connected with SDG 1 (End Poverty), 2 (Zero Hunger), 3 (Good Health and Wellbeing), 5 (Gender Equality), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 9 (Industry Innovation and Infrastructure), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 13 (Climate Action), and 15 (Life on Land). Therefore, the country must ensure concerted and convergent efforts towards achieving the Sustainable Development Goals.

Co-created with inputs of stakeholders from research and development, government, international donors, local implementing CSOs, farmer organisations, FPOs, private sector, etc. secured via three regional consultations (Himalayan Region, Gangetic and North Region, and Central and South Region), this roadmap is the first attempt towards putting together a strategic plan towards achieving sustainable soil management and improving soil health by 2030.

The roadmap delineates the necessary steps for the Union and State Governments, research organisations, donors, CSOs, etc., prioritising the short-, medium-, and long-term strategies for relevant stakeholders, to facilitate coordinated and convergent efforts for soil health.

Through this evolving strategic plan, at least 50% of the 262 million hectares of land of India under forest cover, pastures, grazing, and agriculture is expected to have healthy soils by 2030.

Through this evolving strategic plan, at least 50% of the 262 million hectares of land of India under forest cover, pastures, grazing, and agriculture is expected to have healthy soils by 2030.

Annexure I

A1.1: Co-discovering context-specific learnings

Through step 1, we identify the key success factors that enabled the scale-up of popular soil health management practices. First, we identified the leading soil health-focused practices within the three agroclimatic zones - Indo-Gangetic, Himalayan, and Southern. We then used the existing literature to analyse the impact of these practices on various soil health parameters. We shortlisted the top 10 practices for the regional consultations using a ranking framework. Through the regional consultations, we dive deep into each of these best practices and identify the enabling factors that have led to the scale-up of relevant soil health management practices.

A1.1.1 Shortlisting soil health management practices at the regional level

The list of best soil management practices at the regional level was developed using a two-step approach.

Level 1- Scoping

In level 1, we identified an exhaustive set of soil management practices within each region. These practices were graded based on their impact on the soil's physical, chemical, and biological parameters.

i. Physical parameters - available water capacity, surface hardness, crumb structure, etc.

ii. Biological parameters - humus content, soil protein index, soil respiration, etc.

iii. Chemical parameters - cation exchange capacity, pH balance, etc.

We developed a framework for scoring the impact of these practices across these indicators based on the direction of the impact of the practices and the strength of evidence. Using this framework, we selected the top 20 practices for level 2.

Level 2- Prioritising

In level 2, we focused on the shortlisted practises (from level 1) which have shown a reasonable level of adoption within the region. This was done using two parameters:

i. Scale of adoption - number of villages or districts adopting this practice.

ii. Replicability across social groups, agroclimatic zones, etc.

From these 15-20 practices shortlisted from level 1, the top eight to ten practices with the highest scale in that region were selected for the regional consultations.

A1.1.2 Deep diving into the short-listed practises in the regional consultation:

The three consultations at regional levels were attended by various stakeholders (Refer to Annexure III) in the sector, ranging from implementers of specific soil health practices at the ground level, CSOs, research experts, private sector representatives, public sector officials. Using the scalability framework (Agarwal et al., 2023), we identified the relevant success factors that enabled the scale-up of these best practices.

A1.2: Co-envisioning India's 'Soil Mission'

Through this step, we aim to create a comprehensive and actionable plan for India's Soil Mission, ensuring the involvement and commitment of all relevant stakeholders.

We consolidated the recommendations from participants in the three regional consultations and clearly outlined the actions different stakeholders would have to deliver to achieve soil health. We discussed and deliberated on the actions required by the Union and the State Government departments, donors, other private sector agencies, research institutions, civil society organisations (CSOs), and non-governmental organisations (NGOs).

Furthermore, we categorise actions by each stakeholder, aligning them with the success factors they help achieve.

A1.3: Consolidating the regional inputs to co-create the first draft of the National Sustainable Soil Roadmap.

A national-level consultation was conducted on December 4th and 5th with representatives from the regional consultations, national-level experts on soil, researchers, academic institutions, related government departments, etc. The success factors identified at the regional level consultations were discussed with a feasibility assessment, forming the basis for developing a national-level roadmap for soil health.

A1.4: Fine-tuning the roadmap along with the 'anchor institution' and public launch in 2024.

Through this final step, we focus on enhancing the effectiveness of the Roadmap by integrating valuable insights and feedback from the anchor institution.

