Ecology, Economy and Society–the INSEE Journal 5 (1): 23-30 January 2022

COMMENTARY

Framework For a Collective Definition of Regenerative Agriculture in India

Shannon B. Olsson*, Minhaj Ameen**, Saransh Bajpai***, Ravikanth Gudasalamani****, Chirag Gajjar*****, Srajesh Gupta+, Søren Hvilshøj++, Jyotsna Krishnakumar+++, Crispino Lobo++++, Rohan Mukherjee+++++, Abhayraj Naik#, Ajay Raghavan##, Hansika Singh###, Kesavan Subaharan####

Abstract: The concept of regenerative agriculture has received increasing attention worldwide as a method to restore and conserve natural resources while maintaining crop productivity. However, there remains a lack of consensus as to what conditions define regenerative agriculture, making it difficult for decision-makers,

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* Global Director, the echo network; Special Scientific Envoy to India, Danish Academy of Technical Sciences, Copenhagen, Denmark; Associate Professor, National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bangalore, India. shannon@echonetwork.in

** CEO, National Coalition for Natural Farming. minhajameen@gmail.com

*** Senior Manager, Climate Program, World Resources Institute India. Saransh.Bajpai@wri.org

**** Senior Fellow, Ashoka Trust for Research in Ecology and the Environment, Bangalore, India. gravikanth@atree.org

***** Individual Expert. chirag8315@gmail.com

+ Programme Associate, National Coalition for Natural Farming. Srajeshg792@gmail.com

++ Global Division Director, Water Resources. Rambøll. SRHS@ramboll.com

+++ Director, Community Well Being Programme, Keystone Foundation. jyotsna@keystone-foundation.org

++++ Managing Trustee, Watershed Organisation Trust; Executive Director, Sampada Trust. cslobo1@gmail.com

+++++ Programme Coordinator, Keystone Foundation. rohan@keystone-foundation.org

Co-founder, Initiative for Climate Action & Visiting Faculty, Azim Premji University, Bengaluru. abhayraj@actionclimate.org

Initiative for Climate Action. ajay@actionclimate.org

Principal Strategist, Forum for the Future & Community, Member, Initiative for Climate Action. h.singh@forumforthefuture.org

Principal Scientist, ICAR - National Bureau of Agricultural Insect Resources, Bengaluru. Kesavan.Subaharan@icar.gov.in

Published by Indian Society for Ecological Economics (INSEE), c/o Institute of Economic Growth, University Enclave, North Campus, Delhi 110007.
ISSN: 2581–6152 (print); 2581–6101 (web)
DOI: https://doi.org/10.37773/ees.v5i1.662

researchers, the agricultural sector, and the public to adopt regenerative agriculture practices. Here, we present the initial process to create a unified, cross-sectoral definition for regenerative agriculture in India that considers the viewpoints of multiple stakeholders and addresses the current challenges faced by the Indian agricultural sector. To this end, we compiled interactions with individuals from across India to identify the most pressing concerns for India's human and environmental ecosystems. We conducted over 30 hours of workshops to discuss these concerns with 50 experts from five sectors and four countries. We summarize these discussions and propose a common framework to collaboratively develop region-specific techniques that employ existing and supplementary resources to generate evidence for regenerative agriculture and foster conducive practices.

Keywords: Food Security; Sustainability; Ecosystem Services; Biodiversity; Climate Change

The UN estimates that during the period 1998–2017, India suffered climate-related losses amounting to $80 billion (UNISDR 2018). Germanwatch currently places India seventh-highest in the Global Climate Risk Index for 2021 (Eckstein, Künzel, and Schäfer 2021). Apart from the damage and losses it inflicts, climate change is also causing a decline in the productivity of many cereal crops, especially wheat and rice, which form the bulk of South and East Asian diets. Meanwhile, water-use efficiency is low across all key crops in India. More than 50% of the country's farmland grows water-intensive crops such as rice, wheat, sugarcane, and cotton. The Government of India (GOI) predicted in 2021 that while rainfed rice yields are likely to reduce by up to 2.5%, irrigated rice yields are projected to decrease by 7% by 2050 and 10% by 2080; wheat yields by 6–25%, and maize yields by 18–23% by 2100 (Rao *et al.* 2019; MoA&FW 2021). Further, a report compiled by the National Institution for Transforming India (NITI Aayog) in 2018 indicated that India continues to face one of the "worst water crises in its history" (NITI Aayog 2018). In addition, the World Resources Institute's Aqueduct tool ranked India 13th for overall water stress in 2019 (WRI 2019). Diminishing groundwater resources demand better water management practices from all water-consuming sectors, including agriculture.

