# Letting the Land Heal: What We Gain

Raah FOUNDATION

RAAH FOUNDATION'S CENTRE FOR POLICY RESEARCH AND ACTION

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# Index



# Disclaimer

This report is based on a combination of publicly available data, academic research, stakeholder consultations, and primary data collected from field sites in Maharashtra under Raah Foundation. Field insights have been gathered through direct interactions with farmers, community members, and practitioners, with careful attention to ethical engagement and representation.

Every effort has been made to ensure the accuracy, validity, and contextual sensitivity of the information presented. Any unintended inaccuracies, omissions, or misrepresentations are unintentional, and corrections are welcomed. The report does not include any proprietary, classified, or confidential material.

This document is intended to inform public discourse, advance policy engagement, and promote awareness of regenerative agriculture as a viable pathway for ecological restoration and rural resilience. The authors and the publishing organisation respect the intellectual, cultural, and experiential knowledge of all contributors and communities involved in this research and do not claim ownership over traditional or indigenous practices.

We remain committed to transparency, accountability, and respect for all forms of knowledge shared during the course of this research.

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# Executive Summary

This report builds a comprehensive case for regenerative agriculture as a transformative model for India's farming futures. It is anchored in the lived realities of farmers in Maharashtra, informed by interdisciplinary scholarship, and guided by the twin objectives of ecological restoration and livelihood resilience.

This report seeks to address a fundamental question:

> How can India cultivate an agricultural system that is ecologically just, economically viable and socially equitable?

The answers lie not only in policy reform or technological innovation, but in reimagining the very ethos of agriculture - as a regenerative relationship with the earth, rooted in care, reciprocity, and resilience.

This report is not a blueprint, but an invitation: to farmers, policymakers, researchers, civil society actors, and communities to come together in pursuit of a regenerative agricultural future. In the face of climate collapse and rural precarity, the call is clear - to shift from extraction to regeneration, from monoculture to diversity, from dependency to sovereignty.

# An Overview of Chapters

**'Unearthing the Crisis'** lays the groundwork by examining the evolution and current state of traditional agricultural practices in Maharashtra. It explores the systemic vulnerabilities arising from input-intensive models, the environmental degradation they have catalysed and the differentiated impacts on regions, gender and generations.

**'What is Regenerative Agriculture? A Paradigm Shift in Practice'** introduces the conceptual and practical foundations of regenerative agriculture. It synthesises ecological science with field-based knowledge, detailing core principles, practices, and the social-ecological co-benefits that regenerative farming systems offer in a climate-unstable world.

**'What it Takes to Farm Differently: Comparing Costs'** presents a comparative cost analysis of diverse cropping systems in the Northern Western Ghats. By juxtaposing regenerative, conventional and organic models, it provides granular evidence on the economic implications of transitioning to ecologically sound practices.

**'From Scheme to System: Rethinking Agricultural Policy for Regeneration'** critically analyses the policy and institutional ecosystem surrounding sustainable agriculture in India. It identifies existing gaps and offers a roadmap for strengthening the enabling environment for regenerative agriculture through financial, institutional and community-driven support mechanisms.

# Introduction

Agriculture is the backbone of India's rural economy. Yet it is also one of the most threatened by ecological damage and climate change. Over 60% of Indians rely on farming for their livelihoods. But modern farming methods often drain the soil, waste water, reduce biodiversity, and leave farmers in debt.

This crisis stems from seeing nature as something to control, not care for. Since the Green Revolution, many farmers have come to depend on chemical fertilisers, pesticides, and expensive seeds. Soils have lost fertility. Water tables have fallen. Small and marginal farmers suffer the most, especially women and communities in fragile areas.

Climate change further compounds these vulnerabilities: erratic rainfall, droughts, heat waves, and pest outbreaks now threaten food security and farmer livelihoods across India. As both a contributor to and victim of climate change, agriculture must urgently evolve beyond incremental adaptation toward systemic transformation. Regenerative agriculture offers such a pathway as a paradigm shift toward restoring soil health, enhancing biodiversity, improving water cycles, and rebuilding rural resilience.

For India's predominantly small and marginal farmers, regenerative approaches are not an ideal but a necessity. By reducing input costs, revitalising soils, conserving water, and diversifying incomes, they can offer ecological security and economic stability. Yet regeneration is also a social and political project for it challenges industrial agribusiness, elevates local knowledge and calls for governance that empowers communities and decentralises decision-making.

CHAPTER 2

# Unearthing the Crisis

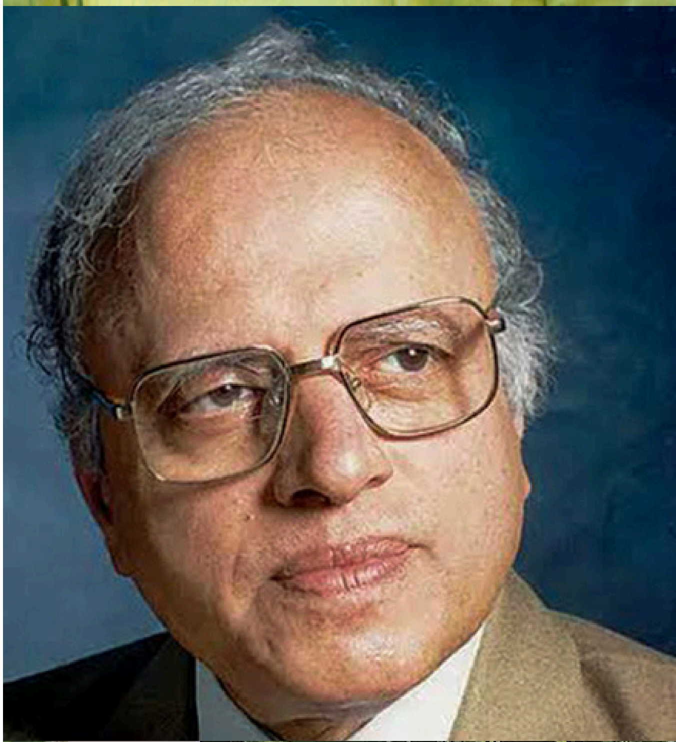
Maharashtra is one of India's most agriculturally significant states. It presents a complex landscape of traditional farming practices shaped by historical legacies, policy interventions, and ecological conditions. Through Green Revolution, agricultural practices across the state have undergone profound changes — transforming from community-driven, low-input systems to input-intensive, market-oriented models. While this transformation initially boosted yields and food security, it has also ushered in a host of systemic challenges that now threaten both the ecological foundations of agriculture and the socio-economic well-being of farming communities.

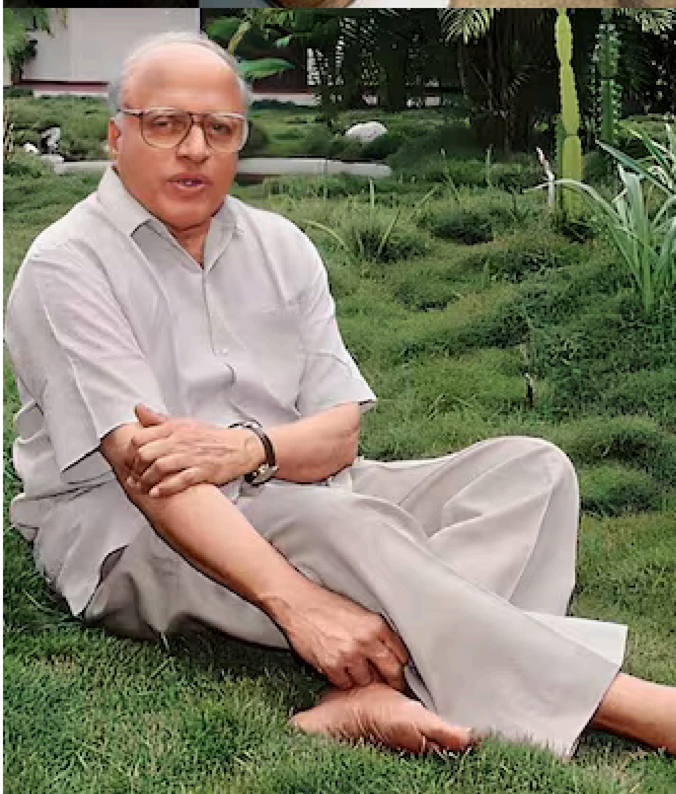
In Maharashtra, these traditional yet modernised practices include monocropping, excessive use of chemical fertilisers and pesticides, and a deep reliance on hybrid and genetically modified seeds. Regions like Vidarbha, Marathwada, and Western Maharashtra each tell a distinct story of how traditional agriculture has unfolded and the consequences it has left in its wake — from groundwater overextraction and soil nutrient depletion to farmer suicides and growing gender and youth inequities in agrarian life.

The environmental costs of this model are now stark. Soil organic matter is at critically low levels, groundwater reserves are drying up and biodiversity is in sharp decline. Simultaneously, the economic returns from farming have diminished. Farmers face rising input costs, volatile market prices, deepening debt, and persistent financial insecurity. These impacts are felt acutely by small and marginal farmers who make up over 80% of the state's agrarian population.

This chapter explores the defining characteristics of Maharashtra's traditional agricultural systems, detailing their ecological, economic, and social dimensions. It highlights the input-intensive nature of these systems, the shift toward monocultures and cash crops, the growing dependency on external institutions and inputs, and the ongoing degradation of natural resources. The chapter further examines regional variations in agricultural distress, the gendered and generational impacts of agrarian crisis, and the broader policy and institutional gaps that perpetuate unsustainable practices.

# The Green Revolution by M.S. Swaminathan





The Green Revolution of the 1960s introduced input-intensive farming practices in India with the extensive use of chemical fertilisers such as urea and diammonium phosphate (DAP), along with synthetic pesticides, to boost yields for staple crops like wheat and rice. While this shift initially led to increased food production, it created a dependency on chemical inputs, leading to long-term ecological and economic consequences.

According to the Indian Council of Agricultural Research (ICAR), the national average usage ratio of nitrogen, phosphorus, and potassium (N:P:K) stands at approximately 6.7:2.6:1, diverging sharply from the agronomically ideal 4:2:1 ratio. This imbalance has resulted in micronutrient deficiencies, soil fatigue and declining productivity over time. The overuse of pesticides in agrarian states like Punjab and Haryana has also been linked to serious health issues, including rising cancer rates symbolised by the so-called "cancer train" from Bathinda to Bikaner.

Economically, the per-hectare cost of fertilisers and pesticides has increased by an estimated 18–22% over the past decade, exacerbating the financial burden on farmers (NSSO & Ministry of Agriculture). Furthermore, prolonged reliance on agrochemicals diminishes the natural pest control functions of ecosystems, creating a cycle of increasing chemical dependence.

This system is compounded by the widespread adoption of hybrid and genetically modified (GM) seeds, particularly Bt cotton, which are predominantly supplied by multinational corporations such as Monsanto (now Bayer). These seeds are non-replicable, forcing farmers to purchase them afresh each season, with costs ranging between INR 2,000 and INR 4,000 per acre - excluding additional inputs. Research by the Central Research Institute for Dryland Agriculture (CRIDA) has found that many of these hybrids perform sub-optimally under rainfed and stress-prone conditions. Simultaneously, the cultivation of traditional, climate-resilient seed varieties has sharply declined. The National Bureau of Plant Genetic Resources (NBPGR) reports a significant erosion of indigenous seed diversity over the last three decades, raising concerns about long-term sustainability and food system resilience.

## Monocropping-induced Biodiversity Loss

The shift toward monocropping and the dominance of commercial crops in Indian agriculture has significantly altered land use patterns, biodiversity and food security. In Maharashtra, districts such as Jalna and Parbhani now devote over 80% of their cultivable land to cash crops like cotton and soybean which reflects a broader national trend of prioritising market-driven agriculture. The simplification of cropping patterns disrupts natural pest control cycles and undermines long-term sustainability.