A1.5: Methodology for Policy Analysis

The following matrix highlights the methodology adopted for policy analysis:

Stage	Method	Rationale
Choosing policies	• Policies under MoAFW that are linked to soil with significant allocation in the current year's budget. • Policies under allied Departments - DoRD, Dept. of Fertiliser and Dept. of Water Resources, River Development and Ganga Rejuvenation with soil linkages. • Policies under MoAFW with no linkages to soil. • Policies under allied sectors related to agriculture but not with soil health.	• Such policies were required to study how agricultural policies cater to soil health. • To understand how allied sectors' policies are addressing soil health. • To understand the policies that can be strengthened with success factors. • To understand the agriculture-related policies with significant budgets, which can be strengthened with identified success factors.
Tracking Soil Linkages	• Reviewing scheme guidelines of the ministries to study if the scheme's objective or strategy would impact soil health. • Taking recommendations from the stakeholders on how novel linkages within the scheme can be formed so that the scheme leads to improvement in soil health.	
Tracking Policy Recommendations	• Reviewing impact evaluation reports on the scheme. • Recommendations by Stakeholders to include specific interventions in the scheme that can improve soil health.	

Annexure II

The policy discussion highlighted how contemporary schemes have linkages with improving soil health. The team organised three consultations with experts, agriculture practitioners, agri-entrepreneurs, etc., in Guwahati, Delhi, and Mumbai to understand how these linkages can be strengthened. The learnings from these consultations are given below:

Policies of DoAFW linked with Soil Health

a) Rashtriya Krishi Vikas Yojana (RKVY) - Soil Health and Fertility

Areas of improvement as identified from the consultation:

- The turnaround time for a soil health test report can be reduced to 2-3 days so that required interventions can be made on time. Presently, it takes a month to deliver the soil test results to farmers.
- Village consortiums can be formed to promote decentralised soil testing, which can reduce the turnaround time for soil health test reports.
- Public-private partnerships can be encouraged to establish and upgrade soil health testing infrastructure to ensure quick turnaround of soil test results.
- Microbiology labs in convergence with health departments can be set up at the district level to study soil microbiology. Indicators that are easy to track can be studied at the Panchayat level by building the capacity of the local cadre.
- Training for local government officials and extension workers can be conducted so that they can communicate existing knowledge on the optimal use of fertilisers to farmers.
- Conduct conferences with leading soil scientists in India to understand the indicators crucial for soil health and create a soil quality index. This can be embedded in this scheme.
- Training can be made mandatory for fertiliser retailers to ensure only the required amount of fertiliser is provided to farmers.

b) Mission on Integrated Development of Horticulture (MIDH)

Areas of improvement identified from the consultation:

- Encourage multi-cropping and multi-layer farming in horticultural systems.
- Promote cover cropping for horticulture in the Himalayan region.
- The Union government can consider subsidising entrepreneurs for setting up bio-input resource centres.
- Promote the cultivation of seeds among farmers to ensure high-quality seeds for horticulture.

c) Formation and Promotion of 10,000 FPOs Scheme

Areas of improvement as identified from the consultation:

- Legislative action needs to be taken to keep a check on the distribution of chemical fertilisers by FPOs as a principal-agent dynamic is formed between chemical fertiliser manufacturers and FPOs.
- Standards are needed to be developed to test the toxicity of produce by FPOs. Procurement should not be done if the toxicity exceeds the permissible amount. This will make FPOs discourage their members from applying excessive fertilisers.

Policies of DoAFW linked with Agriculture but not with Soil Health

a) Pradhan Mantri Fasal Bima Yojana (PMFBY)

Areas of improvement as identified from the consultation:

- Inclusion of tenant farmers in the scheme can incentivise them to ensure sustainable soil management.
- Motivate farmers to follow some 'good practices' by reducing premiums for those who adopt such practices. The scheme may be modified to reduce the introduction of foreign genetic resources, encourage indigenous varieties and crop diversification and other good practices that are beneficial for soil and reduce crop damage risk.

Policies of Department of Water Resources, River Management and Ganga Rejuvenation linked with Agriculture and Soil Health

a) Pradhan Mantri Krishi Sinchayee Yojana (Command Area Development, Har Khet Ko Paani, and Accelerated Irrigation Program)

Areas of improvement as identified from the consultation:

- Monetary incentives on the lines of carbon credits can be provided for not consuming high amounts of water.
- Water provision and price could be conditional upon crop diversification practices to enable convergence between soil and water agendas.
- The term irrigation needs to be redefined to include utilisation of soil moisture for irrigation.
- Measures to reduce salinity caused by flood irrigation can be incorporated into the scheme.
- Sensor-based technology can ensure judicious water use while also fixing the time for water provision.