A lack of access to water, coupled with the intensification of floods and droughts due to climate change, can lead to socioeconomic insecurity with inconsistent crop yields and low returns to farmers, a lack of storage and transport facilities, and limited access to markets, leading to food wastage. These issues can lead to a stagnation in productivity and trigger significant rural to urban out-migration from farming to other vocations. Women, in particular, face extreme disadvantages: 85% of rural women in India are employed in agriculture, yet they own only 13% of the land (Oxfam 2018).

A lack of autonomy, financial distress, and feelings of hopelessness in these rural communities are also related to gender-based violence, which disproportionally impacts these same women (WHO 2005). There is an urgent need for strategies that empower small and marginal farmers to protect and regenerate their environment using science and technology innovations that complement and respect traditional and indigenous practices for improved productivity and sustained income. These strategies should incorporate experimental and replicable crop production and protection models in the Indian context to scientifically validate appropriate and sustainable mechanisms to improve yields and the value chain.

The term "regenerative agriculture" has received increasing attention worldwide as a means to restore soil health and other natural resources while maintaining crop productivity (Rhodes 2017). The concept itself has existed since the initiation of the Rodale Institute's "Farming Systems Trial" in 1981 (Rodale Institute 1981). A recent stakeholder meeting, hosted by several Indian organizations, identified several points of action to promote regenerative techniques across India, including scientific research to evaluate regenerative agriculture in the Indian context; analysis and quantification of how regenerative agriculture contributes to and benefits from existing national policies and support; and integration of multiple viewpoints (TAAS *et al.* 2021). A clear science-based and India-focused definition of regenerative agriculture is necessary for the widespread adoption of these efforts.

However, there is currently no legal definition in India or the world that outlines or restricts what constitutes regenerative agriculture, and a recent review of over 200 articles and websites found a wide variety of definitions and usages of the term (Newton *et al.* 2021). Indeed, there are several alternative farming systems that can ensure soil health (although not necessarily crop productivity), including low-input sustainable agriculture, conservation agriculture, organic farming, natural farming, and zero-budget natural farming (TAAS *et al.* 2021). This lack of consensus in terminology and practice can confuse researchers and the public as to what defines regenerative agriculture (Newton *et al.* 2021). Such confusion can reduce the credibility of solutions and make it difficult to establish policies, funding, technologies, and programmes that promote their adoption (Newton *et al.* 2021).

Creating a unified science-based definition for regenerative agriculture that appropriately weighs inputs from both scientific and social sectors requires cross-sector exchange and interdisciplinary collaboration. The echo network is a social innovation partnership with the specific focus of increasing scientific awareness, engagement, and insight regarding India's human and environmental ecosystems. We have developed a unique process for enabling multisector interactions between decision-makers, knowledge generators, and on-ground actors to generate effective knowledge resources and targeted science-based actions that can be quickly adopted in our communities. These efforts have already contributed to other programmes dedicated to ecosystem-based sustainability efforts, such as Ecosystems-based Adaptation for Resilient Incomes (ECOBARI 2021).

In 2019 and 2020, the echo network facilitated interactions with more than 250 individuals from academic, industrial, governmental, non-governmental, and philanthropic sectors, and public at large to identify the most pressing concerns for India's human and environmental ecosystems. We used an analytical technique known as semantic network analysis (Drieger 2013) to summarize over 400 statements we gathered from our public interactions and generate networks that could be used to identify related themes and topics across the statements (Paranyushkin 2021). One of the four major clusters generated from these statements was influenced by agriculture and food security. Statements in this cluster were dominated by four major concepts relating to sustaining our water and farming systems. The following indicate the percent of total statements that were connected by the given topic sentence:

- Improving the quality of farmer livelihoods (19%)
- Developing sustainable agriculture practices that address food security (nutritional needs) and sustainable development (15%)
- Conservation and management of water and carbon for ecosystems and biodiversity (13%)
- Mitigating the impact of climate change on the health of natural systems for our prosperity (11%)

We then examined structural gaps where these four clusters were not directly connected to each other in the network, indicating that the concepts in those separate clusters did not occur together in any of the gathered statements. The topics of conservation and management of water and carbon and the health of our natural systems (see topic sentences above) were not directly connected in any of the gathered statements and thus served as a potential focus area to unite clusters together (Paranyushkin 2021). Through this process, we identified the following unifying question:

How can we improve the productivity and livelihoods of India's agricultural sector by leveraging water and carbon conservation to mitigate the impact of climate change on our natural systems?

This question, gleaned from our many cross-sector public exchanges, also broadly connects many regenerative agricultural definitions (Rhodes 2017; Newton *et al.* 2021). Therefore, we propose that understanding how science and technology can address this question in the Indian context can help establish a collective, science-based definition for regenerative agriculture in India. To this end, from November 2020 to July 2021, the echo network hosted a series of discussions with 50 experts from five sectors (government, academia, non-governmental organizations, philanthropy, and industry) and across four countries (India, United Kingdom, Denmark, and the USA). We conducted a total of 32 hours of workshops on this topic to identify ways in which science and technology can address the central question we identified, given the current status of Indian agriculture.