The economic rationale for this shift is undermined by the volatility of global commodity markets; cotton prices, for example, fell by over 20% in the 2023–24 season due to international oversupply, highlighting the income instability inherent in monoculture-based systems.

This trend has precipitated a steep decline in agro-biodiversity. India has lost more than 75% of its native rice varieties over the past five decades, as reported by Navdanya and the FAO, a loss that undermines ecological resilience and adaptability to climate variability. Traditional intercropping systems like Baranaja in Uttarakhand, which once fostered ecological balance and minimised risk, have become increasingly rare.

This transition has come at the cost of traditional food crops such as pulses, coarse grains and millets. For instance, India experienced a 60% reduction in millet-growing area between 1966 and 2006. This in turn, contributed to dietary imbalances and reduced nutritional diversity (ICRISAT).

Monocultures disrupt soil microbial diversity due to repetitive cultivation of single species, which results in homogenous root exudates and continuous chemical application, impairing essential nutrient cycling and long-term soil health.

Livestock biodiversity is also in decline, with traditional breeds of cattle, goats, and poultry increasingly replaced by crossbred or exotic breeds. These commercial breeds often require higher feed inputs and are more susceptible to disease, reducing their viability for resource-poor farmers in drought-prone or marginal areas.

The ecological consequences of monocropping extend to declines in beneficial insect populations; the FAO reports a 40% global reduction in pollinators like earthworms, and birds. Their sharp declines have been attributed to habitat fragmentation, excessive pesticide use, and the removal of trees and hedgerows from agricultural landscapes. This loss of supporting biodiversity further diminishes the productivity and ecological stability of farming systems.

## Input and Institutional Over-Dependence

According to NABARD's Financial Inclusion Survey, traditional farmers spend over 40% of their income on agricultural inputs such as seeds, fertilisers, and pesticides, straining their already limited financial resources. This input-intensive model has contributed to a pervasive cycle of indebtedness, with the National Sample Survey Office (NSSO, 2019) reporting that 52% of agricultural households in India are in debt.

Debt is a persistent and deeply rooted challenge in Indian agriculture, especially among small and marginal farmers. According to reports by NABARD, over 40% of marginal farmers rely on informal credit sources, including local moneylenders who charge exorbitant annual interest rates ranging from 24% to as high as 60%. Such exploitative borrowing practices create a cycle of debt that is difficult to escape, particularly when compounded by poor harvests and income shocks.

Access to formal credit remains inadequate for many farmers due to stringent collateral requirements and procedural hurdles. Although initiatives such as the Kisan Credit Card (KCC) aim to provide affordable institutional credit, their reach remains limited. Farmers frequently cite low awareness, cumbersome documentation, and delays in processing as major obstacles to availing these services. As a result, many continue to rely on high-cost informal loans for meeting their operational needs.

The lack of adequate financial safety nets exposes farmers to significant distress in the event of crop failure. With national-level crop insurance penetration hovering around 30%, the majority of farmers bear the brunt of climatic and market risks themselves. Recurrent loan defaults and the inability to break free from the cycle of indebtedness have been strongly correlated with psychological stress and agrarian distress. The highest rates of farmer suicides continue to be reported in states such as Maharashtra, Telangana, and Karnataka, highlighting the urgent need for comprehensive policy interventions that address both the economic and mental well-being of farmers.

Access to formal credit remains a major barrier; only 15–18% of smallholders receive loans from institutional sources, leaving the majority reliant on informal moneylenders who charge exorbitant interest rates ranging from 20% to 60% annually.

India’s agricultural extension infrastructure is severely under-resourced, with one extension worker for every 1,000 farmers, compared to the recommended ratio of 1:250. This limits farmers’ access to critical and timely information on crop management, pest outbreaks, market prices, and climate advisories. Furthermore, public procurement mechanisms, largely concentrated around rice and wheat, fail to adequately support the cultivation of millets, pulses, and oilseeds, despite their nutritional and ecological value.

The lack of comprehensive crop insurance further exacerbates risks. Although schemes like the Pradhan Mantri Fasal Bima Yojana (PMFBY) were introduced to provide risk cover, their implementation has faced criticism due to delayed claim settlements, low payout ratios, and limited farmer enrollment, undermining their intended protective role.

## Degradation of Natural Resources

Soil degradation has emerged as a critical environmental challenge facing Indian agriculture, particularly due to unsustainable land management practices. Continuous ploughing without adequate fallow periods disrupts the natural structure of the soil and accelerates the erosion of the nutrient-rich topsoil layer. The repeated mechanical tillage also reduces microbial activity essential for maintaining soil fertility and ecosystem services. Compounding the problem is the over-reliance on chemical fertilisers, often applied without the concurrent use of organic amendments such as compost or green manure.

This imbalance has led to a significant decline in Soil Organic Carbon (SOC), which is vital for water retention, nutrient cycling, and soil resilience. the Indian Council of Agricultural Research (ICAR) estimating that over 60% of

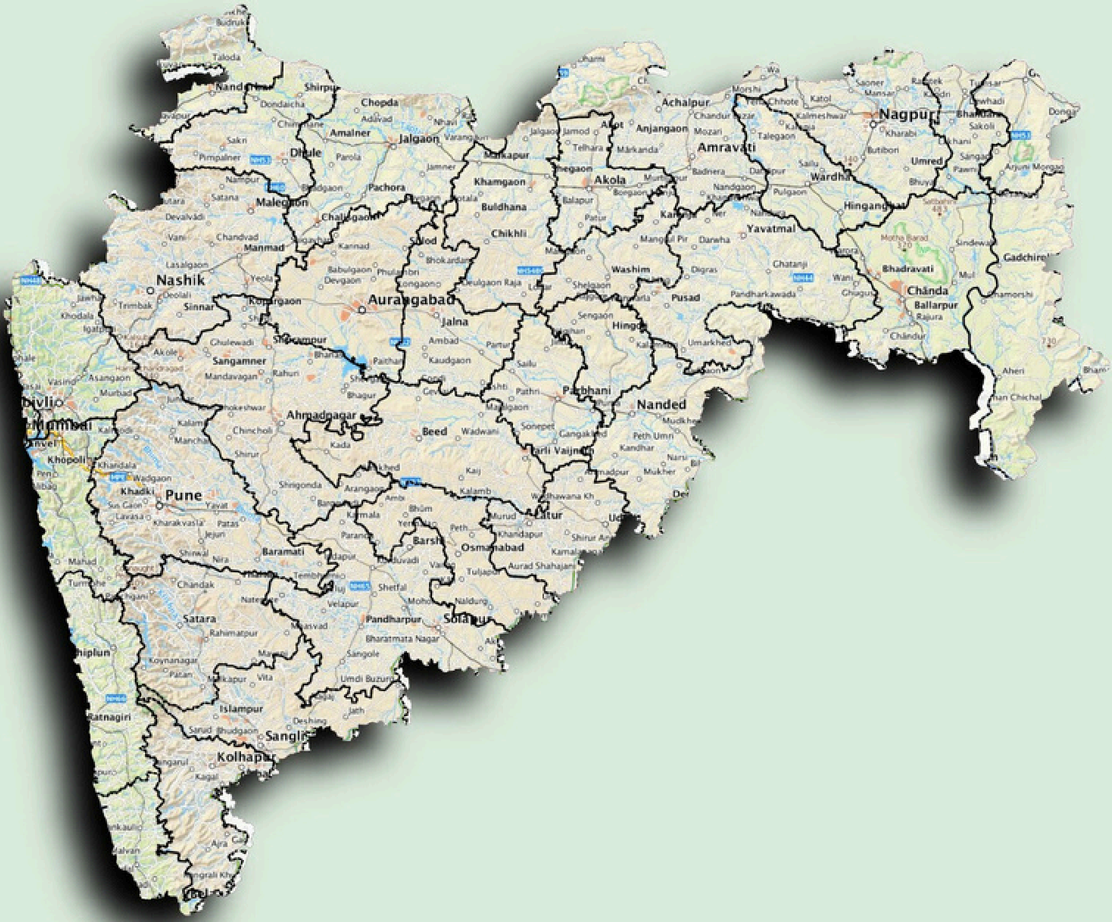
Indian soils contain less than 0.5% organic carbon - a critical threshold below which soil fertility, structure and water retention capacities are severely compromised.

The widespread nutrient imbalance in Indian soils further exacerbates soil degradation. The application of macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) is frequently skewed, with regional NPK ratios as disproportionate as 6:2:1, compared to the agronomically recommended 4:2:1. This imbalance has led to micronutrient deficiencies, particularly of essential elements such as zinc, boron, and sulfur, which affect crop health and yield. Moreover, the increasing use of heavy machinery has caused soil compaction in many regions. Compacted soils restrict root development, hinder microbial processes, and significantly reduce the soil's ability to absorb and retain water, increasing surface runoff and susceptibility to erosion.

Poor irrigation practices and inadequate drainage have led to the salinisation of more than six million hectares of agricultural land, rendering it less productive over time.

Parallelly, there is the acute overexploitation of groundwater resources. Crops like sugarcane, which require approximately 1,500–2,000 mm of water per growing cycle, are increasingly cultivated in drought-prone regions like Marathwada, furthering water stress. The Central Ground Water Board has reported that groundwater levels in over 256 districts have fallen below critical thresholds, reflecting a national trend of unsustainable withdrawal. Traditional flood irrigation practices, still prevalent across much of the country, result in water losses exceeding 60%, yet adoption of efficient systems like drip and sprinkler irrigation remains limited - covering barely 12% of irrigated land despite significant government subsidies (Ministry of Jal Shakti).

Additionally, the energy-water nexus contributes to this crisis; the provision of free or heavily subsidised electricity incentivises over-pumping of groundwater. In states such as Punjab and Maharashtra, agriculture accounts for more than 35% of total electricity consumption which reinforces unsustainable water use patterns and deepening the environmental strain on critical natural resources.




# A focus on Maharashtra

Maharashtra's diverse agro-climatic zones present starkly different experiences of climate vulnerability, agricultural distress, and natural resource stress. This section unpacks the regional variations across three key zones: Vidarbha, Marathwada and Western Maharashtra.

## Vidarbha

The Vidarbha region, encompassing districts such as Yavatmal, Amravati, and Wardha, has emerged as one of the most prominent hotspots of agrarian distress in India. Over the past two decades, it has consistently recorded a high incidence of farmer suicides. Between 2015 and 2022, Maharashtra witnessed over 13,000 farmer suicides, a significant proportion of which were concentrated in Vidarbha. The drivers of this crisis are multifaceted, involving structural and climatic vulnerabilities.

The Vidarbha region, encompassing districts such as Yavatmal, Amravati, and Wardha, has emerged as one of the most prominent hotspots of agrarian distress in India. Over the past two decades, it has consistently recorded a high incidence of farmer suicides. BA major factor is the region's dependence on cotton monoculture, particularly genetically modified Bt cotton. While Bt cotton was promoted as a pest-resistant variety, in practice it has led to increased input costs due to secondary pest infestations and the need for more fertilisers and pesticides. These costs are often financed through informal credit, which leaves small and marginal farmers vulnerable to debt traps, particularly in years of crop failure. Compounding this is the volatility of market prices for cotton, where the Minimum Support Price (MSP) frequently fails to cover the cost of cultivation, leading to negative returns for many cultivators.

Vidarbha is situated in a rain-shadow zone and receives between 700 to 900 mm of annual rainfall, making it naturally prone to water scarcity. This challenge is exacerbated by the increasing variability in the monsoon pattern, with delayed onset, erratic intra-seasonal distribution, and early withdrawal becoming more common. Such climate anomalies frequently lead to crop damage and reduced yields. The region also suffers from depleting groundwater resources. According to the Groundwater Surveys and Development Agency (GSDA), several blocks in Vidarbha have witnessed a consistent decline in groundwater levels, with many now classified as semi-critical or critical.

