



सत्यमेव जयते

Government of Rajasthan

**Chief Minister's Rajasthan Economic
Transformation Advisory Council
(CMRETAC)**

DEPARTMENT OF PLANNING, RAJASTHAN

**POLICY STUDY ON
SUSTAINABLE AGRICULTURE**

CEEW
THE COUNCIL



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ASSOCIATES

Technical Support Organisation
CMRETAC

2022



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**Chief Minister
Rajasthan**



MESSAGE

Every state is important in the scheme of national development. We cannot assure the progress of India without the progress of the states. The Constitution binds us in a federal polity where every order of the government (Union, State and Local) has an important role to play.

State governments are certainly closer to the people and hence bear an enormous responsibility towards ensuring effective delivery of goods and services. In this endeavor, they have a direct, indirect and enabling role to play. Rajasthan is committed towards that goal and has been at the forefront of many reforms since long. Our sincere and unceasing efforts, during the pandemic and otherwise, have been recognized widely.

The Bhilwara COVID-19 containment “model” has been recognized as a replicable model globally. Ours was also one of the first states in India which came up with a comprehensive strategy for economic revival in the wake of the pandemic. Besides taking a plethora of immediate steps to extend social and economic relief to the people during COVID-19, Rajasthan has also introduced several transformative measures in the recent past to boost the economy of the state. Rajasthan Investment Promotion Scheme, 2019; Food Processing Policy, 2019; Tourism Policy, 2020; MSME Facilitation Act, 2019; Handicraft Policy 2022; and Rajasthan Investment Promotion Scheme, 2022 are some of the path breaking initiatives.

We have also started the practice of 'thematic' annual budgets for converging our efforts and energy on most pressing issues and have ensured that governance is truly decentralized. Our recent campaigns on 'Prashasan Shehron Ke Sang Abhiyan' and 'Prashasan Gaon Ke Sang Abhiyan' are examples of that spirit.

While our efforts are incessant, we are also aware that nation-wide structural slowdown of the economy and recurring shocks like the recent pandemic, call for an even greater effort. Towards this end, the state government in March 2020 set up Rajasthan Economic Transformation Advisory Council under my Chairmanship with the mandate to

suggest robust and resilient economic restructuring for the state. To ensure that the Council gets best possible advice, we invited eminent dignitaries and experts as members of the Advisory Council.

I am pleased to state that the Council has delivered a set of nine policy reports across areas as diverse as Fiscal Management; Managing Urban Informal Sector; Integrated Agro-Business Infrastructure; Sustainable Agriculture; Doing Business; Quantifying Intangible Cultural Assets; Education and the New Paradigm (bridging digital divide); Medical Services; and Public Private Partnership in Infrastructure. These policy areas may appear to be separate and discreet but one commonality that binds them all is that they are truly geared towards a bottom up approach to the development of the state. I urge my colleagues in the state government to also focus on inter-linkages in these policy areas for the best possible outcome.

While the Council is still at work with many new emergent areas that deserve attention, I am happy to state that the present policy study is very much a part of this endeavor.

I am grateful to the Members of the Council, my Ministerial colleagues, officers of the Government, all collaborators and organizations who have worked tirelessly to make this possible. My special acknowledgement of Shri Arvind Mayaram, Vice Chairman of the Council, whose leadership and contribution towards this endeavor has been extremely valuable. My appreciation is also to the entire team at the Council who have diligently worked to put these reform oriented reports together.

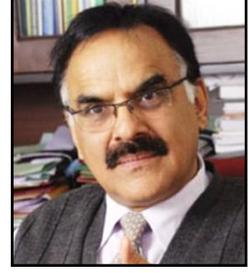


(Ashok Gehlot)



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**Economic Advisor to CM
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Transformation Advisory Council**



FOREWORD

Over the years, deepening agrarian crisis has caused decline in farmers' income and agricultural productivity. Increased frequency of climate shocks like droughts have aggravated soil degradation, water scarcity and crop failures, amongst other things. The Covid-19 pandemic has further brought significant disruptions and made policy makers reflect upon the vulnerability of the agriculture sector and communities that are dependent upon it.

Sustainable agriculture approaches like natural farming adopted by several states is therefore an area worth exploring for Rajasthan, particularly in light of the fact that close to a third of state GDP is dependent on agriculture and two third of population is rural.

Evidence from other states suggests that such practices are worth scaling up for the promise they hold for the farmers, consumers, ecology as well as the state economy. In other words, if scaled up, natural farming has the potential to transform local production, secure farm livelihoods, and generate employment while increasing nutritional security.

Many organizations and farmer bodies in Rajasthan have already been engaged in natural farming. However, the need is to vitalize such efforts and launch a coherent mission at scale which is informed by research and evidence. In doing so, there is also a need to appreciate and address the potential risks associated with transition and scaling up.

