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Do we know enough to scale up Sustainable Agriculture in India? †

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Abstract: This study maps India's state of sustainable agriculture and how it can be scaled up to secure farm incomes, nutrition security, and natural capital in a climate-changing world. It identifies around 30 most relevant sustainable agriculture practices practised in India and assesses the 16 most promising of them in detail. This research gathers insights through a systematic literature review and more than 40 consultations with government officials, agriculture institutions, and a primary survey with 180 CSOs promoting sustainable agriculture. An extensive study of these practices infers sustainable agriculture to be on the margins in the country. The gathered insights pinpoint specific measures to promote sustainable agriculture by reassessing public support structures, building evidence and capacity of farmers, etc. By assessing the on-ground adoption of these practices and their impact on incomes, environment, and society, this research aims to aid researchers, policymakers, donors and civil societies to make informed decisions for stepping up sustainable farming in India.

Keywords: Sustainable agriculture; Natural Farming; Organic; Rainfed; Systematic review; Scale-up; India

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1. Introduction

India's agricultural sector at present embodies significant adverse environmental and social externalities. While the Green Revolution's promotion of high-yielding seed varieties and fertilisers did solve the problem of food-grain shortages, its drawbacks are visible in the form of degraded land, soil, and water quality, farmer indebtedness due to a high dependency on external inputs. On the economic front, India has increased its cereal production tremendously since the 1970s, and now it is the largest producer and exporter [1]. For instance, wheat and rice production have increased by 310 per cent and 160 per cent, while a rise of only 45 per cent for the Nutri-cereals [2]. The income rise on the farms has been the slowest compared to the income rises in other sectors.

The social reality is that while India has become calorie-secure, around 22 per cent of India's adult population (15 - 49 years) are undernourished, and more than 58 per cent of Indian children (up to 5 years) are anaemic [3]. Essentially cereals have fulfilled calorie needs, but our nutrient needs are still lacking. About 60 per cent of farmers dependent on rainfed [4] have not been impacted much by the benefits of the Green Revolution.

Our current production patterns have led to land degradation, desertification, and years of chemical application have reduced the ability of the crops to respond to fertilisers by almost 3.5 times between 1970 and 2005 [5]. About 78 per cent of applied urea still goes into the environment, pollutes groundwater, affects biodiversity, and degrades soil [6]. These mounting realities make it imperative to look at an alternate approach to agriculture that is more sustainable - economically, socially, and environmentally. Sustainable agriculture could be more remunerative by diversifying crops and lowering input costs. It can be socially more inclusive as it enhances incomes for small farmers and promotes diverse nutrient-rich diets. Environmentally, sustainable agriculture reinforces ecological balance and increases resilience. For example, natural farming fields in Andhra Pradesh have shown resilience during extreme weather events, and integrated pest management (IPM) tactics have helped control locust attacks that are increasingly on the rise.

Thus, this research highlights the state of sustainable agriculture in India by first identifying the most widespread sustainable practices. Second, it assesses them through an agroecological lens; third, it documents the current state of adoption (geographic spread and scale) of these practices among farmers in India; fourth, it understands each of their impacts on the economy and society and environment. Besides, the study identifies the gaps in the literature and gives direction to prioritise research areas based on the existing impact evidence gaps.

2. Methodology

2.1 Review of existing literature

An extensive review of existing literature related to the terms' sustainable agriculture' and 'agricultural sustainability' led us to review papers that analysed over 70 different definitions of the concept [7]. Thirty sustainable practices implemented in the country were identified. Practices focus only on one dimension of agriculture while systems are more holistic that can include several components within. They are collectively referred to as Sustainable Agricultural Practices and Systems (SAPSs).

2.2 Applying the FAO's agroecological framework

FAO's ten agroecology elements [8] are utilised as an analytical framework or tool to shortlist the practices and systems as it helps to evaluate the social, economic, and environmental impacts in a well-integrated manner. Eight out of the ten agroecological elements were selected to assess the SAPSs shown in table 1. Using a criterion of at least four of the elements set as a benchmark, around 16 practices were selected for in-depth review (Table 1).

Table 1. SAPSs selected for a deeper review using FAO's agroecological elements

Sustainable Agricultural Practices and Systems (SAPSs)	Diversity	Co-creation & sharing of knowledge	Synergies	Efficiency	Recycling	Resilence	Human & social values	Culture & Food Traditions
Permaculture								
Organic farming								
Natural farming								
System of Rice Intensification (SRI)								
Biodynamic agriculture								
Conservation agriculture (CA)								
Integrated Farming System (IFS)								
Precision farming								
Vermicompost								
Agroforestry								
Integrated Pest Management (IPM)								
Crop diversification								
Cover crops and mulching								
Contour farming								
Rainwater Harvesting (RWH)								
Floating farming								
	Furthered							
	No evidence of being furthered							

2.3. Systematic review of literature

The evidence for each SAPSs was mapped against a few indicators through a systematic review of publications. A literature search strategy was developed to identify and select publications for each SAPSs. It involved selecting the search engines, inclusion or exclusion criteria, Boolean/keywords identification, and finalising the publication types. The publication timeline was dated between 2010 and 2020 to keep the literature review manageable and focus on more contemporary evidence. Further, the research scope was limited to the first 75 and 30 publications in the Google Scholar Advanced Search and Google Advanced Search to keep the literature review manageable.