Irrigation coverage in Vidarbha remains among the lowest in the state, with less than 11% of agricultural land under assured irrigation. The region's reliance on rain-fed agriculture makes it particularly vulnerable to climate-induced shocks. Unlike Western Maharashtra, surface irrigation infrastructure in Vidarbha is minimal, and the expansion of micro-irrigation systems has been limited due to infrastructural and financial constraints.

## Marathwada

Marathwada includes districts such as Beed, Latur, and Osmanabad, it is one of Maharashtra's most drought-prone regions. It has experienced at least five major droughts over the last fifteen years. Annual rainfall in Marathwada ranges between 500 and 700 mm and is highly erratic, both temporally and spatially. In 2016, the severity of water scarcity reached such extremes that over 4,000 villages were declared drought-affected and drinking water had to be supplied via train tankers to Latur - a stark illustration of the region's chronic water insecurity.

Despite this acute water scarcity, the region continues to cultivate significant quantities of sugarcane - a crop that is extremely water-intensive. Sugarcane is grown on more than 5% of the region's agricultural land but consumes over 70% of its irrigation water. The crop requires approximately 20–25 million litres of water per hectare per year, much of which is applied through traditional and inefficient flood irrigation methods. The political economy of sugar, marked by the influence of powerful sugar cooperatives, has contributed to skewed cropping patterns that prioritise water-intensive cash crops over more climate-resilient and water-efficient alternatives.

Groundwater is the principal source of irrigation in the region, accounting for over 60% of irrigated land. The GSDA classifies more than 70% of administrative blocks in Marathwada as either semi-critical, critical, or over-exploited in terms of groundwater availability. The absence of robust monitoring mechanisms, including aquifer mapping, groundwater metering, and community-level regulation, has facilitated unsustainable extraction rates. This has led to a vicious cycle of groundwater depletion, poor recharge, and increasing dependency on deeper, costlier borewells.

## Western Maharashtra

Western Maharashtra, encompassing districts such as Pune, Satara, Sangli, and Kolhapur, benefits from a historically well-developed irrigation infrastructure. This region has leveraged perennial rivers like the Krishna and Bhima to build a relatively extensive canal network. Consequently, irrigation coverage in these districts is among the highest in the state, reaching up to 60% in some areas. However, this infrastructure-led growth has fostered a perception of water abundance, obscuring emerging risks of overexploitation and inter-sectoral competition.

The region is also the heartland of Maharashtra's sugar industry, with over 150 sugar factories concentrated in the area. The dominance of sugarcane monoculture has led to intensive application of chemical fertilisers and pesticides. Over time, this has degraded soil health, with declining levels of organic carbon and increasing cases of nutrient imbalance. Furthermore, nutrient runoff from fertilised fields has contributed to eutrophication in local water bodies, impacting aquatic ecosystems and water quality. Studies have also reported a reduction in agro-biodiversity and ecosystem services due to monoculture practices.

Despite relatively better access to surface water, Western Maharashtra is witnessing rising stress on its groundwater resources. The growing urban and peri-urban demand, particularly for drinking water and industrial use, is increasingly being met through groundwater extraction. In Pune district, for example, pre-monsoon groundwater levels have declined by 25–30% over the past decade. The compounding effects of climate change such as more intense rainfall events compressed into shorter durations, have reduced natural recharge efficiency and exacerbated groundwater stress.

Additionally, the rapid urbanisation of Pune and the industrial expansion in Satara and Sangli have intensified the pressure on water resources beyond the agricultural sector. Competing demands from domestic, industrial, and ecological sectors are beginning to strain the region's water security. This growing multi-sectoral demand, in the absence of integrated water resource management, threatens the long-term sustainability of Western Maharashtra's irrigation-led development model.

| Parameter | Vidarbha |
|---|---|
| Rainfall | 700–900 mm |
| Irrigation Coverage | < 15% |
| Dominant Crop | Cotton |
| Groundwater Status (GSDA) | Critical/Semi-critical |
| Soil Health Issues | Salinisation, Poor OM |
| Agrarian Distress | Very High |
| Water Use Conflicts | Moderate |

| Parameter | Marathwada |
|---|---|
| Rainfall | 500-700 mm |
| Irrigation Coverage | <18% |
| Dominant Crop | Sugarcane, Soybean |
| Groundwater Status (GSDA) | Over-exploited |
| Soil Health Issues | Degraded topsoil |
| Agrarian Distress | High |
| Water Use Conflicts | High (agri-centric) |

| Parameter | West Maharashtra |
|---|---|
| Rainfall | 800-1200 mm |
| Irrigation Coverage | >50% |
| Dominant Crop | Sugarcane, Horticulture |
| Groundwater Status (GSDA) | Emerging stress |
| Soil Health Issues | Nutrient imbalance |
| Agrarian Distress | Moderate, rising |
| Water Use Conflicts | High (multi-sectoral) |

# Social Dimensions of the Crisis

India's agrarian distress extends beyond economic and environmental factors. The impacts of agricultural crises are not felt evenly across society. Gender, age, and psychological well-being intersect with structural inequalities, shaping who bears the brunt and how they cope.

## Gendered Impact

Women play a foundational role in India's agricultural economy, contributing an estimated 60–80% of food production, particularly in labour-intensive activities such as sowing, transplanting, weeding, and post-harvest processing. Despite their centrality to agricultural productivity, much of this labour remains unpaid or significantly underpaid. The Food and Agriculture Organisation (FAO) highlights that in some regions, women carry out over 70% of agricultural work, yet are rarely recognised as farmers within formal policy frameworks. This invisibilisation results in their exclusion from key entitlements and benefits targeted at agricultural stakeholders.

The gender disparity in land ownership remains a significant structural barrier to women's economic autonomy in agriculture. As per the Agricultural Census 2015–16, women hold only 13.96% of the land. The gender disparity in land ownership remains for operational land holdings in India. This lack of legal ownership directly impedes their access to institutional credit, government subsidies, crop insurance, and participation in schemes such as the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN). The exclusion not only limits economic opportunities for women farmers but also reinforces their subordinate position in rural economies and households.

Women agricultural workers face systemic barriers in accessing financial and material resources. Despite comprising a substantial proportion of the rural workforce, they receive less than 10% of total agricultural credit disbursed in India. Prevailing social norms and institutional requirements such as the need for male co-signers on loan applications further curtail their financial independence. Consequently, women often rely on informal credit sources, exacerbating their vulnerability to debt cycles and economic shocks.

The widespread phenomenon of male outmigration to urban areas for wage labour has led to the feminisation of agriculture in many regions. In the absence of male household members, women are compelled to assume full responsibility not only for agricultural production but also for household maintenance, including tasks such as water and firewood collection, childcare, and eldercare. This double burden intensifies time poverty and physical fatigue, with significant implications for women's health, agency, and ability to engage in community life or education.

Despite their critical contributions, women remain underrepresented in institutional decision-making spaces such as Gram Sabhas, Panchayati Raj institutions, and farmer producer organisations (FPOs). This marginalisation limits their ability to influence agricultural policy, access extension services, or advocate for resource allocation. However, empirical studies suggest that women-led collectives and self-help groups (SHGs) tend to adopt more sustainable and community-oriented practices. Nonetheless, these groups remain peripheral to mainstream agricultural governance and extension systems.

## Youth Disengagement

A key driver of youth disengagement from agriculture is the widespread perception of the sector as economically unviable. Rising input costs, erratic climate conditions, and poor market linkages have reduced profitability. According to the National Sample Survey Office (NSSO) 2019 report, the average monthly income per agricultural household is INR10,218, with only INR 3,140 derived from cultivation activities. This income disparity renders farming unattractive to younger generations, who seek more stable and lucrative employment alternatives.

Youth migration from rural areas is a growing demographic trend driven by limited livelihood opportunities in agriculture. The Census of 2011 reported approximately 215 million internal migrants in India, a substantial portion of whom are rural youth moving to urban centers. However, this migration often results in employment in the informal sector, characterised by low wages, poor job security, and hazardous working conditions. The absence of robust support systems in both rural and urban areas exacerbates economic and social precarity.

The disengagement of youth from agriculture has led to the erosion of traditional knowledge systems that are essential for sustainable and adaptive farming practices. Intergenerational transmission of indigenous knowledge related to local seed varieties, soil management, and ecological stewardship—is being disrupted. Furthermore, the increasing adoption of mechanised farming and standardised educational curricula further alienates youth from context-specific knowledge, weakening the cultural and ecological fabric of agrarian communities.

Agricultural education in India is limited in scope, poorly resourced, and often misaligned with contemporary needs. Existing institutions seldom offer interdisciplinary or practical curricula that can prepare youth for agro-entrepreneurship or climate-resilient farming. Additionally, the dominance of urban-centric, technology-driven education leaves rural youth ill-equipped to pursue livelihoods in agriculture. Bridging this disconnect requires reforms in both formal education and vocational training systems tailored to the needs of agro-based rural economies.

## Mental Health Issues

Indian farmers increasingly face chronic psychological stress resulting from climate variability, crop failures, pest infestations, and price volatility. The unpredictability of yields and returns, compounded by inadequate institutional support, contributes to persistent anxiety, depression, and feelings of helplessness. Structural factors such as the dismantling of public procurement systems and the rising cost of inputs have made small and marginal farmers particularly vulnerable to market shocks and debt cycles.

One of the most visible and tragic manifestations of agrarian distress is the farmer suicide crisis. According to the National Crime Records Bureau (NCRB), 10,881 suicides were reported among farmers and agricultural labourers in 2021. A major contributing factor is indebtedness from non-institutional sources such as moneylenders who charge exorbitant interest rates. A study by the Tata Institute of Social Sciences (TISS) found that 79% of farmer suicides in Maharashtra's Vidarbha region were linked to unsustainable debt burdens, indicating a failure of both market mechanisms and policy interventions.

Mental health services in rural India are severely underdeveloped. The ratio of mental health professionals to the population is significantly below World Health Organisation (WHO) recommendations, with an average of one psychiatrist per 10,000 people in rural areas. The absence of psychologists, counselors, and community health workers exacerbates mental health challenges. Additionally, deep-rooted stigma around mental illness prevents individuals from seeking support, further entrenching distress and social isolation.

The consequences of agrarian distress extend beyond the individual farmer, affecting entire households and communities. Women, particularly widows of suicide victims, often face social ostracisation, loss of land rights, and inherited debt burdens. They may be forced to take on precarious labour to sustain their families.

Children in these households are more likely to drop out of school, engage in child labor, or experience psychological trauma. These intergenerational effects underscore the urgent need for a holistic policy response.

CHAPTER 3

# Regenerative Agriculture: A Paradigm Shift

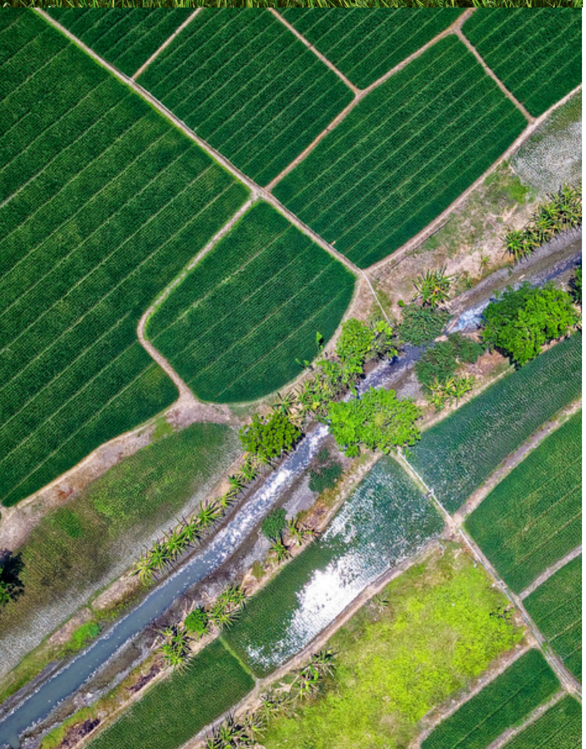
This chapter introduces regenerative agriculture as an ecological and systems-based approach to farming that aims not just to sustain but to actively restore the land. It begins by defining the concept and tracing its roots in both indigenous knowledge and contemporary ecological science. The model is positioned in contrast to conventional and organic farming across dimensions like soil health, input dependency, ecosystem integration, and climate impact.