Policies under the Department of Fertilisers linked with Agriculture and Soil Health

a) Nutrient-Based Subsidy

Areas of improvement as identified from the consultation:

- Quantity of fertiliser required must be ascertained by tracking micronutrients in soil.

b) Urea Subsidy

Areas of improvement as identified from the consultation:

- Strengthening the capacity to track inefficient urea usage on farms. The optimum quantity required must be advised, and a comparison can be made on how much urea should be used.

c) PM PRANAM

Areas of improvement identified from the consultation:

- Farmers may be incentivised to cultivate leguminous crops.
- The funds released under PM PRANAM can be transferred directly to farmers as a monetary incentive.
- An area-based approach can be taken — if all the farmers in a Gram Panchayat follow a practice that leads to an overall reduction in fertiliser consumption in that area, then these farmers can be incentivised irrespective of whether the state has reduced overall consumption.
- Farmers who can lose on yield due to shifting to bio-inputs can be incentivised with higher MSP.
- Payment for ecosystem services can be provided to farmers who reduce consumption of chemical fertilisers.
- State governments can plan the establishment of bio-input resource centres.
- Soil health may be connected with crop type and optimal fertiliser amounts can be suggested for individual fields.
- Community-led, localised monitoring mechanisms can be established to keep fertiliser usage in check at the village level.

Policies under the Department of Rural Development linked with Agriculture and Soil Health

a) National Rural Employment Guarantee Scheme

Areas of improvement identified from the consultation:

- The social forestry component under NREGS is underutilised. These components can be used for bamboo plantations and agro-forestry to improve soil health.
- Labour can be leveraged through MGNREGA for multi-cropping and cover cropping.
- Collection of cattle dung and urine for bio-input preparation can be included under NREGS.

a) National Rural Livelihood Mission

Areas of improvement as identified from the consultation:

- Enabling capacity building on soil conservation and management practices like cover crops, grass covers, crop rotation, fallow land policy, water management of fields, crop diversification with local crops under NRLM as soil erosion is an important issue in the Himalayan region.

- Incorporation of Decentralised Seed Banks (or seed fairs, seed cooperatives, etc.) into NRLM, where SHGs can be a helpful vehicle. This needs to be done in tandem with developing market linkages for the SHGs. Seed banks can double up as collection centres by giving out seeds for sowing in return for seeds after harvest.

b) Pradhan Mantri Krishi Sinchayee Yojana (Watershed Component)

Areas of improvement as identified from the consultation:

- Decentralised and community-led management of watersheds may be encouraged as many structures become ineffective due to silt collection.

Annexure III

List of participants from the North region workshop held in Delhi on 7 and 8 November 2023

Name	Organization
Pankaj Kumar	Samagra Shikshan Evam Vikas Sansthan (SSEVS)
Prashant Anand	Samagra Shikshan Evam Vikas Sansthan (SSEVS)
Akash Asthana	Digital Green
Saumya Sen	Urban farms
Vikash Abraham	Urban farms
Manvendra Sharma	Lupin
Vivek Kumar	MoRD
Priya Agarwal	India Climate Collaborative
Akhilesh Chauhan	NRLM Mord
Ganesh Bedare	BAIF
Santosh Chaudhari	WOTR
Dr. Pramod Murari	Dehaat
Ashish Ambasta	SRIJAN
Abhishek Jain	CEEW
Jonas Bartholomay	GIZ
Mukesh Pandey	Nav Chetna
Aparna Srivastava	Nav Chetna
Nihal Singh	Pavitra Mentha
Mahadev Gomare	Art of Living
Umendra Dutt	Kheti Virasat Mission (KVM)
Jagtar Singh	Kheti Virasat Mission (KVM)
Rumi Prakash	Change alliance
Binayak Dutta	DRCSC
Rahul Kumar	Sehgal Foundation
Nikhil Goves	EDF