With this objective, CMRETAC commissioned a policy study to the Council on Energy, Environment and Water (CEEW) to determine the feasibility of natural farming in the state and suggest methods to scale it up.

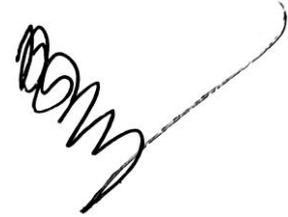
In this regard, this report serves as a guiding framework to relevant government departments to operationalize an effective scale-up. It also provides a framework for convergence between relevant departments, timely implementation of the plan and diligent risk management.

I am also pleased to state that Rajasthan's Organic Farming Mission 2022 has been informed by this study and is an encouraging step forward to build the momentum towards sustainable agricultural practices in the state.

I would add that this study is a robust body of work which must be considered in detail for a well-informed scale up. I express my sincere thanks to Hon'ble Chief Minister for providing continuous support and guidance, and congratulate CEEW and all collaborators for putting this timely study together.

The study would not have been so rich and comprehensive but for the very active and continuous support of all the concerned departments and their senior officers.

My special gratitude is to all concerned Ministers, esteemed members of CMRETAC for their valuable guidance, concerned departments and Technical Support Organization to CMRETAC.

A handwritten signature in black ink, consisting of several loops and a long, sweeping tail that curves upwards and to the right.

(Dr. Arvind Mayaram)

Acknowledgments

At the outset, the authors of this study would like to express their deepest gratitude to the Chairman of Chief Minister's Rajasthan Economic Transformation Advisory Council (CMRETAC) Hon'ble Chief Minister Shri Ashok Gehlot, Hon'ble Minister for Agriculture Shri Lal Chand Kataria, and Hon'ble Minister for Rural Development Shri Ramesh Chand Meena.

We are indebted to Dr Arvind Mayaram, Vice Chairman, for his valuable guidance, for being generous with his time, and for providing prompt feedback on our work. We are grateful to the members of CMRETAC who have guided this study from time to time. In particular, we express our sincere thanks to Shri Vijay Kumar Thallam, Executive Vice Chairman, Andhra Pradesh RySS, and member of CMRETAC for his sound advice and bringing perspectives from his experiences at Andhra Pradesh Community Managed Natural Farming (APCNF). We are also thankful to Shri Ashok Gulati, Infosys Chair Professor, ICRIER, and member of CMRETAC for his valuable guidance.

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Acronyms

ACZ	agro-climatic zone
AEZ	agro-ecological zone
AHD	Department of Animal Husbandry
APCNF	Andhra Pradesh Community Managed Natural Farming
APMC	Agriculture Produce and Livestock Market Committee
ATC	adaptive trial centre
ATMA	Agricultural Technology Management Agency
BRCs	bio-input resource centres
CIG	common interest group
CMRETAC	Chief Minister's Rajasthan Economic Transformation Advisory Council
CRP	community resource person
CSOs	civil society organisations
DAP	diammonium phosphate
DOA	department of agriculture
FGD	focus group discussion
FPO	farmer producer organisation
FYM	farmyard manure
GoR	Government of Rajasthan
GP	<i>gram panchayat</i>
ICDS	Integrated Child Development Services
ING	Indian Nitrogen Group
INR	Indian rupee
KfW	<i>Kreditanstalt für Wiederaufbau</i> ('Credit Institute for Reconstruction')
KUMS	<i>Krishi Upaz Mandi Samiti</i>

KVK	<i>Krishi Vigyan Kendras</i>
MOP	potassium chloride
MPUAT	Maharana Pratap University of Agriculture and Technology
MGNREGA	<i>Mahatma Gandhi National Rural Employment Guarantee Act</i>
NABARD	National Bank for Agriculture and Rural Development
NCNF	National Coalition for Natural Farming
NF	natural farming
NGO	non-governmental organisation
NPKS	nitrogen phosphorous potassium sulphur
NSS	national sample survey
NUE	nitrogen use efficiency
OMM	Odisha Millet Mission
PDS	public distribution system
PGS	Participatory Guarantee System for India
PMU	project management unit
PoP	package of practices
Rajeevika	<i>Rajasthan Grameen Aajeevika Vikas Parishad</i>
RKVY	<i>Rashtriya Krishi Vikas Yojna</i>
RSSOCA	Rajasthan State Seed and Organic Certification Agency
RySS	<i>Rythu Sadhikara Samstha</i>
SAPSS	sustainable agricultural practices and systems
SAU	state agricultural universities
SGVA	state gross value added
SOM	Sikkim Organic Mission
PK3Y	<i>Prakritik Kheti Khushal Kisan Yojana</i>
SRLM	State Rural Livelihood Mission
SSP	single superphosphate
SWOT	Strengths, Weaknesses, Opportunities, and Threats