The core principles explored include improving soil organic carbon, enhancing biodiversity above and below ground, managing water efficiently, reducing reliance on chemical inputs, and building resilience through diversification and farmer empowerment. These principles are illustrated through practices such as no-till farming, composting, polycropping, agroforestry, rainwater harvesting, and the use of indigenous seed varieties.

The chapter also presents the broader ecological, economic, and social benefits of regenerative methods from carbon sequestration and drought resilience to reduced input costs and strengthened local food systems. It also acknowledges the practical challenges to scaling such systems. It concludes with enablers and pathways for adoption, including capacity-building, policy support, and community-driven innovation.

# Agricultural Paradigms - A Comparison

| Dimension | Conventional Farming | Organic Farming | Regenerative Agriculture |
|---|---|---|---|
| **Soil Management** | Monocropping, intensive tillage, chemical use; leads to erosion and loss of fertility | Avoids synthetic inputs; may not actively restore soils | Actively builds soil organic matter; uses composting, low/no-till, green manuring |
| **Input Dependency** | High dependence on chemical fertilisers, pesticides, GM seeds; large subsidies | Uses natural inputs like neem, dung, etc., but may be externally sourced | Focus on internal nutrient and pest cycles using on-farm compost, nitrogen-fixing plants |
| **Ecosystem Integration** | Linear, industrial model; often leads to habitat loss and pollution | Includes some biodiversity practices (e.g., crop rotation), but remains product/yield-focused | Treats the farm as a living ecosystem; uses agroforestry, silvopasture, polycultures |
| **Climate Impact** | Major GHG emitter (~25% of global emissions); vulnerable to climate shocks | Reduces emissions by eliminating fossil-based inputs, but limited focus on sequestration | Sequesters 1.5–4 tons $CO_2$/ha/yr via practices like agroforestry, biochar, perennial crops |
| **Profitability & Resilience** | Short-term profits; long-term costs from degraded soil and high input expenses | Moderate profitability where markets allow; limited by certification and yield gaps | Lower input costs, diversified income sources (timber, carbon credits, etc.); greater long-term financial stability |
| **Farmer & Community Well-being** | High input costs, health risks, and debt burdens common | Better for farmer health; certification costs and market access can be barriers | Encourages autonomy, local markets, shared learning; supports women, smallholders, and indigenous knowledge |



# What is Regenerative Agriculture?

Regenerative agriculture is a holistic and systems-based approach to farming that seeks not merely to sustain, but to restore and enhance the health of ecosystems while producing food, fiber, and fuel. Unlike conventional or even certified organic agriculture, which often focus on minimising harm, regenerative agriculture is oriented toward active ecological improvement. It blends time-tested indigenous practices with contemporary ecological science to create resilient agroecosystems that regenerate soil health, conserve biodiversity, improve water cycles, and sequester carbon.

At its core, regenerative agriculture emphasises soil regeneration by building soil organic matter and enhancing microbial life through techniques such as composting, cover cropping, reduced tillage, and green manuring. It actively promotes biodiversity enhancement, both above and below ground, by integrating diverse crop rotations, agroforestry, silvopasture, and polycultures. The approach restores the water cycle through improved infiltration, reduced runoff, and enhanced groundwater recharge. Importantly, it contributes significantly to carbon sequestration by drawing atmospheric carbon into biomass and soil, thus playing a role in climate change mitigation. Moreover, regenerative systems revive critical ecosystem services such as pollination, nutrient cycling, and erosion control.

A key strength of regenerative agriculture is its integration of indigenous knowledge systems such as multi-cropping, seed saving, and natural pest deterrents with modern ecological science, including systems thinking, agroecology, and carbon farming methodologies. This synthesis enables the development of locally adapted and ecologically resilient practices that improve both farm productivity and community well-being.

Studies have shown that regenerative agriculture can significantly increase soil organic carbon stocks by approximately 3 to 6 tons per hectare per year depending on soil type, climate conditions, and specific practices employed (FAO; Rodale Institute).

In drought-prone regions, regenerative farms have demonstrated up to 30% higher yields than conventional systems, highlighting their capacity to buffer against climate extremes (Rodale Institute).

# CORE PRINCIPLES OF REGENERATIVE AGRICULTURE

## 1. ENHANCE SOIL HEALTH

- Soil organic carbon sequestration
- Increase microbial and fungal presence
- Prevent soil compaction and erosion

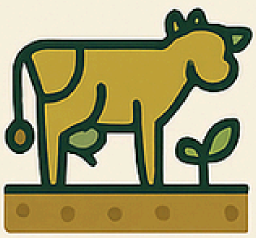
## 2. INCREASE BIODIVERSITY

- Above-ground biodiversity through agroforestry and polyculture
- Under-ground biodiversity through soll fauna and microorganisms

## 3. IMPROVE WATER MANAGEMENT

- Enhance soil water retention
- Surface runoff reduction
- Aquifer recharge
- Micro-irrigation and water-efficient crops

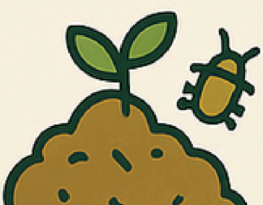
## 4. BUILD LONG-TERM FARM RESILIENCE



- Integrate crop-livestock system
- Diversify to mitigate market volatility

Enhance farmer education and indigenous knowledge collection

## 5. REDUCE EXTERNAL INPUTS



- Compost and green manure
- Natural pest management strategies
- Preservation of indigenous seed

# Soil-centric Practices

Soil health is the cornerstone of regenerative agriculture. Healthy soils support plant growth, sequester carbon, and enhance water retention which are critical to sustainable agricultural productivity and climate resilience.

## No-till or Minimum Tillage

No-till or minimum tillage refers to farming methods that minimise soil disturbance during planting. Rather than plowing or tilling the land, seeds are directly inserted into the soil, preserving its structure and microbial life. This practice can reduce soil erosion by up to 90% compared to conventional tillage methods (FAO, 2021), particularly in areas with high rainfall or sloped terrain. Additionally, no-till practices contribute to soil carbon sequestration, potentially increasing soil organic carbon by 10–20% over time (Lal, 2020). These benefits are accompanied by improvements in microbial activity and the stability of plant root systems, fostering long-term fertility. However, no-till farming may require special equipment and may not be feasible for all crop types or soil (Natural Resources Conservation Service, USDA).

## Cover-cropping

Cover cropping involves cultivating specific plant species, such as legumes or grasses, during fallow periods to protect and enrich the soil. This method reduces erosion by 60–70% (USDA, 2017), enhances nitrogen content through biological fixation, and improves soil aggregation and water infiltration. Moreover, dense cover crop growth helps suppress weeds and contributes to overall farm productivity. However, improper management may result in excessive biomass or allelopathic effects that hinder subsequent crops (Natural Resources Conservation Service, USDA; Economic Research Service, USDA).

## Composting and Biofertilisers

The use of compost and biofertilisers provides an organic alternative to synthetic inputs.

Composting recycles farm and household organic waste into nutrient-rich amendments, improving nutrient cycling, water retention, and microbial diversity. Biofertilisers—comprising beneficial microbial strains—enhance nutrient availability and soil vitality. These practices can reduce input costs by 30–40% while promoting a circular economy (FAO, 2019). Challenges include the time and technical knowledge required for proper application (FAO; Open Knowledge FAO).

# Crop Management Techniques

Diverse and well-managed cropping systems are central to the productivity and resilience of regenerative agriculture. These methods reduce pest outbreaks, enhance biodiversity, and stabilise yields under climate stress.

## Crop Diversification

Crop diversification entails the cultivation of multiple crop types in a single farming system rather than relying on monocultures. This practice disrupts pest life cycles and enhances disease resistance. Research indicates that crop diversity can reduce pest populations by up to 50% (Altieri, 2018). It also mitigates climate risks and promotes income diversification by catering to varied market demands. Nevertheless, diversified systems demand advanced planning and management skills (Taylor & Francis; BES Journals).

## Polycropping and Intercropping

Polycropping and intercropping involve the simultaneous cultivation of complementary crops within the same field. These systems mimic natural ecosystems and enhance

functions such as pollination and pest regulation. Intercropping with legumes, for instance, increases soil nitrogen content, while varied root structures help retain soil moisture. Such practices contribute to agroecological stability and dietary diversity, though they require careful selection of compatible crop species and understanding of their growth patterns.

## Use of Indigenous Seed Varieties

Indigenous seed varieties are locally adapted cultivars that demonstrate resilience to native climatic conditions and pests. They often require fewer inputs and play a vital role in conserving agrobiodiversity. These seeds are critical for climate adaptation strategies, particularly for smallholder farmers in ecologically sensitive areas. However, preserving and accessing these varieties remains a challenge, as they are increasingly displaced by commercial hybrids.

# Integration with Nature

Integrating trees, livestock, and native plant species into agricultural systems can amplify ecosystem functions, improve farm productivity, and sequester carbon.

## Agroforestry Systems

Agroforestry is a regenerative practice that incorporates trees into agricultural landscapes alongside crops and livestock. The inclusion of diverse plant species enhances soil fertility, supports water infiltration, and reduces surface runoff. Notably, agroforestry systems can sequester up to 20% more carbon than monoculture farming (Teixeira et al., 2021). Trees also provide economic benefits through timber, fodder, fruits, and medicinal products. Nonetheless, competition between trees and crops for water and nutrients necessitates careful planning (SpringerLink; ScienceDirect).

## Integrated Livestock Management

Integrated livestock management practices, such as rotational grazing, align animal husbandry with ecological processes. Livestock manure contributes to soil nutrient cycling and microbial health, with rotational systems increasing soil organic matter by up to 40% (Dunn et al., 2020). These systems also facilitate weed and pest control through managed grazing. However, poor planning can lead to overgrazing and land degradation (ResearchGate; SpringerLink).

## Natural Fencing and Living Borders

Natural fencing employs native plants such as vetiver, bamboo, or moringa to create protective and productive borders. These living fences stabilise soil, reduce erosion by up to 90% (National Academy of Sciences, 2018), and provide habitat for pollinators and beneficial insects. In addition, some species offer food and medicinal value, contributing to farm resilience. Initial setup can be resource-intensive, but the long-term ecological benefits are substantial (National Academies Press).

# Water Focused Interventions

Water management is a pivotal element in regenerative agriculture, particularly in regions facing water scarcity or erratic rainfall patterns. These interventions enhance water use efficiency and improve resilience to climate extremes.

## Rainwater Harvesting

Structures such as farm ponds, check dams, and percolation tanks capture and store rainwater for use during dry spells. These systems enhance water availability, reduce dependency on external sources, and improve groundwater recharge through infiltration. FAO highlights the value of rainwater harvesting in sustainable water management (Open Knowledge FAO). However, their feasibility depends on local rainfall patterns and requires upfront investment.