2.4. Primary survey and stakeholder consultations

An online survey was done to identify the key stakeholders, including Civil Society Organisations (CSOs), involved in researching and implementing the various SAPSs. About 180 CSOs and research institutions across 36 states and union territories responded to the online questionnaires. More than 50 stakeholders from government, research and academic institutions, and CSOs were consulted who were experts within each SAPSs to fill in the study gaps.

3. Results and Discussion

3.1. State of sustainable agriculture in India

Findings strengthen the generic understanding that sustainable agriculture in India is on the margins. This is because only five practices have more than 4 per cent of the net sown area. While most SAPSs have around 4 per cent (less than five million) adopters implementing them and less than one per cent adopt several of these practices out of the total population of farmers. Figure 1 summarises the area and adoption of each SAPSs.

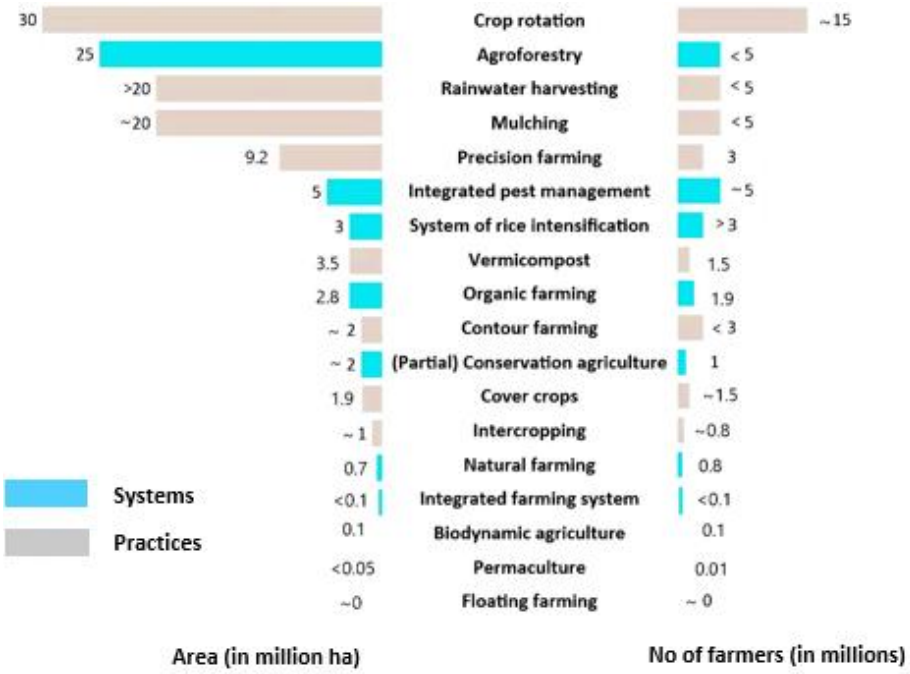

Figure 1. Area and adoption of various SAPSs in India

Notes: Area and adopters are liable to change with the availability of new information
Precision farming: Figures pertain to micro-irrigation; *Conservation agriculture*: Partial CA; *Crop rotation*: Figures include cereal-cereal rotation; *Rainwater harvesting:* Area estimates based on not just farm area but watershed development area under the Integrated Watershed Management Programme; *Cover crops*: Estimates include leguminous cover in plantation crops; *Intercropping*: Excludes horticultural crops.

3.2. Impact evidence of SAPSs on outcomes

- Literature review discloses practices like agroforestry, the system of rice intensification (SRI) and organic farming to be most researched among the SAPSs on several indicators (Figure 3).

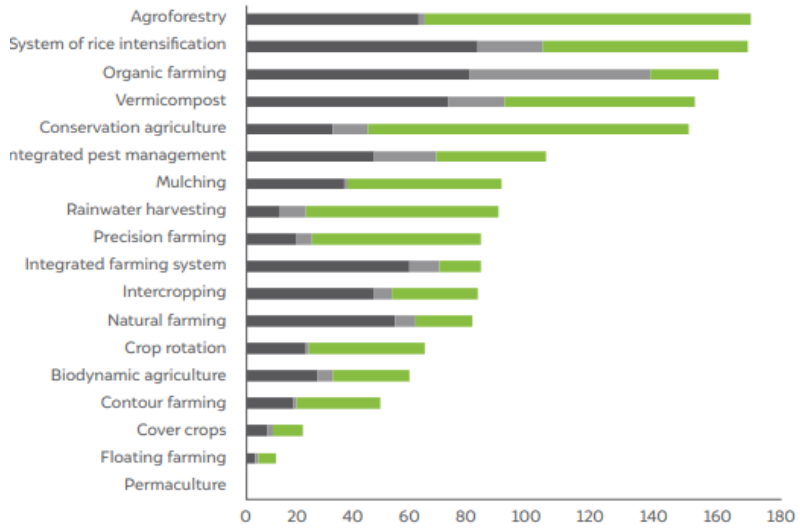

Figure 3. In the last decade, evidence on several SAPSs varied for different indicators