WASSAN	Watershed Support Services and Activities Network
WRD	Water Resources Department
WSHG s	women self-help groups
ZBNF	Zero Budget Natural Farming

Executive summary

Natural farming (NF), a sustainable agricultural practice, is being adopted across 11 Indian states, with more than 6.5 lakh hectares (ha) covered under it.¹ There is initial evidence that it can benefit farmers in several ways, such as by contributing to income rise, nutrition security, and increased farm resilience. NF also promises benefits for the government, such as savings in power subsidies. Given this momentum, the Chief Minister's Rajasthan Economic Transformation Advisory Council (CMRETAC), under the chairmanship of the chief minister, commissioned the Council on Energy, Environment and Water (CEEW) to assess the following:

- Should Rajasthan scale up NF?
- If yes, how can Rajasthan scale up NF?

In response, CEEW pursued an eight-month-long study consisting of the following elements:

- Quantitative analysis of state's agricultural sector using data on more than 100 indicators obtained from 10 state departments and 13 local civil society organisations (CSOs).
- Review of state initiatives on sustainable agriculture in Andhra Pradesh, Himachal Pradesh, Odisha, and Sikkim.
- Consultation with 22 local CSOs (engaging more than 25,000 farmers) promoting NF.
- Field visits to NF pilots in four districts in different agro-climatic zones (ACZs), bringing together 61 officials from 20 district-level departments.
- A two-day state-level workshop with around 40 officials from 10 relevant departments to co-create the roadmap.

Based on this study, we recommend that Rajasthan invest in scaling NF in a phased manner with an adequate risk mitigation plan. We found that NF could provide substantial benefits to farmers, consumers, the state government, and the environment. If scaled up in a phased manner, the risks of not realising the expected benefits or risks of unintended impacts are low. Additionally, NF is also going to be easy to implement/adopt, if scaled up in a phased manner.

NF promises benefits on multiple fronts:

1. NF practices such as adding cover crops, intercropping, and the application of biostimulants could improve soil health and its water retention capacity and encourage water infiltration, in turn reducing the water required for irrigation

¹ Source: NITI Aayog: <https://naturalfarming.niti.gov.in/>.

by up to 60 per cent. This will improve farm resilience in water-scarce regions. Moreover, if merely 20 per cent of the state's farmers were to adopt NF, the government's annual power subsidy outlay could be reduced by INR 7.81 billion (INR 781 crore).²

2. The reduction in or absence of chemical input under NF could save cultivation costs by up to 60 per cent for crops such as wheat.³ Such cost savings can potentially improve farm incomes by 30–40 per cent, reducing farmer indebtedness.⁴ Improving farm incomes can help reduce the state's outlay on debt waivers, which amounted to INR 75.50 billion (INR 7,550 crore) during 2018–2020,⁵ and fertiliser subsidies, which amounted to INR 79 billion (INR 7,900 crore) as of 2021–2022 for Rajasthan.⁶ Reduced chemical use will also limit water, soil, and air pollution caused by excess nitrogen (N) and pesticides. Currently, the cost of N pollution to public health and the economy, ecosystem, and climate is estimated to be INR 261.40 billion (INR 26,140 crore), and the impact of pesticide pollution on human health is estimated to be INR 46 billion per year (INR 4,600 crore).⁷
3. NF improves crop diversity in farms, improving the nutrition of farming households and bolstering farm resilience.
4. NF practices and associated interventions such as 365 days of green cover, pre-monsoon dry sowing in Andhra Pradesh, and community water harvesting such as *khadin* in Rajasthan can unlock additional cropping cycles in rainfed areas, increasing the farm's net output per hectare in such regions, which would in turn increase farm incomes.

The extent of the benefits would vary across regions and cropping systems. For instance, while irrigated areas will benefit more in terms of reduced expenditure on power for irrigation, mitigating effects of groundwater pollution, and so on, rainfed regions will benefit more in terms of cropping intensity increase, and thus, an improvement in income and resilience.

The **risks** of not realising the expected benefits and the risks of unintended impact, however, persist because there is no conclusive evidence regarding NF's impact in

² Assumptions: (a) area under cultivation and cropping intensity remains the same, (b) the same proportion of farmers switch to NF across rainfed and irrigated regions, and (c) 20 per cent of farmers across Rajasthan switch to NF, resulting in a reduction of their average water consumption by 30 per cent, *ceteris paribus*.

³ CSO survey.

⁴ State IB report, APCNF, RySS, Department of Agriculture, Government of Rajasthan.

⁵ *Economic Review*, Government of Rajasthan, 2020.