## Groundwater Recharge

Techniques such as recharge shafts, soak pits, and contour bunds are employed to enhance groundwater levels by facilitating water percolation into aquifers. These methods support long-term water sustainability and improve the quality of water through natural filtration. Regular maintenance and topographical considerations are crucial to their success (Open Knowledge FAO).

## Mulching

Mulching involves covering the soil with organic materials like straw or leaves to reduce evaporation, moderate soil temperature, and suppress weeds. This technique can reduce water loss by up to 70% (FAO, 2017), helping maintain soil moisture during dry periods. Mulching also protects the soil from erosion and improves fertility as the organic matter decomposes. The main limitation lies in the availability and replenishment of suitable organic materials (Open Knowledge FAO).

# Co-Benefits of Regenerative Agriculture

The paradigm shift offers a multidimensional framework for sustainable land use that integrates ecological integrity, economic resilience, climate mitigation, and social empowerment. Unlike conventional agricultural systems that often prioritise yield maximisation at the expense of environmental and human well-being, RA takes a holistic approach by restoring natural ecosystems, enhancing farmer livelihoods, and promoting adaptive capacity to climate variability. The co-benefits of RA extend far beyond productivity gains, providing a viable model for equitable and climate-resilient rural development.

## Ecological

One of the most well-documented ecological advantages of regenerative agriculture is its ability to enhance soil carbon sequestration. Practices such as no-tillage, cover cropping, composting, legume integration, agroforestry, and animal integration contribute to increased soil organic matter and improved microbial activity. A study published in Frontiers in Sustainable Food Systems found that these seven regenerative techniques are effective across both arable and woody perennial landscapes in sequestering atmospheric carbon into the soil, thereby establishing long-term carbon sinks.

In addition to sequestering carbon, RA is a powerful tool for restoring degraded land. Globally, approximately 25% of agricultural land is classified as highly degraded (FAO). Techniques such as crop rotation, silvopasture, and integrated livestock systems rebuild soil structure and fertility, reversing processes like desertification and salinisation. Notably, the FAO and WWF-Mongolia successfully restored over 292,200 hectares of degraded rangelands, while promoting Assisted Natural Regeneration (ANR) as a cost-effective method to accelerate ecosystem recovery by facilitating natural succession.

Another significant ecological benefit is the enhancement of biodiversity. RA fosters more complex and diverse agroecosystems by reducing chemical inputs and encouraging polycultures, tree integration, and natural pest management. These interventions support both aboveground biodiversity such as pollinators, birds, and insects and belowground biodiversity, including fungi, bacteria, and other soil organisms. The Institute of Sustainability Studies at California State University, Chico, highlights how RA systems create resilient ecological niches that strengthen pest resistance and ecological balance.

## Economic

Regenerative agriculture also presents robust economic advantages, particularly for smallholder and resource-poor farmers. One of the most immediate benefits is the reduction in input costs. By minimising the use of synthetic fertilisers, genetically modified seeds, and chemical pesticides, farmers can lower operational expenses while improving soil fertility through composting, green manures, and biofertilisers. According to case studies from La Via Campesina, farmers in India reported a 30–50% decline in input costs within the first two to three years of transitioning to RA.

Over the medium term, RA systems tend to enhance yield stability. Although some regenerative methods may involve initial yield reductions, numerous long-term studies, such as the Rodale Institute's 40-year trial, demonstrate that organic and regenerative systems achieve comparable or superior yields to conventional systems, especially during drought years. Improved soil health leads to better water retention and nutrient cycling, reducing variability in output and contributing to income security.

Moreover, RA enables income diversification through multiple agricultural outputs. The integration of beekeeping, livestock, poultry, agroforestry (for timber, fruit, and fuelwood), and cultivation of medicinal plants allows farming households to reduce economic risk and increase resilience to market volatility. The World Economic Forum and the World Business Council for Sustainable Development emphasise that while transitioning to RA carries certain short-term risks, the long-term business case is compelling when income diversification is taken into account.

## Climate Resilience

From a climate perspective, regenerative agriculture significantly improves the resilience of farming systems to extreme weather events. Healthier soils exhibit higher water infiltration and retention capacities, thereby reducing the impact of both drought and flood events. According to the Natural Resources Defense Council (NRDC), regenerative farms can store up to 20,000 gallons more water per acre than conventionally tilled land, a finding supported by Landcare Research. Mulching, cover cropping, and tree cover further stabilise microclimates and mitigate water evaporation and surface runoff.

RA also plays a critical role in enhancing food security, especially for vulnerable and marginalised communities. By stabilising yields, lowering input costs, and encouraging diverse cropping systems—including nutrient-dense crops like pulses, millets, and leafy greens—RA contributes to year-round food availability and improved nutrition. Reports from the Asian Development Bank show that conservation agriculture practices significantly benefit dryland wheat and maise production, improving both ecological and economic outcomes.

In terms of global climate mitigation, RA aligns with the objectives of the Paris Agreement and national climate policies. Practices that reduce tillage, enhance tree cover, and improve grazing management help sequester carbon, lower methane emissions from livestock, and cut nitrous oxide emissions from synthetic fertilisers. Project Drawdown estimates that widespread adoption of regenerative agricultural methods could mitigate up to 23.15 gigatons of $CO_2$ emissions by 2050. Scholarly reviews in journals like PLOS and ScienceDirect corroborate these findings by emphasising the role of RA in reducing soil carbon loss and enhancing soil carbon stocks.

## Social

Beyond environmental and economic gains, regenerative agriculture contributes significantly to social well-being and community empowerment. One of the core social benefits is its capacity to foster collective learning and traditional knowledge sharing. Community-based institutions such as farmer field schools and self-help groups provide platforms for experiential learning, peer-to-peer exchange, and the revival of indigenous knowledge systems ranging from crop calendars to natural pest control. These networks strengthen community cohesion and create a sense of ownership over local resources.

RA also plays a vital role in strengthening local food systems by promoting shorter and more transparent supply chains. Farmers benefit from direct-to-consumer models such as farmers' markets, farm-to-school initiatives, and community-supported agriculture (CSA), which can increase their profit margins while reducing dependence on volatile global markets. Localised food systems are also better positioned to withstand disruptions, including those arising from climate shocks or geopolitical instability.

Finally, RA contributes to women's empowerment and the inclusion of smallholder farmers. The low-cost, low-input nature of regenerative methods makes them particularly accessible to women and marginalised communities, who often face structural barriers in accessing land, capital, and technology. Women frequently lead key activities such as composting, seed saving, backyard agroforestry, and herbal medicine cultivation. These roles not only enhance household food security and income but also elevate women's leadership and decision-making in agricultural communities.

# Scaling Regenerative Agriculture - Challenges

A major constraint to the widespread adoption of regenerative agriculture among small and marginal farmers in India is the lack of awareness and technical know-how. According to the National Sample Survey (2021), only 6.8% of Indian farmers have received any form of formal agricultural training. Even more strikingly, data from ScienceDirect indicates that merely 1.2% have accessed training through Krishi Vigyan Kendras (KVKs); there is a critical gap in agricultural capacity building. Many regenerative practices such as cover cropping, composting, water harvesting, and mulching, require not only practical skills but also a nuanced understanding of agroecological contexts.

The deficiency is exacerbated by the limited availability of localised and language-accessible training materials and platforms. Traditional extension mechanisms have struggled to adapt, while farmers continue to rely heavily on agri-input dealers for agricultural advice. These dealers, incentivised by the sale of chemical inputs, often promote high-input solutions at the expense of sustainability. The lack of community-based knowledge-sharing networks and inadequate institutional support significantly impedes the transition toward regenerative practices.

Another key barrier to scaling regenerative agriculture is the risk of yield reduction during the transition period. The Food and Agriculture Organisation (FAO, 2022) estimates that yields may decline by 10% to 30% in the first few years depending on crop type, local agro-climatic conditions, and baseline soil health. This short-term decline poses a major threat to smallholder livelihoods, particularly when farmers operate on precariously thin margins and cannot afford a single failed harvest.

The ecological basis for this yield lag lies in the time required for soil systems to regenerate. Microbial communities and organic matter content can take between two to five years to reach a balanced and productive state. However, this risk is not universal. Empirical evidence from Andhra Pradesh's Community Managed Natural Farming (APCNF) initiative, as reported by Future of Food, shows that villages adopting regenerative methods have experienced an average yield increase of 11% in crops such as paddy, maize, finger millet, and red gram. These findings suggest that with appropriate support, the yield risks of regenerative transition can be mitigated or even reversed.

India's agricultural policy architecture continues to be oriented toward conventional, high-input systems. Subsidies, insurance mechanisms, and price supports remain largely geared toward monoculture production and chemical-intensive farming. Programs such as PM-KISAN and the Pradhan Mantri Fasal Bima Yojana (PMFBY), while substantial in coverage with disbursing over INR 1.70 lakh crore in claims, do not directly support regenerative or agroecological transitions.

Further complicating matters is the regulatory ambiguity surrounding regenerative agriculture. Organic farming benefits from national-level certification frameworks, but regenerative agriculture lacks a formal definition and institutional recognition in India. This absence hinders access to finance, extension services, and markets. Land tenure issues further impede adoption, particularly for tenant farmers who constitute an estimated 35% of cultivators in India.

In Telangana, for instance, 36% of farmers are tenants and are typically excluded from government schemes. Without land security, farmers have little incentive to invest in long-term soil health or biodiversity improvements.

Market challenges also discourage farmers from adopting regenerative practices. In the absence of a recognised certification system, regenerative produce lacks credibility in consumer markets. This undermines its potential to fetch price premiums or access niche retail segments. Unlike organic produce, regenerative crops are often sold in the same mandis as conventionally grown commodities, limiting opportunities for price differentiation.

Supply chain limitations further deter adoption. Infrastructure such as cold storage facilities, aggregation centers, and specialised transport logistics is often lacking, particularly for niche or diversified crop outputs. These constraints pose serious risks to market access, especially in remote or rainfed regions, thereby weakening the economic case for regenerative farming.

CHAPTER 4

# What it Takes to Farm Differently: Comparing Costs

This chapter presents a detailed comparative cost analysis of eight cropping systems practiced across the northern Western Ghats region of Maharashtra, a biodiversity hotspot marked by a fragile ecological balance, increasing land degradation, and climate-induced vulnerability. The crops paddy, millets (nachni/ragi), mango, cashew, amla (gooseberry), mahogany, food forests, and compact farming (vegetables/herbs) are representative of both rainfed and irrigated systems cultivated by small and marginal farmers in the region.

The analysis compares three primary agricultural models: **Regenerative Agriculture** (rooted in ecological principles, emphasising reduced external inputs, soil health restoration, and on-farm nutrient cycling), **Conventional Synthetic Agriculture** (relying heavily on chemical fertilisers, pesticides, and mechanised practices for short-term yield maximisation), and **Certified Organic Agriculture** (adhering to third-party organic standards with regulated input use and traceability, often attracting premium market pricing).

For each cropping system, the cost data is disaggregated into: **Material Costs** (e.g., seeds, fertilisers, pesticides/biopesticides, compost), **Labour Costs** (e.g., weeding, transplanting, harvesting, application of inputs), and **Fixed Costs** (e.g., land rent, certification, interest on working capital).

The cost ranges reflect both variability in practices and regional input prices based on field-level data collection and expert consultations. By juxtaposing these systems, the chapter aims to provide farmers, policymakers, and development practitioners with evidence-based insights into the economic trade-offs involved in transitioning from input-intensive to ecologically sound practices in the context of climate resilience and sustainable livelihoods.