Note: Evidence is generated from different publication types (reports, peer-reviewed papers, case studies), and papers that established clear evidence for various themes were identified

- The literature for most SAPSs consists of short-term assessments (below three years) for all indicators, while long-term studies are missing. A few exceptions were CA, for which long-term assessments mainly concentrated on ecological impact in the Indo-Gangetic regions.
- Except for agroforestry, studies conducted at a landscape or an agroecological level were missing for most practices as they were restricted majorly to plot-level field trials.
- On the publication evidence, themes like crop yields, income, water, and soil are more researched, while gender and health aspects, emissions, and biodiversity are less explored comparatively.
- Papers evaluating the impact of SAPSs predominantly tend to focus on a single theme like soil health, water, etc., rather than multidimensional.
- There are inadequate measurement indicators to measure farm productivity, and conventional methods are often not sufficient. Generally, sustainable practices promote crop and livestock integration; however, evidence for the total farm output is lacking.

3.3. Policy scenario for sustainable agriculture in India

A comprehensive framework in the National Mission of Sustainable Agriculture (NMSA) has existed at the national level since 2014-15 with several components on rainfed areas, water and soil management, and agroforestry [9]. National Innovations in Climate Resilient Agriculture (NICRA) under ICAR focuses on CA and SRI. Rainwater harvesting is promoted through the Integrated Watershed Management Programme, and the Pradhan Mantri Krishi Sinchai Yojana encourages precision irrigation and water saving methods.

Nonetheless, the budget allocation to the NMSA is minuscule (0.8 per cent) compared to the overall budget of the Ministry of Agriculture and Farmers Welfare (MoAFW) (Figure 4). Further, around INR 71,309 crore (USD 10 billion) is spent on fertiliser subsidies by the Central government annually besides MoAFW's budget of INR 142,000 crore (USD 20 billion) [10]. This showcases that while sustainable agriculture is being promoted, the support is heavily directed towards conventional farming or the green revolution-led cultivation approaches.

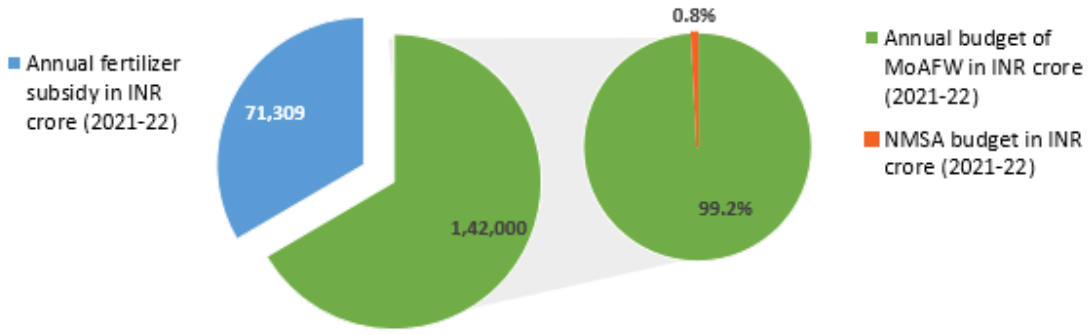

Figure 4. Massive scope to increase the budgetary support

Only eight of the SAPSs receive some budgetary support: organic farming, vermicomposting, precision, contour farming, integrated farming, mulching, RWH, and IPM. Of recent, the Bhartiya Prakritik Krishi Padhati was established to promote natural farming in 2020-21; however, the financial allocation of INR 12,200/ha (USD 162) [11] for a three year transition period is inadequate. While a meagre INR 12 crore (USD 1.6 million) was dedicated for National Project on

Organic farming and only INR 34 crore (USD 4.7 million) for National Project on Agroforestry for 2021-22 [12]. Of all the practices, organic farming garners the most attention, as observed through several state organic farming policies.

4. Conclusions

India needs alternative approaches to farming, and our observations find sustainable practices to show potential for an easier transition in 60 per cent of the drought-prone rainfed areas where agriculture endures in resource-constrained environments. It will diversify income opportunities for the 86 per cent of the smallholder farmers for whom these practices are easier to replicate. Despite this, the adoption of sustainable agriculture overall remains low though few states like Andhra Pradesh and Sikkim managed to attain scale. The limited evidence on various indicators necessitates building long-term conclusive outcomes for SAPSs.

The budgetary allocation needs a significant uphaul, and certain SAPSs could be targeted and contextualised as per the region's feasibility and agroclimatic characteristics. Farmers need to be supported to ease their situation in the transition phases and hand-holding required to build knowledge and capacity. Investing in these practices will further help tackle the core issues of malnutrition as the focus shifts towards nutrition security from food security. A long-term vision of sustainability for the agriculture sector will require a reorientation of our food, agriculture, and farm production systems supported by policy incentives that enable their scale-up efficiently and inclusively.

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Conflicts of Interest:

No conflict of interest.

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