⁶ Based on the yearly average fertiliser subsidy data (Central Government) and the total fertiliser subsidy allocated by the Government of India for the year 2014–2016 compared with 2021–2022 data.

⁷ Devi, PI, "Pesticide use in the rice bowl of Kerala: health costs and policy options," Working paper No 20–07 (2007). South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu.

Rajasthan. The main risk is related to the uncertain impact of NF on crop yields, and thus, food security. We propose two clear approaches to manage this risk: first, in the short term, it is better to focus on regions with lower yields (e.g., rainfed regions), thus lowering the risk exposure; second, in parallel, impact assessments of NF projects should be undertaken across Rajasthan to bridge evidence gaps and hence eliminate uncertainties in the future.

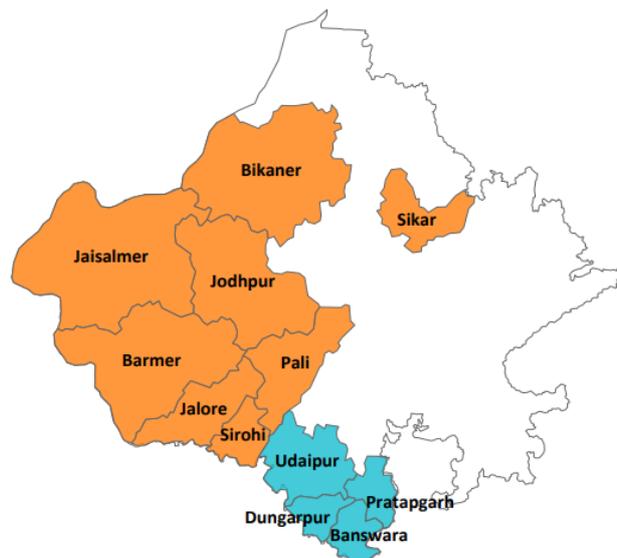
Ease of adoption/implementation

Scaling NF in the state is not a greenfield effort, given the existing base of practising farmers (more than 170,000 certified farmers practising organic farming), community resource persons (more than 100,000 (women farmers engaged with *Rajasthan Grameen Aajeevika Vikas Parishad (Rajeevika)*), and 24 CSOs working on NF in collaboration with government departments.

However, the suitability of NF adoption varies across Rajasthan. The following two regions exhibit high suitability for scaling NF:

- Western Rajasthan: Farmers are more likely to adopt NF, given the low water availability for irrigation, high salinity of groundwater, and prevailing low usage of chemical inputs.
- Southern Rajasthan: The large proportion of tribals who are more accepting of NF practices, high number of existing self-help groups (SHGs), *mahila kisans* (women farmers of which a many are practising NF), kitchen gardens, and so on make this region well-suited for NF.

Figure ES1. Districts for scaling up natural farming



Based on a district-wide assessment, we found the following 12 districts to be well suited (high expected benefits, low risk of unfavourable trade-offs, and high ease of implementation/adoption) to the scaling up of NF: Barmer, Bikaner, Jaisalmer, Jodhpur, Pali, Sikar, Jalore, Sirohi, Banswara, Dungarpur, Pratapgarh, and Udaipur.

Our study proposes a scale-up strategy, road map, and institutional structure that enables the following:

- 1. A phased and targeted approach:** Not all of Rajasthan's regions, crops, population segments, and so on are equally suited for scaling up NF initially. A targeted and phased approach will maximise the ease of adoption and potential benefits and minimise risks; hence, the scale-up will initially target eight districts in western Rajasthan and four in southern Rajasthan. The decision to scale up in other regions should happen once the potential benefits, risks, and ease of adoption of NF are assessed in those regions during phase 1. The priority districts have been further differentiated based on how easily they can adopt NF, and they will be accordingly targeted with high, medium, and low intensities of intervention. Refer to Table 1 for details regarding the scope of intervention and penetration level planned for these districts.
- 2. Convergent plan:** Active engagement and convergence with multiple departments, particularly with the Department of Rural Development and Panchayati Raj, are important for successfully scaling up NF. Broader participation can lead to pooling resources and capacity, synergies, and broader ownership. Opportunities of convergence identified in consultation with relevant state departments are detailed in the 'Relevant opportunities of convergence with other departments' in Annexure 6.
- 3. Strengthen and generate robust, local evidence:** Current evidence from NF pilots and universities such as Maharana Pratap University for Agriculture and Technology (MPUAT) looks promising; however, more conclusive, holistic, and context-specific evidence is required for different ACZs and farm sizes across Rajasthan. Continuous investment is necessary for evidence consolidation from existing and new projects, pilots, farmers, state-level research and development, state agricultural universities (SAUs), *Krishi Vigyan Kendras* (KVKs), CSOs, and so on. Furthermore, the targeted evidence needed to support scale-up in phase 2 districts will need to be consolidated in phase 1.
- 4. Focus on innovation and customisation:** Replication of the success of other states or districts within Rajasthan in the target districts cannot happen by

simply transferring innovations and packages of practices (PoPs) as they are. Instead, tailored PoPs specific to the respective ACZs and other contextual factors must be developed across the state. For this to happen successfully at scale, both top-down (via SAUs, KVKs) and bottom-up (via participatory research and innovation by progressive farmers) innovation must be ensured.