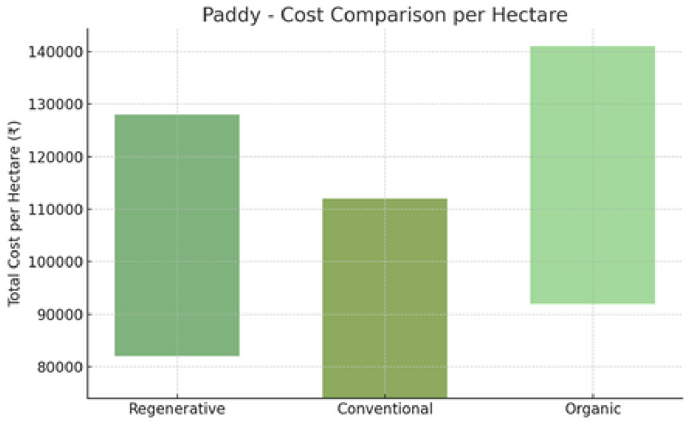
# Paddy

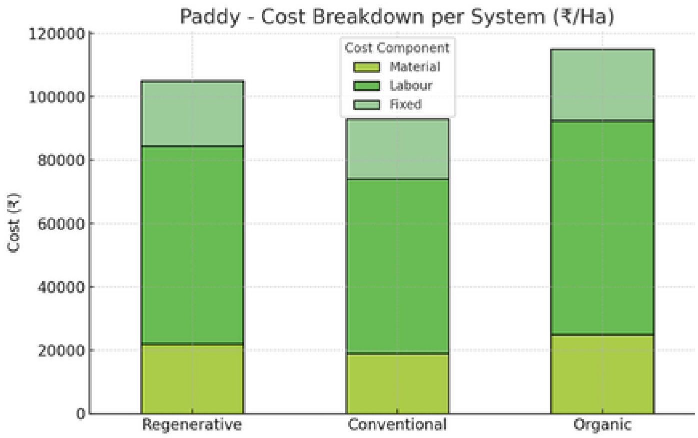
In paddy cultivation, labour costs dominate across all farming systems due to intensive activities like transplanting, weeding, and harvesting. Regenerative and organic systems incur higher labour due to the use of SRI techniques and manual pest management. Material costs are moderate but slightly higher in organic systems due to biofertilisers and compost. Fixed costs are uniform, with organic showing a bump due to certification.

Regenerative farming shows the highest overall cost primarily driven by labour (INR 40,000–60,000). This reflects SRI techniques like manual transplanting and weeding. Material costs range from INR 16,000–28,000, and fixed costs from INR 16,000–25,000.

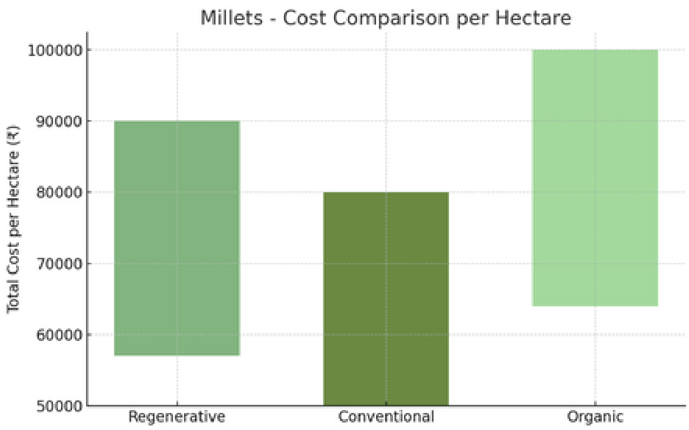
Conventional farming benefits from mechanisation and herbicides, keeping labour costs lower at INR 35,000–50,000. Material costs are INR 14,000–24,000, and fixed costs are INR 15,000–23,000.

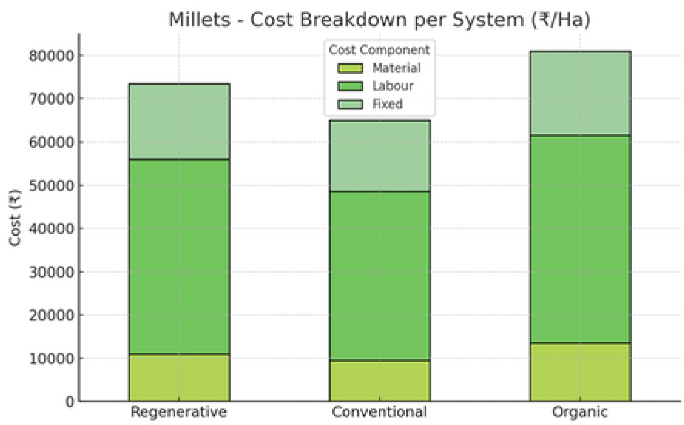
Organic farming reaches the highest total cost, with labour at INR 45,000–65,000, material costs at INR 19,000–31,000, and fixed costs (including certification) at INR 18,000–30,000.



# Millets




Millets are inherently low-input crops, which reflects in their cost structure. Labour remains the largest cost across systems, especially under regenerative and organic practices where manual weeding and compost use are common.

Material and fixed costs are relatively low and stable, making millets a cost-effective crop choice across all methods.

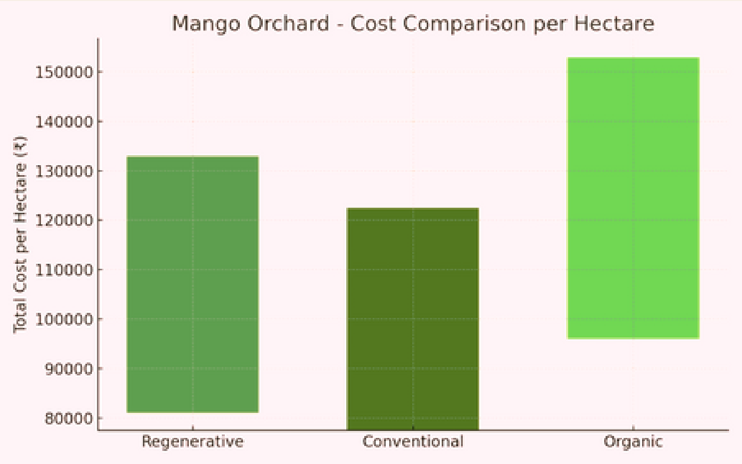
Regenerative systems show material costs of INR 8,000–14,000, labour INR 35,000–55,000, and fixed costs INR 14,000–21,000.

Conventional systems are cost-efficient, with material at INR 7,000–12,000, labour INR 30,000–48,000, and fixed costs INR 13,000–20,000.

Organic systems incur higher material (INR 10,000–17,000) and labour costs (INR 38,000–58,000), plus certification-linked fixed costs pushing that component to INR 16,000–25,000.

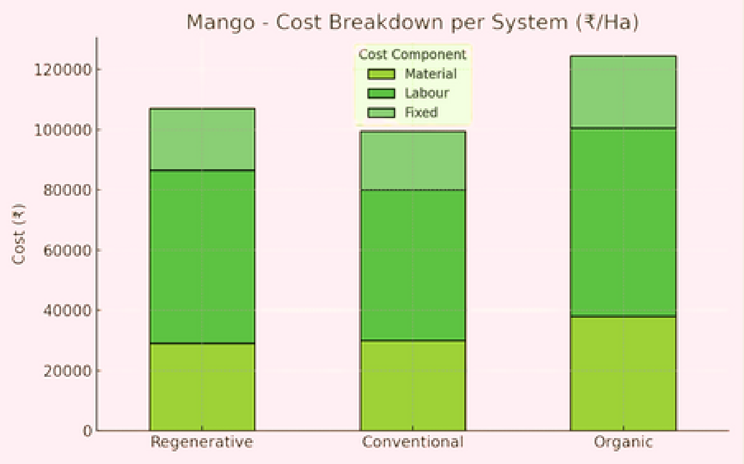
# Mango

Mango orchards show a significant increase in both material and labour costs under organic systems, largely due to compost, vermicompost, and manual pest management inputs like traps and botanical sprays.



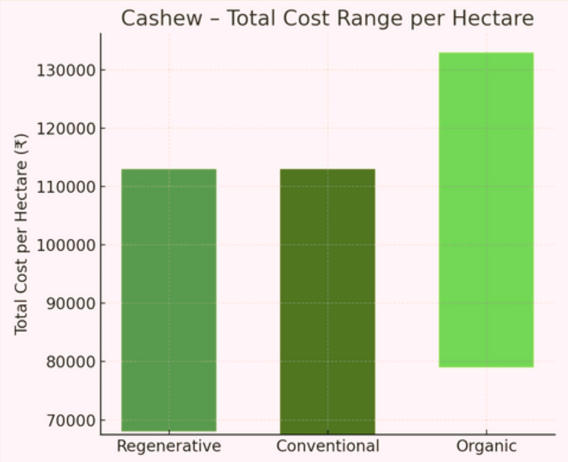

Regenerative systems aim to reduce these costs by improving ecosystem health. Fixed costs are comparable across systems, though organic includes certification.

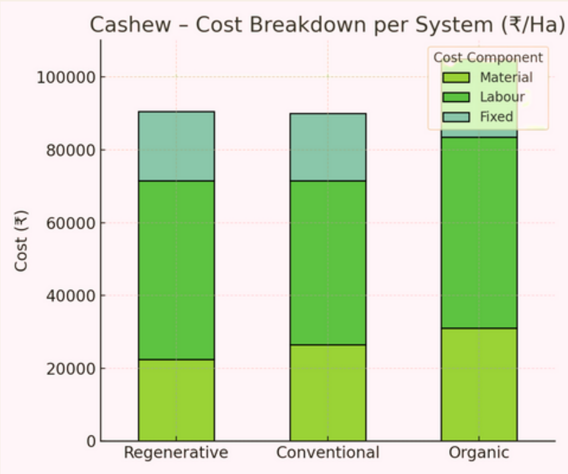
In Regenerative Agriculture, material costs are INR 20,000–38,000, labour INR 45,000–70,000, and fixed costs INR 16,000–25,000.




In Conventional Agriculture, material costs are similar (INR 22,000–38,000) but labour is slightly lower (INR 40,000–60,000), with fixed costs at INR 15,500–24,000.

Organic Agriculture shows the highest total costs, with material at INR 28,000–48,000, labour at INR 50,000–75,000, and fixed costs (with certification) at INR 18,000–30,000.




# Cashew

Cashew cultivation is labour-intensive, especially during nut collection and pruning. Organic systems have higher material and labour costs due to the use of organic manures and biopesticides, while conventional systems spend more on synthetic pesticides. Fixed costs are similar, with organic systems carrying extra certification burdens.

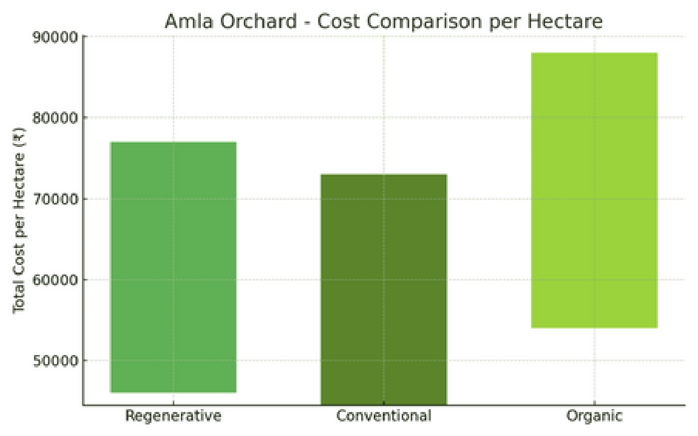
In Regenerative Agriculture, material costs are at INR 15,000–30,000, labour at INR 38,000–60,000, and fixed costs at INR 15,000–23,000.

Conventional Agriculture has slightly higher material (INR 18,000–35,000) and similar labour (INR 35,000–55,000), with fixed costs at INR 14,500–23,000.