Name	Organization
Abhishek Ashutosh	Pavitra Mentha
Deepika Agarwal	Pavitra Mentha
Shamika Gandhi	The Art of Living
Shweta Mittal	The Art of Living
Sudeep Sharma	VAAGDHARA
Dr. Pradip Dey	ICAR
Dr. Bholanath Saha	Bihar Agriculture University
Jitendra Yadav	GIZ
Rohit Yadav	Ecociate
Mamta Gupta	Ecociate
Dr. Rohit Sharma	Digital Green
Archana Jha	The Art of Living
Swapnil Ganvir	FES
Kshitij Urs	IBBN
Kumar Abbhishek	Dr. Reddy's Foundation
Malika Shrivastava	Centre for Microfinance, Jaipur
Apoorve Khandelwal	CEEW
Gursimer Gulati	CEEW
Parvathy Subha	CEEW
Aastha Bafna	CEEW
Rohan Gupta	CEEW
Kim Arora	GIZ
Anna Spiller	GIZ
Bholanath Saha	DKAC, BAU
Navin Horo	GIZ
K Satheskumar	CEEW

List of participants from the South and Central India convening held in Mumbai on 20 and 21 November 2023

Name	Organization
Ranjit Mohanty	FES
Sandip Pattanayak	Green Foundation
Muhammad Shoaib Rahman	Dvara E-Registry
Narender Kande	
Amit Choubey	SANMAT
Ravi Trivedi	The Nudge Institute
Mr. Srinivas	SOIL
Mr. Minhaj Ameen	Bharat Agroecology Fund
Dr. V.R. Prabavathy	MSSRF
Dr. Rengalakshmi	MSSRF
Phaneesh K.	IBBN
Prabhakar	IBBN
Mr. Seenivasan	PRADAN
Dr. Ashok Kumar	IRRI
Mr. Vinay Dabral	NCNF
Mr. Pratik Ramteke	WOTR
Ms. Prachi Patil	RRAN
Ms. Raghini	Vrutti - Livelihood Impact Partners
Ms. Bharati	Vrutti - Livelihood Impact Partners
Dr. Ramanjaneyulu	Centre for Sustainable Agriculture
Mr. Ram Chandra Tosh	Odisha Millets Mission
Manas Swain	Shivansh Farming
Yogesh Gajaralwar	Vidarbha Sales
Mr. Rajesh Deshpande	Vidarbha Sales
Ajit Machhindranath Bhor	GIZ
Mr. Ganesh Bidre	BAIF
Ravi Kote	BAIF
Harpalsinh Chudasama	AKRSP
Mr. Rahul Juware	Social Lab Environmental Solutions
P P Chahande	FSDD/NABARD
Mr. Vikash Sinha	ReNew Company
Narayanasamy Krishnan	Vrutti - Livelihood Impact Partners
Dr. Manzoor Dar	ICRISAT
Kailas	Criyagen
Chandan Sanjay Tripathi	Dept. of Agriculture, Govt. of Chattisgarh

List of participants from Himalayan region convening held at Guwahati on 23 and 24 November, 2023

Name	Organization
Dev Raghavendra Badri	
Dr. Rajeew Kumar	GBPUAT
Dr. Dinesh Raturi	BAIF
Dr. B Mohan Kumar	Former Vice-Chancellor Arunachal Agricultural University
Mr. Vijay Jardhari	BBA
Dr. Uma Melkania	CHEA
Mr. Dwarika Prasad Semwal	JADDI
Mr. Nek Ram	
Dr. Pankaj Tiwari	Aarohi Organization
Mr. Rasam Chandel	MVS
Dr. Gourav Chouhan	KVK Barthin
Mr. Premchand Sharma	
Mr. James Kharkongor	MBDA
Ms. Jillianda Kharjana	MBDA
Ms. Tamara Law Goswami	Bharat Agroecology Fund
Mr. N. Tomba Singh	KVK Thoubal
Mr. Kailash Chandra Bhatt	REAP
Mr. S. Prabin Singh	KVK Thoubel
Kanti Nanda Initiative	IDH - the Sustainable Trade
Mr. Romeo Koch	SeSTA
Mr. Dhrupad Choudhury	ICIMOD
Mr. Sanjay Bhati	Himmotthan Society
Mr. Ghanshyam Kalki Pande	INHERE
Prof. Rajesh Kaushal	Dr. Yashwant Singh Parmar University of Horticulture & Forestry
Jatin Bavishi	IDH - the Sustainable Trade Initiative
Bettina Renner	GIZ
Dr Pradip Dey	ICAR
Mr. Nabin Kumar Roy	NABARD
Mr. Shankar Das	NABARD
Ms. Annapurna Kekare	NABARD

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