- 5. Saturation approach:** The programme will need to drive saturation at two levels: first, covering a sufficient number of neighbouring *gram panchayats* (GPs) to enable aggregation (for inputs, produce, or service provision) for greater commercial viability, and second, saturating a GP with a significant number of farmers (60–80 per cent) practising NF to minimise the risk of farmers reverting to conventional practices while also improving the economics of aggregation.
- 6. Keeping farmers at the centre of intervention design:** The programme will need to engage closely with farmers and farmer leaders/representatives to develop tailored, context-specific solutions and interventions so that farm-level risks identified in the study are mitigated in a timely and effective manner for the farmers.
- 7. Sequentially enabling support services:** Interventions will be introduced depending on their need and suitability of implementation. For example, the programme will need to begin with relevant capacity building of key stakeholders (such as state-, district-, and GP-level government officers from the most relevant line departments, particularly the Department of Agriculture (DoA) and Department of Rural Development and *Panchayati Raj*, *Krishi* and *Pashu Sakhis* (Community agriculture care service providers and Community animal care service providers), *Anganwadi* workers, and school/Midday Meal (MDM) scheme implementers). The farmers will also need to be provided with support during the initial transition to NF through incentives and support to purchase input tools such as drums, sprayers, and so on. Later, transformative market-side interventions (e.g., introducing quotas for NF produce in public procurement systems, and marketing campaigns) need to be taken up in some pockets of Rajasthan once NF production becomes significant enough to be able to attract participation from relevant demand-side market actors.
- 8. Agility for course correction:** Many important aspects related to PoPs, evidence, intervention designs, and so on are supposed to emerge throughout the trajectory of the programme because continuous research and innovation are built into the programme. Therefore, the programme strategy, road map, institutional structure, and processes to drive them will need to be extremely

agile to enable course correction and evolution.

These recommendations on the state's strategy and roadmap have been co-created with input from stakeholders who will be impacted as well as those who will drive the impact. Translating the strategies into action, the Government of Rajasthan has allocated INR 6 billion (INR 600 crore) to the *Rajasthan Organic Farming Mission* and kickstarted the transformation. It is time for all stakeholders invested in the transformation of Rajasthan's agriculture to come together and capitalise on what NF has to offer.

Team

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1. Context

Rajasthan is a predominantly agrarian state. Agriculture and allied activities account for 25 per cent of the state's gross value added (SGVA 2019–2020) and employ nearly 66 per cent of its population. However, 56 per cent of its net sown area remains rainfed (NABCONS 2020), although it is affected by severe water scarcity owing to the fact that it has only about 1 per cent of India's total water resources and receives an average of 580 mm of rain compared to India's average of 1,100 mm (NRMC 2018).

The prevalent agricultural models are aggravating soil degradation and water scarcity. For instance, popular crops in Rajasthan such as wheat utilise five to six irrigations per season. More than 82 per cent of the state fell under the water-level depletion zone during 2008–2009 to 2012–2013 (NRMC 2018), so the sector faces several challenges as competition for water resources increases. This will pose problems not just for crops but for livestock too, and Rajasthan accounts for more than 11 per cent of the total livestock population of India (Government of Rajasthan (GoR) 2017). Climate impacts are making the situation worse because the average temperature is expected to rise by around 1.8°C to 2.1°C by 2035. Almost 88 per cent of districts in the state are vulnerable to extreme events, specifically extreme drought events (Mohanty 2021). Therefore, the business-as-usual scenario for Rajasthan's agriculture is not sustainable.

A shift towards sustainable agricultural practices and systems (SAPSs) such as NF, agroforestry, crop rotation, rainwater harvesting, and mulching, which are not only economically more remunerative but also socially inclusive and climate resilient, is seen as a promising way forward (Gupta et al. 2021). Moreover, the agricultural context in Rajasthan makes it easier to promote sustainable agricultural practices. For decades, Rajasthan's farmers have adopted diversified cropping patterns and relied on livestock as an augmented livelihood source, thus hedging the risks associated with dryland agriculture. Furthermore, most of the net sown area is rainfed and has not been influenced much by the Green Revolution. Also, an extensive network of non-governmental organisations (NGOs) and civil society organisations (CSOs) is already actively promoting water resource management and sustainable agricultural practices in the state.