Organic Agriculture has the highest expenditure with material costs of INR 22,000–40,000, labour at INR 40,000–65,000, and fixed costs at INR 17,000–28,000.

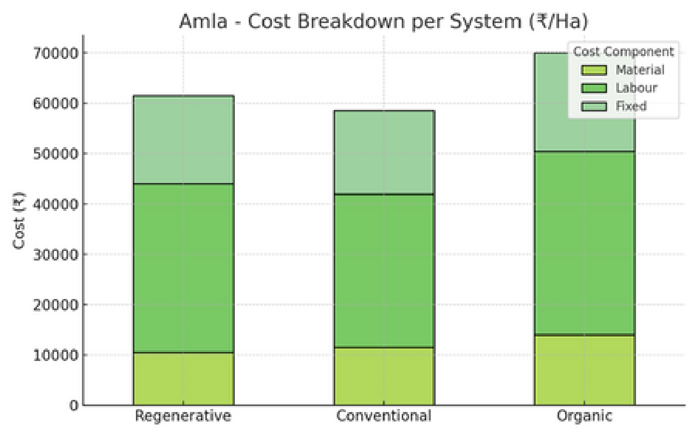
# Gooseberry (Amla)

Amla is a hardy, low-maintenance crop, and this is reflected in the modest cost distribution across all systems. Labour is still the largest component, mainly for weeding and harvesting. Material and fixed costs are lowest in regenerative and conventional systems, with organic systems incurring slightly more due to bioinputs and optional certification.



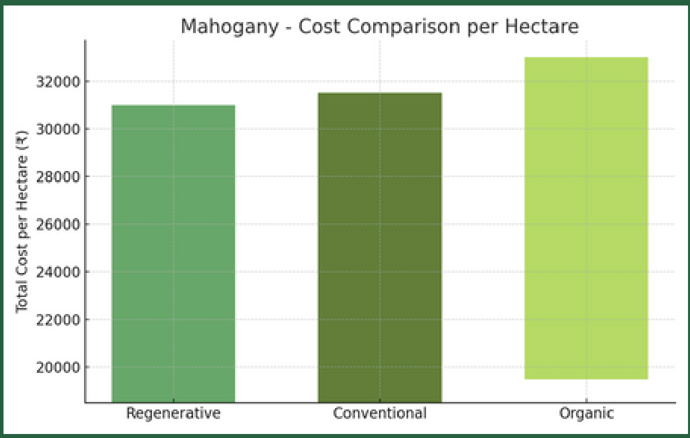

In Regenerative Agriculture, material costs are just INR 7,000–14,000, labour costs of INR 25,000–42,000, and fixed costs at INR 14,000–21,000.

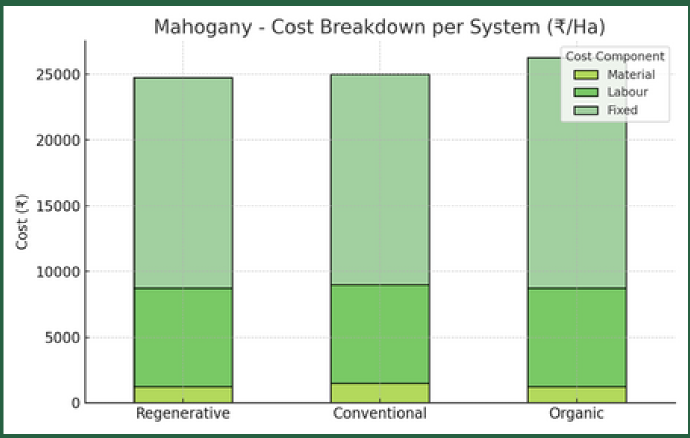
Conventional Agriculture has a similar structure with material costs at INR 8,000–15,000, labour costs at INR 23,000–38,000, fixed costs at INR 13,500–20,000.




With Organic Agriculture, costs increase slightly with material costs from INR 10,000–18,000, labour costs from INR 28,000–45,000, and fixed costs from INR 16,000–25,000 due to bio-inputs and optional certification.

# Mahogany



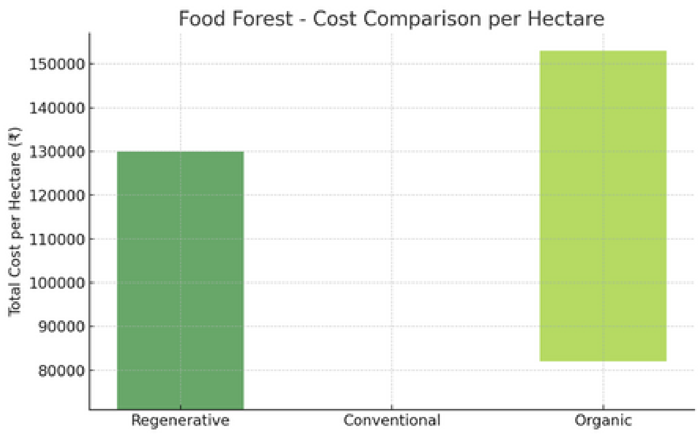

During its maintenance phase, mahogany plantations show minimal costs across all systems. Labour involves occasional pruning and monitoring. Inputs are nearly negligible, and fixed costs like land rent and interest form the bulk of expenses. There's little cost difference across systems since intervention is low at this stage.

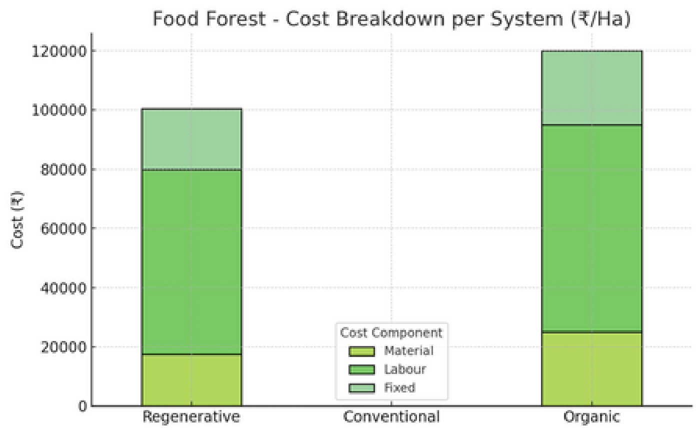
In Regenerative Agriculture, Conventional Agriculture, and Organic Agriculture systems all show similar costs in material INR 500–2,000, labour INR 5,000–10,000, fixed INR 13,000–19,000 (Organic can reach INR 22,000 with optional FSC certification).

# Food Forest

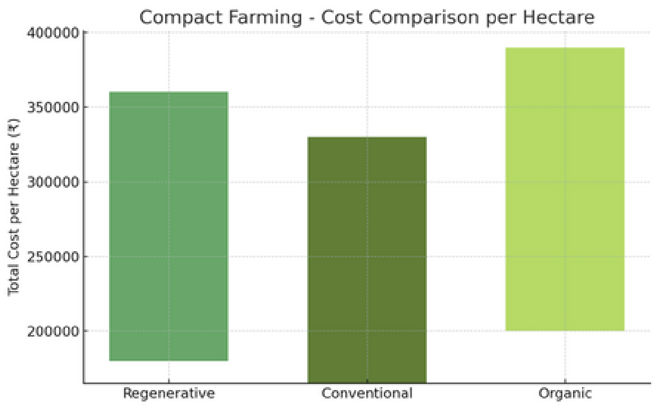
Food forests are labour-driven ecosystems. Regenerative systems prioritise internal cycling of nutrients, resulting in lower material costs. Organic systems, where attempted, may rely on purchased compost and carry higher fixed costs due to complex certification. Both systems require skilled management, reflected in the high labour share.

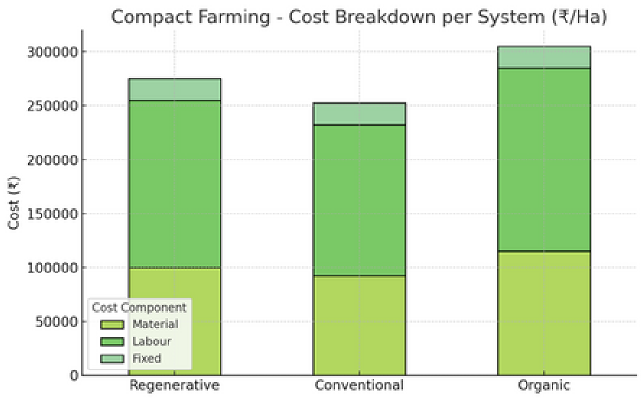
In Regenerative Agriculture, material costs are INR 10,000–25,000, labour INR 45,000–80,000, and fixed costs INR 16,000–25,000.
In Organic Agriculture, material costs jump to INR 15,000–35,000, labour to INR 50,000–90,000, and fixed costs to INR 17,000–28,000 due to certification challenges in multi-crop systems.



# Compact Farming




Compact farming systems (vegetables/herbs) are the most input- and labour-intensive, with labour and material costs surpassing all other cropping systems. Organic systems, in particular, incur steep costs for certified seeds, compost, and pest control. Fixed costs are comparatively minor, but the overall system requires significant capital and managerial investment.

In Regenerative Agriculture, material costs range from INR 70,000–1,30,000, labour INR 1,10,000–2,00,000, and fixed costs INR 16,000–25,000.

In Conventional Agriculture, material costs at INR 65,000–1,20,000, labour INR 1,00,000–1,80,000, and fixed INR 15,000–23,000.

Organic Agriculture has the highest costs across the board with material INR 80,000–1,50,000, labour INR 1,20,000–2,20,000, and fixed INR 18,000–30,000.

CHAPTER 5

# From Scheme to System: Rethinking Agricultural Policy for Regeneration

This chapter examines the evolving policy and institutional landscape that influences the transition to regenerative agriculture in India, with particular attention to Maharashtra. It begins by analyzing key national and state-level schemes like PKVY, NMSA, the Soil Health Card Scheme, PMKSY, Magel Tyala Shettale, and the Satyamev Jayate Water Cup to evaluate their effectiveness in promoting sustainable farming. While these initiatives have advanced awareness and infrastructure for climate-smart agriculture, their impact is often constrained by fragmented implementation, limited financial reach, and weak extension and market support for small and marginal farmers.

The chapter then proposes a strengthened policy roadmap grounded in five pillars: financial incentives, extension services and training, market development, community-based approaches, and institutional innovation. Recommendations include multi-year transition grants, input subsidies for regenerative inputs, payment for ecosystem services, the creation of Regenerative Agriculture Research and Training Institutes (RARTIs), and targeted support for women-led farmer groups.

Together, these measures offer a pathway for embedding regenerative practices into agricultural policy and governance, enabling a more inclusive, resilient, and ecologically sustainable farming systems in vulnerable rainfed regions.

# National-level Initiatives for Sustainable Agriculture

## Paramparagat Krishi Vikas Yojana

The Paramparagat Krishi Vikas Yojana (PKVY) is a flagship initiative by the Government of India aimed at promoting cluster-based organic farming through third-party certification or the Participatory Guarantee System (PGS). Under this scheme, 20-hectare clusters are encouraged for collective certification, thereby facilitating economies of scale in organic farming. Financial assistance of INR 50,000 per hectare over three years is provided, covering costs associated with organic inputs such as biofertilisers, vermicompost, and botanical extracts, as well as certification and marketing efforts.

PKVY has made significant strides, bringing over 32 lakh hectares under organic cultivation (Ministry of Agriculture and Farmers Welfare, 2023) and enhancing awareness among smallholder farmers regarding organic techniques. However, the scheme's emphasis on certification often comes at the expense of deeper ecological goals such as enhancing soil biology and increasing carbon content. Moreover, the cluster-based approach tends to exclude marginal and tenant farmers who may not have access to contiguous landholdings. Even among certified farmers, many struggle to access remunerative organic markets due to persistent infrastructural and market linkage gaps.

