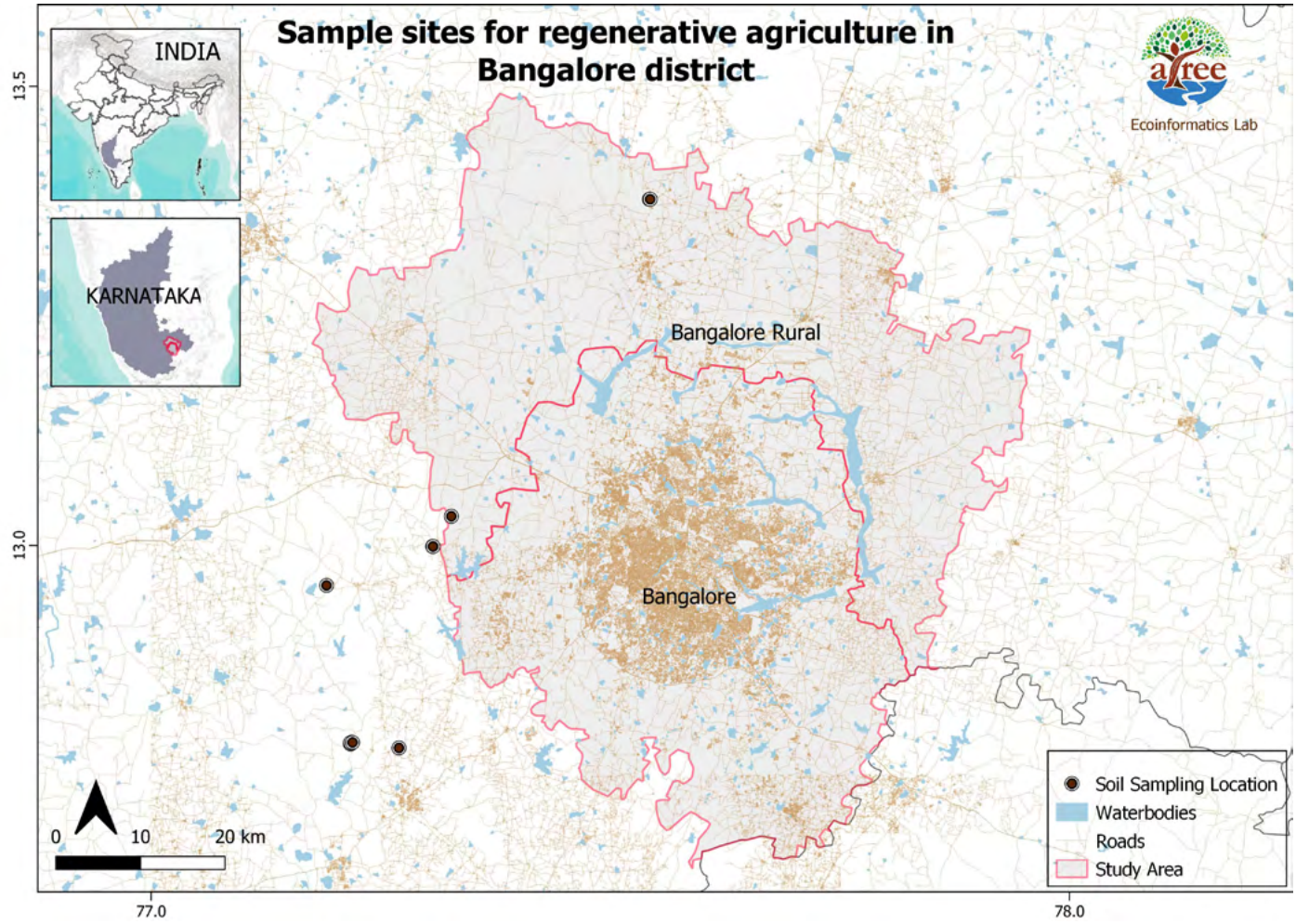
Regenerative agriculture for improved soil health

Policy brief | 2022

SHEFS

atree

Soil sample collection sites in Bengaluru District



Executive Summary

Agricultural intensification during the green revolution involved heavy use of chemical fertilisers and pesticides which have had detrimental effects on the environment, soil and human health. Indiscriminate use of chemical fertilizers has led to soil acidification, and soil health is failing due to intensive agriculture with no application of soil revival techniques, unsustainable land management practices such as leaving the soil open to weathering between two crops, etc. Additionally, use of chemical pesticides has resulted in unintentional killing of useful insects (pollinators), animals, birds and organisms, while also contributing to serious human health issues. Farmers who apply these chemicals are highly prone to their adverse health effects.

In this brief, we explore the role of regenerative agriculture in soil health, and suggest the following measures to improve impact:

1. Support integrated agroecological farming infrastructure
2. Invest in innovative supply chains and products
3. Enable farming of local resilient foods

SHEFS

What is the Problem

The unchecked use of chemical fertilisers and pesticides has damaging consequences at multiple levels. In the soil, intensive chemical use can disturb microbial communities and natural nutrient cycles. These chemicals may even leach into irrigation or rainwater runoff, making water bodies unsuitable for aquatic life or human use. While intended to boost crop health and keep pests at bay, these chemicals often also harm or dissuade natural pollinators and pest control such as bees, birds, insects, earthworms, amphibians and reptiles. In the absence of proper application protocol, farmers using these chemicals may also suffer from their toxicity.

Farmers across India are trying out various natural regenerative agriculture methods, but the effect of these methods on soil health remains understudied. Among the well-known regenerative agriculture methods are no till, cover cropping, crop rotation, mixed cropping, and use of natural home- or farm-based nutrient mixtures for soil rejuvenation. These passive and active measures for soil regeneration can have different outcomes for soil microbial communities and soil nutrient composition. Together, soil microbial communities and nutrient composition significantly influence the growth and yield of crop plants. There is a need for scientific evidence to promote appropriate practices to enhance agricultural productivity.