Therefore, given this background, there is a need to cautiously assess the alternative farming models of sustainable agriculture for their scalability in Rajasthan. An actionable long-term roadmap that enables the government to efficiently facilitate the initial adoption and navigate the complexities of scaling up could be developed.

1.1. Objective of the study

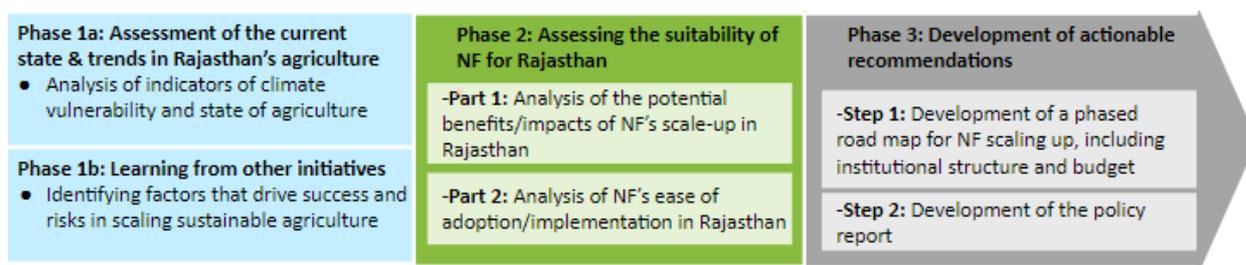
NF, one of the SAPSs, is being adopted across 11 Indian states over more than 6.5 lakh hectares (ha). According to initial evidence, there could be several benefits for farmers, such as a rise in incomes, nutrition security, and resilience. It also promises benefits for the government, such as savings in power and fertiliser subsidies. Given this momentum, the CMRETAC, under the chairmanship of the chief minister, invited CEEW to assess the following:

- Should Rajasthan scale up NF?
- How can Rajasthan scale up NF?

2. Methodology

To achieve the aforementioned study objectives, we followed a three-phase approach. Figure 1 illustrates phase-wise activities undertaken for the study.

Figure 1: Phase-wise research methodology



Source: Authors' methodology

Abbreviation: NF, natural farming

- **Phase 1: Assessing the prevailing state of affairs in Rajasthan and beyond**

In this phase, we gathered the background knowledge necessary for enabling effective analyses in phases 2 and 3. First, we assessed the current state of Rajasthan's agricultural sector and trends by reviewing the available literature from multiple state agriculture reports, census reports, web portals and dashboards, and engaged with several state departments (Annexure 1, Table A1) to obtain the necessary data.

Second, we reviewed four state-driven initiatives (outside Rajasthan) in sustainable agriculture that have achieved scale (refer to Annexure 1, Table A2): Andhra Pradesh Community Managed Natural Farming (APCNF), *Prakritik Kheti Khushal Kisan Yojana* (PK3Y), Himachal Pradesh, Odisha Millet Mission (OMM), and Sikkim Organic Mission (SOM). We consolidated transferrable learnings from these initiatives into a 'strengths, weaknesses, opportunities, and threats (SWOT)' framework and identified the key factors that drive success and risks (refer to Tables 6, 7, and 8). We later used this knowledge to inform the NF roadmap for Rajasthan.

- **Phase 2: Assessment of suitability of NF for Rajasthan**

We assessed the suitability of NF for Rajasthan by first identifying the evaluation criteria for suitability and then conducting a district-wise mapping and gap analysis of Rajasthan's agricultural sector to assess the suitability of scaling up NF. This district-level analysis was also used to identify the regions with higher suitability for the NF scale-up. We also consulted local CSO stakeholders (Annexure 1, Table A3) engaged in NF and related interventions to contextualise

the local suitability.

We conceptualised ‘suitability’ as a composite indicator consisting of three aspects: (a) expected benefits to farmers, the state government, and the environment; (b) risks of not realising the expected benefits and risks of realising unintended impacts; and (c) ease of adoption or implementation of NF scale-up.

To assess the potential benefits of the NF scale-up, we reviewed the existing literature analysing NF projects and programmes currently active in India. This was complemented by a primary survey administered to CSOs (Annexure 1, Table A3) to source local evidence on the benefits of NF as compared to conventional farming methods.

Field visits to NF projects in four districts from different agro-climatic zones (ACZs) were organised to further contextualise and validate our findings. The overall findings from phase 2 were presented to a state-level round table (Annexure 1, Table A4) to discuss the potential intervention strategies, investments, policy options, and prioritised areas for an NF scale-up.

● **Phase 3: Development of actionable recommendations**

In the third phase, a two-day state-level virtual workshop was conducted with the relevant departments (Annexure 1, Table A5) to co-create a phase-wise roadmap for scaling NF in the state. In the workshop, we also identified opportunities for convergence across governmental departments. We complemented the policy recommendations with budget estimations (developed in collaboration with the DoA) for phase 1 of the roadmap. Table 1 provides a summary of the key research activities.