## National Mission for Sustainable Agriculture

The National Mission for Sustainable Agriculture (NMSA) comprises four key components: Soil Health Management (SHM), Rainfed Area Development (RAD),


On-Farm Water Management (OFWM), and Climate Change and Sustainable Agriculture Monitoring, Modelling and Networking (CCSAMMN). Together, these aim to enhance agricultural resilience against climate variability through the promotion of sustainable management practices, especially in rainfed and ecologically vulnerable regions.

Achievements of NMSA include the integration of climate adaptation frameworks into State Action Plans (SAPs) and the elevation of sustainable agriculture within national policy discourses. Nonetheless, its effectiveness is undermined by fragmented implementation, where programmatic silos limit convergence and synergy on the ground. Furthermore, while the mission emphasises adaptation, it insufficiently addresses regenerative agricultural principles such as soil restoration, agroforestry, and diversified polycultures. Monitoring and evaluation mechanisms remain weak, with limited follow-up at the field level to assess long-term impacts.

## Soil Health Card Scheme

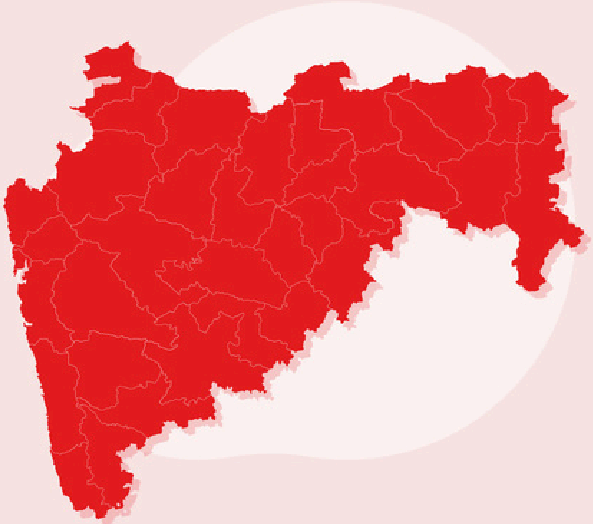
The Soil Health Card Scheme was launched to address nutrient imbalances in Indian agriculture by promoting soil testing and providing farmers with tailored fertiliser recommendations. Between 2015 and 2022, more than 22 crore Soil Health Cards were distributed (Department of Agriculture, Cooperation and Farmers Welfare, 2023), leading to a reported 8–10% reduction in chemical fertiliser use in some states (NITI Aayog, 2021). The scheme also contributed to increased awareness among farmers regarding soil health.

Despite these gains, the scheme suffers from several limitations. Most notably, field-level advisory support post-distribution remains limited. Soil health recommendations tend to be generic rather than location- and crop-specific, thereby reducing their effectiveness. Additionally, without ongoing monitoring or behavioural nudges, many farmers revert to traditional, imbalanced fertiliser usage over time.

## Pradhan Mantri Kisan Sinchayee Yojana (PMKSY)

The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) aims to improve water-use efficiency in agriculture under the slogan "More crop per drop." Its key sub-components include the Per Drop More Crop (PDMC) initiative for promoting micro-irrigation and a Watershed Development component aimed at improving soil and moisture conservation.

As of early 2024, the scheme has facilitated the expansion of micro-irrigation coverage to approximately 1.2 crore hectares, with notable successes in drought-prone states such as Maharashtra, Karnataka, and Gujarat (PMKSY Portal, 2024). However, the adoption of such technologies has been largely limited to medium and large farmers, with smallholders exhibiting resistance due to financial and behavioural barriers. The scheme also tends to prioritise infrastructural provision over demand-side water management strategies. Furthermore, maintenance and post-installation support for irrigation systems are inadequate, undermining long-term sustainability.



# State-level Initiatives for Sustainable Agriculture

## Magel Tyala Shettale

The scheme in Maharashtra aims to improve localised water security through the provision of financial subsidies, up to INR 50,000, to farmers for constructing farm ponds. Conditional co-funding by farmers is required to ensure ownership and cost-effectiveness. By 2022, the scheme had led to the construction of over 3 lakh farm ponds (Government of Maharashtra, Agriculture Department Report), enabling improved irrigation availability and facilitating second-crop cultivation.

However, several implementation challenges persist. In some instances, ponds were used for pisciculture rather than irrigation, deviating from the scheme's primary intent. Additionally, the absence of technical guidance regarding pond siting, sizing, and lining has led to sub-optimal outcomes in terms of water retention and utility.

## Satyamev Jayate Water Cup by Paani Foundation

Paani Foundation's Satyamev Jayate Water Cup represents an innovative, community-driven approach to watershed management. Villages voluntarily participated in a 45-day competition after undergoing rigorous training in water conservation practices. Between 2016 and 2020, the initiative resulted in the revival of groundwater in over 1,000 villages and the creation of over 10,000 crore litres of water storage capacity through decentralised watershed structures.

The competition model fostered high levels of community ownership, leading to sustainable outcomes in many participating villages. Its success prompted replication by several NGOs and CSR initiatives across the state. Nevertheless, scalability remains a challenge as the competition format limits continuous expansion. Additionally, some villages faced difficulties in maintaining momentum and technical capacity following the competition period.

# Limitations of Existing Policies

Despite the numerous initiatives at both national and state levels, several structural and systemic limitations continue to hinder their transformative potential. One of the primary issues is the lack of inter-departmental coordination across agriculture, water resources, environment, and rural development departments. The siloed nature of funding and execution often results in duplication of efforts or critical service gaps at the field level.

Procedural complexities and bureaucratic hurdles deter smallholders, particularly illiterate and marginal farmers, from accessing scheme benefits. Moreover, the lack of effective grassroots extension and awareness mechanisms limits the adoption of sustainable practices.

Many policies emphasise physical or quantifiable outputs such as the number of ponds constructed or drip kits installed rather than systemic ecological indicators. Consequently, key regenerative goals such as increasing soil organic matter, fostering agroecological diversity, or enhancing carbon sequestration are often neglected.

Current grant and subsidy structures are insufficient to facilitate the full transition to regenerative practices.

The average support is limited to a 2–3 year timeframe, whereas ecological recovery, particularly in degraded soils, often requires sustained investment over 5–7 years. There is an acute shortage of extension personnel trained in regenerative and climate-resilient farming. Existing training programs largely remain focused on conventional input-intensive agriculture, offering little support for system-wide transformation.

Even when farmers succeed in transitioning to sustainable practices, they often encounter barriers in realising premium prices for their produce. Certification costs remain high, and there is limited institutional procurement of organic or regeneratively cultivated goods. As a result, the economic incentive to continue sustainable farming remains weak.

# Strengthening Policy Support

As India advances toward a more sustainable and resilient agricultural paradigm, strengthening policy support mechanisms for regenerative agriculture becomes imperative. This section outlines key strategies across financial incentives, extension services, market development, community empowerment, and institutional innovation to enable a more comprehensive and scalable transition.

## Financial Incentives and Support Mechanisms

A transition to regenerative agriculture often entails short-term economic risks for small marginal farmers, particularly during the initial years when yields may temporarily decline. To address these transitional barriers, multi-year transition grants should be instituted, providing 3–5 years of financial assistance to offset income loss. Research from the FAO (2021) indicates that yield declines of 10–30% are common during the first 2–3 years of transition, making such support crucial. These grants should prioritise small and marginal farmers, who constitute 86.2% of India's farming population (Agricultural Census, 2015–16), and disbursements can be linked to verifiable milestones such as the adoption of no-till practices, cover crops, or biodiversity improvements.

Further, input subsidies can catalyze adoption by reducing upfront costs. Subsidising 50–70% of expenses for organic soil amendments like compost and biofertilisers, typically priced at INR 3,000–INR 5,000 per tonne, can ease financial burdens. Similarly, special subsidy categories for indigenous, climate-resilient seed varieties and the provision of free or low-cost cover crop seeds (e.g., legumes, millets) would promote agroecological diversity and resilience.

A Payment for Ecosystem Services (PES) framework could provide ongoing income for ecosystem stewardship. Annual payments of INR 2,000–INR 5,000 per hectare can reward measurable increases in soil organic carbon, using robust measurement, reporting, and verification (MRV) systems. Additional PES schemes could support farmers who maintain biodiversity plots, hedgerows, and agroforestry corridors, or invest in groundwater recharge infrastructure such as contour trenches and percolation ponds.

## Extension Services and Farmer Training Programmes

Institutional capacity building is foundational for the long-term success of regenerative transitions. The establishment of Regenerative Agriculture Research and Training Institutes (RARTIs) at the state level, modeled on the Krishi Vigyan Kendra (KVK) network but with a dedicated focus on agroecology, can serve as key knowledge hubs. These institutes should offer integrated curricula on soil health science, farm biodiversity, climate adaptation, and the economics of regenerative farming systems.

To disseminate this knowledge effectively, extension workers must undergo specialised training and certification in agroecology. A national target to train at least 10,000 extension workers in regenerative practices by 2028 could bridge current knowledge gaps at the grassroots level. Complementarily, Farmer Field Schools (FFS) should be scaled up, with one school serving every five villages and showcasing localised regenerative models such as no-till systems, crop diversification, and agroforestry. Seasonal farmer exchanges and experiential field visits would further reinforce learning.

Peer-to-peer learning networks also hold transformative potential. Identifying and supporting 1–2 lead farmers per 10 villages, with stipends and technical support, can anchor community-based knowledge systems. Digital platforms, including WhatsApp groups and region-specific knowledge hubs, can complement these efforts by facilitating real-time, localised knowledge exchange.

## Market Linkages and Value Chain Development

The absence of robust market incentives continues to hinder the widespread adoption of regenerative practices. A critical first step is the adoption of green procurement policies mandating that at least 25% of public food procurement, such as for school mid-day meals and anganwadi centers, be sourced from certified regenerative farmers by 2030. To make this viable, preferential pricing mechanisms should be introduced, offering a 10–15% premium for regenerative produce.

In parallel, public-private partnerships (PPPs) can drive the development of regenerative brands. These initiatives should focus on certification, marketing, and traceability. Technologies such as QR-code-based transparency systems can appeal to a growing segment of conscious consumers, urban demand for sustainable produce is growing at a 20% compound annual growth rate (IMARC, 2023). Branding efforts should emphasise farm-to-fork storytelling to highlight ecological and social impacts.

To reduce barriers to certification, policy should support Participatory Guarantee Systems (PGS) and group certifications, which are cost-effective and community-based alternatives to formal third-party audits. Group certification models can reduce average certification costs by 40–60%, enabling broader participation among smallholder farmers.

## Community-based Approaches

Community institutions are central to scaling regenerative agriculture in an inclusive and sustainable manner. Farmer Producer Organisations (FPOs) should receive tailored technical guidance, market aggregation support, and access to affordable credit products aligned with regenerative principles. Low-collateral credit with interest subvention (4–6%) can address the current financing gap for regenerative investments. Additionally, financial and logistical support for collection centers and cold storage can enhance value chain efficiencies.

Recognising the pivotal role of women in agriculture, policies must actively promote women's leadership. Funding for all-women FPOs focused on regenerative value chains (e.g., indigenous rice, organic spices) should be accompanied by dedicated capacity-building programs in leadership and financial literacy. A minimum target of 30–40% women's representation in program design and implementation committees should be institutionalised.

Lastly, Soil and Water User Associations (SWUAs) should be empowered to co-develop village-level soil health plans and water governance frameworks. Participatory soil health mapping and watershed planning should be co-financed through an 80:20 government-to-community model. Establishing revolving maintenance funds at the village level will ensure the sustainability of soil and water conservation infrastructure.



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