Understanding the problem

External drivers

Ready availability

Guaranteed outcomes

Chemical inputs to agriculture are damaging soil health

Soil health impacts plant and agricultural productivity

Chemical inputs also contaminate water and harm wildlife

Chemical contamination impacts human and wellbeing

Impaired livelihoods, food security, and nutrition outcomes

External impacts

Biodiversity loss

Lowered productivity

SHEFS

atree

The Research

Introduction

Research was carried out to determine the influence of various regenerative agriculture practices carried out over different lengths of time (≤3 years and >5 years), on soil nutrient and microbial health in comparison to conventional (chemical) agriculture and barren land and eucalyptus planted soil, around Bengaluru district. Barren land soil formed the negative control, while the eucalyptus plantation land soil was taken here to understand the impact of monocultures on soil health.

Regenerative agriculture plots were using a mix of practices including application of Jeevamrutha, Beejamrutha, no-till, farm manure, neem oil for pest control, crop-rotation, inter- and mixed-cropping, seed treatment with Pseudomonas and Trichoderma, mulching, vermicompost and Panchgavya etc. Two crops – ragi and vegetable (tomato/beans) were considered for the study.

Methods

Collected soil samples were each assayed for electrochemical properties, and for major and minor nutrient composition. DNA was isolated from the soil and sent for 16S metagenomics analysis to determine the bacterial composition in each of the samples. Following this the obtained sequences were analysed using multiple softwares to determine the bacterial community structure in each and to compare with corresponding samples.

SHEFS

atree

Findings

A more heterogeneous bacterial community structure was observed in regenerative plots, with higher representation of phyla such as Actinobacteriota, Firmicutes, and Cyanobacteria, which are known to have a large proportion of beneficial bacterial genera. A comparison for the Plant Growth Promoting Rhizobacteria (PGPRs) showed an enhanced representation of Pseudomonas spp in regenerative vegetable plots, and a similar abundance of Bacillus spp and Mesorhizobium spp in regenerative ragi plots. Enrichment for these PGPR genera in regenerative soils have been reported to have significant beneficial attributes associated with the vegetable and ragi crops respectively.

All regenerative agriculture practices were almost equally successful in boosting bacterial composition in soil. Almost all regenerative agricultural plots considered in the study use farmyard manure, which has been ascribed to inducing increased microbial biomass in soil. One of the regenerative plots taken from Hosur which was practicing regenerative agriculture for 10 years with heavy application of cow dung (400 kg per row) showed the best bacterial profile, and a Soil Organic Content (SOC) of 0.51% which is in the ideal range. Although all other plots showed SOC and nitrogen at less than ideal levels, all other micro- and macro-nutrients were found to be in ideal range in all plots. This indicates that despite no application of chemical fertilization the regenerative agriculture practices were capable of maintaining required composition for most nutrients while also being able to build soil's organic carbon reserves.

Regenerative agriculture farms displayed better soil bacterial diversity, as well as improved nutrient composition, including enrichment of soil organic carbon.

What can be done?

Various existing programmes of the government prescribe regenerative agriculture practices. Operationalising them involves extending support to farmers in the form of infrastructure and training. Infrastructure such as soil testing and composting facilities, as well as finance to develop these n eeds to be made more accessible to farmers. Training farmers in regenerative techniques and regimes is equally important.

Regenerative agriculture can benefit from scalable volumes of organic inputs to improve soil health, such as household vegetable waste and animal manure. In cases where this is inaccessible to smallholder and non-animal farmers, it can be made available by tying up with local citizen, dairy, and poultry cooperatives. The onus of ensuring the quality and safety of the waste can be shared by the farmers and the cooperatives.

Current market labelling and consumer awareness tends to focus on organic production, sustainable packaging, and fair trade. Regenerative agriculture can be incentivised by partnerships to enhance public awareness and demand through campaigning. Further incentives can include incorporating soil health as an indicator in environmental credit programmes.

Solving the problem

Related SDGs

Operationalise regenerative agriculture guidelines

Extend infrastructure support for soil testing, regenerative farming inputs, facility financing, and farmer training

Strengthen circular economies for inputs

Collaborate with dairy, poultry, and citizen cooperatives to source affordable and safe waste products for regenerative farming inputs

Support market linkages for outputs

Improve market accessibility and visibility of regenerative agriculture through labelling, and private partnerships to incentivise regenerative agriculture

SHEFS

atree

How?

Operationalise

Infrastructure support for:

- Soil testing
- Farm finance
- Rregenerative inputs

through the NABARD's National Programme on Organic Farming

Farmer training through:

- Krishi Vigyan Kendra
- Indian Council of Agricultural Research
- Ministry of Agriculture and Farmer Welfare's Doubling Farmer Income programme

Regenerative commitments through:

- Agrobiodiversity Agenda
- National Mission on Sustainable Agriculture
- Organic Mission of India

Strengthen

Aggregated farm inputs from:

- Citizen collectives (household waste)
- Dairy and poultry cooperatives or boards (animal waste)
- Farmer Producer Organisations

Link

Public awareness and access through:

- Campaigning by brands
- Organic Mission of India

Tradeable incentives for farm soil health through partnerships with:

- Indian Agricultural Research Institute
- Private players

Policy Brief produced in 2022 by the Ashoka Trust for Research in Ecology and the Environment (ATREE) under the Sustainable and Healthy Food Systems (SHEFS) programme.

Prepared by:
Indira Singh, Rasika TS, and Mallika Sardeshpande

Design by:
Chendil Kumar P.