Table 1: Research activities conducted as part of the study

Serial no.	Research categories	Scope of research
1	Collating key information at the state level	<ul style="list-style-type: none"> Engaged 10 state departments (listed in Annexure 1, Table A1) for data on ~100 indicators.
2	Consultations and SWOT analysis	<ul style="list-style-type: none"> Consulted six stakeholders from four relevant state programmes (PK3Y programme, APCNF programme, OMM, SOM). Involved 22 local CSO representatives in focus group discussions (FGDs).

Serial no.	Research categories	Scope of research
3	CSO survey	<ul style="list-style-type: none"> Gathered key information/perspectives from 22 local CSOs to understand the situation on the ground. 13 of them responded to the survey; these 13 organisations are working with 26,612 farmers.
4	Field visits and FGDs	<ul style="list-style-type: none"> Organised a nine-day field visit to NF pilots in four districts in different agro-climatic zones. Around 61 officials from 20 district-line departments participated in the field visit to assess the work and contribute to research via multiple deliberations and FGDs. The officials are listed in Annexure 1, Table A6.
5	Round tables and workshop	<ul style="list-style-type: none"> Organised a state-level round table with around 20 state officials from the GoR to synthesise and validate research findings (Annexure 1, Table A4). Facilitated discussion with a state-level virtual workshop with 10 departments and institutions and 40 officials (Annexure 1, Table A5).

Source: Authors' analysis

Abbreviations: SWOT, Strengths, Weaknesses, Opportunities, and Threats; PK3Y, Prakritik Kheti Khushal Kisan Yojana; APCNF, Andhra Pradesh Community Managed Natural Farming; CSO, civil society organisation

(a) Focus group discussion



Source: Kartikeya Jain

(b) State-level round table held on 24 December 2021 in Jaipur, Rajasthan with the Department of Agriculture and other relevant departments



Source: Sijo Abraham



Source: Avisha Jain

(c) State-level virtual workshop held on 11 and 12 January 2022 with the Department of Agriculture and other relevant departments



Source: Zoom snapshots

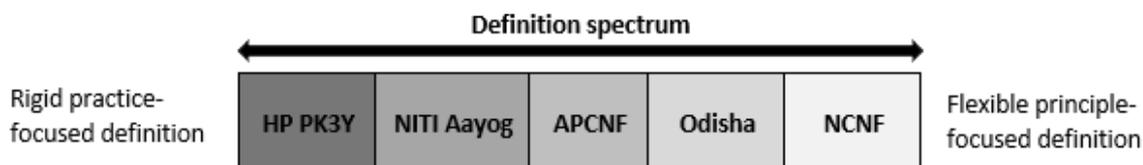
3. State of natural farming in Rajasthan

Before analysing the suitability of NF for Rajasthan, it is imperative to evaluate the current NF scenario in the state.

3.1. What is ‘natural farming’ in Rajasthan?

Different NF proponents and programmes, both in Rajasthan and elsewhere, define NF differently (as highlighted in Annexure 2). On one hand, PK3Y in Himachal Pradesh follows a relatively rigid ‘practice-focused’ definition, rooted in Palekar’s guidelines, prescribing specific practices such as *Beejamrit* (seed coating), *Jeevamrit* (inoculant), *Acchadana* (mulching), and *Waapasa* (soil aeration; SPNF 2022). The National Coalition on Natural Farming (NCNF), on the other hand, follows a relatively flexible ‘principle-focused’ definition, which allows for different combinations of practices as long as they align with the underlying principles, such as moving away from chemical-intensive farming and following local agro-ecological practices (NCNF, n.d.). Their definition also includes themes related to commons (beyond the immediate farm-level intervention). The definition followed by APCNF and NITI Aayog includes both practices and principles, thus falling somewhere in between (Figure 2).

Figure 2 From a rigid practice focused to more flexible approaches, States and institutions differ in their understanding of Natural Farming



Source: Authors’ analysis adapted from various sources

Abbreviations: APCNF, Andhra Pradesh Community Managed Natural Farming; PK3Y, Prakritik Kheti Khushal Kisan Yojana; NCNF, National Coalition for Natural Farming.

In Rajasthan too, the definitions of NF vary widely depending on the organisation promoting it. Figure 3 describes the range of NF practices being followed by Rajasthan’s farmers. We observed that farmers in the state practise the core and additional principles of NF besides a few other sustainable agriculture practices, as shown in Table 2.