Our experts agreed with the conclusions of another recent stakeholder discussion on regenerative agriculture (TAAS *et al.* 2021) suggesting an urgent need for adaptive strategies that address biodiversity-based and climate-resilient agriculture in regional contexts of India. Specifically, while there are numerous examples of such practices worldwide (Rhodes 2017; Newton *et al.* 2021), we need to better adapt and standardize solutions to match region-specific requirements. In addition, the experts noted that several existing innovations are yet to be implemented at scale in the Indian context and do not fully take into account users' needs or their potential response to new types of institutional arrangements among suppliers, farmers, innovators, and other stakeholders. Though extension and developmental agencies are involved in transferring technologies, there remains a gap in transferring ecosystem-based technologies and information between farmers and researchers to assess crop disease, pests, and soil quality. This gap is exacerbated by a lack of availability of biological resources at scale, including, for example, manure, biomass, and botanical materials to develop sufficient quantities for pest control measures. There is also a lack of financial support and collaborative efforts between sectors that have created silos from the highest to the lowest levels. Further, the Indian public does not yet adequately recognize the importance of ecosystems and their inter-relationships with human welfare and well-being, so there remains insufficient penetration and scaling of ecosystem-based practices.

There is, therefore, a need to galvanize interactions between like-minded institutions and communities to create regenerative agriculture solutions that all stakeholders can adopt. We need human-centred design approaches to address institutional challenges such as the need for new and innovative financing mechanisms, re-imagination of extension services, and technological innovation for scaling regenerative agriculture through suppliers and practices. We recommend gathering a set of cross-sector stakeholders and communities to compile the information necessary for implementing regenerative agriculture techniques; crowdsourcing existing work through as broad a process as possible; establishing deep-dives into specific efforts to understand context and potential; and executing convenings between similar efforts. We can then use this information to develop a holistic data system that provides accurate weather and climate forecasting and modelling; efficient delivery of crop advisories; ecosystem-based technologies; and implementation protocols and impact assessments for use by farmers, community organizations, and governments for crop productivity and protection.

Using this cross-sector data platform, existing innovations in agricultural institutions, financing mechanisms, and service delivery (Rhodes 2017; TAAS *et al.* 2021) can then be synergized with traditional systems and knowledge to validate, adapt, and scale regenerative agriculture across India. In parallel, long–term data collection through sustained research efforts in strategic agroecological zones should account for the future impacts of climate change on agriculture. Such research should also explore the efficacy of ecosystem-based, climate-resilient, and agroecology-based practices concerning yields, crop health management, nutrition intensity, soil conservation, climate change mitigation, and ecosystem services. This cross-zone approach can then be used to develop context and region-specific standards. These standards must be accompanied by measures that build adaptive capacities and overall resilience to economic and climatic shocks to ensure farmer buy-in, thereby avoiding delays in adopting alternative approaches due to inappropriate methods. Such measures would necessarily include significantly improving the efficiency and productivity of natural resource use (such as water, soil, and biomass); regenerating ecosystems; conserving local biodiversity; and facilitating remunerative returns to farming investments with appropriate incentives that align consumer demand and preferences. Through these efforts, we can provide farmers and rural communities with timely and accurate forecasts together with customized farm management advisories (on areas such as crop, livestock, soil, and land management), to enable them to reduce weather-induced risks and mitigate the impacts of climate change [see, e.g., FarmPrecise (WOTR 2021)]. This process can, in turn, help us understand how we can promote and stimulate the implementation of science-based standards in different scenarios in India at scale through the massive deployment of digital technologies. It is important to note that as we leverage the transformative powers of digitalization and technology, we must maintain contextual specificity and sensitivity to respect and complement any traditional systems that might already be profoundly regenerative. Thus, this human- and ecosystems-centred approach should include the community knowledge, history, and culture of that particular agro-climate.

In summary, rather than articulating a concrete definition of regenerative agriculture immediately, we propose that regenerative agriculture in the Indian context must be understood as an adaptive farming process that combines science-based, climate-resilient, and agroecology-focused practices with the community knowledge, history, and culture of each particular agro-climatic zone. We, therefore, propose to work as cross-sector consortia across several communities, governments, institutes, and organizations to share ideas, data, field sites, conversations, and planning that will lead to solutions and standards adapted and shaped for the specific needs of the region where they will be implemented. We hope that this process will serve as a template for developing trust, value, and responsibility for our ecosystems across India and the world and inspire similar efforts to tackle sustainability issues through a collective process of co–creation and co-ownership among all stakeholders.

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