Figure 3 Sustainable farming practices done by farmers



Source: Authors' compilation based on CSO FGD and survey

Abbreviations: CSO, civil society organisation; FGD, focus group discussion

Table 2: Diverse practices adopted by farmers in Rajasthan

Principles and practices of natural farming followed	Other sustainable agricultural practices and systems followed
<ul style="list-style-type: none"> ● <i>Jeevamrit</i> (inoculant) ● <i>Beejamrit</i> (seed coating) ● <i>Acchadana</i> (mulching) ● <i>Whapasa</i> (soil aeration) ● Non-utilisation of chemical inputs ● Cultivating diverse crops and trees (15–20 crops) ● Pest management through botanical extracts ● Minimal disturbance of soil ● Using indigenous seeds ● Integrating animals into farming 	<ul style="list-style-type: none"> ● Organic farming (including bio fertilisers and organic fertilisers) ● Agroforestry ● Rainwater-harvesting practices (earthen embankment called <i>khadin</i>, wells, ponds) ● Integrated farming systems (livestock and poultry) ● Precision farming (drip and sprinkler irrigation) ● Vermicomposting ● Intercropping ● Crop rotation ● Contour farming ● Non-pesticide management ● Composting ● Biodynamic farming

Sources: Authors' compilation from the literature and field observations

Instead of replicating the existing models from other states, Rajasthan needs to define NF to suit its specific agro-climatic context, particularly in relation to the water scarcity and social context as well as the prevalent indigenous knowledge and practices.

Image 2: Diverse practices observed in the field

(a) Composting by a farmer in Sikar



Source: Jaun Rizvi

(b) NF practices such as *Jeevamrit* adopted by a farmer in Sikar



Source: Mehr Thapar

3.2. What is the current scale of the natural farming ecosystem in Rajasthan?

Scaling NF in the state will not be a greenfield effort. There already is an existing base CSOs with NF-practising farmers and scientific research on the same. Rajasthan already has a state Organic Farming Policy (GoR 2017), with more than 170,000 certified farmers practising organic farming (Participatory Guarantee Systems (PGS) India 2022). In terms of area, it ranked second after Madhya Pradesh, with a total area of around 481,862 ha under the organic certification process in 2020–2021 (cultivated and wild harvest) (APEDA 2022). More than one lakh women farmers (*mahila kisan*) are engaged with *Rajasthan Grameen Aajeevika Vikas Parishad (Rajeevika)*, the majority of whom practise some principles of NF (refer to the map in Table 10). Around 24 CSOs are implementing NF-related interventions in 25 districts (NCNF 2021), as shown in Annexure 3. Also, Maharana Pratap University of Agriculture and Technology (MPUAT) has developed more than 20 PoPs for sustainable agriculture in the southern districts of Rajasthan.

Image 3: Rainwater harvesting structure ‘*khadin*’



Source: Image from the field visit to Jodhpur

4. Expected benefits of scaling natural farming

We find that NF promises immense benefits to farmers, consumers, state governments, and the environment. This chapter explains the expected short-term and long-term benefits of the NF transition.

4.1 Potential savings on irrigation, water, and power

Around 83 per cent of Rajasthan's total surface water and groundwater is used for agricultural and allied activities, leading to a high-water use intensity⁸ contributions to the gross state domestic product (GSDP) of 174.3 litres/INR (S. Misra, 2017). The higher water use intensity, coupled with the scarcity of available water makes efficient use of water resources imperative in the state's agricultural sector.

Emerging evidence from the literature and stakeholder consultations with successful initiatives, local CSOs, and field visits in Rajasthan indicate that NF practices could be more water efficient. Farmers specifically mentioned a reduction in water use when they adopted NF practices such as growing cover crops, intercropping, and biostimulant use because these practices enhanced water retention capacity and water infiltration. A study in Andhra Pradesh reported that Zero Budget Natural Farming (ZBNF) required around 50–60 per cent less water than conventional agriculture (Suresh et al. 2019). However, the study used farmers' perceptions and reporting, not actual water measurements, as the basis of their findings.

7 of the 12 CSOs surveyed reported that wheat exhibited an average reduction of 0–25 per cent for irrigation water consumed when using NF compared to conventional agricultural methods. As reported by one CSO, the maximum water reduction is 25–50 per cent, observed in maize and *chana*. However, the reporting CSOs only adopted some of the NF and sustainable agricultural practices. Reduction in irrigation water consumption will potentially be higher if the farmers implement a validated complete PoP.

The reduction in irrigation water use directly correlates to agricultural electricity consumption because water pumps are the primary consumers of agricultural power. Agricultural power consumption in Rajasthan was estimated to be 21,509 million kWh in 2018–2019, translating into an annual subsidy⁹ outlay of INR 130.21 billion for the state government (Aggarwal et al. 2020). Reducing

⁸ Based on the water use/allocation pattern and the contribution to GSDP.

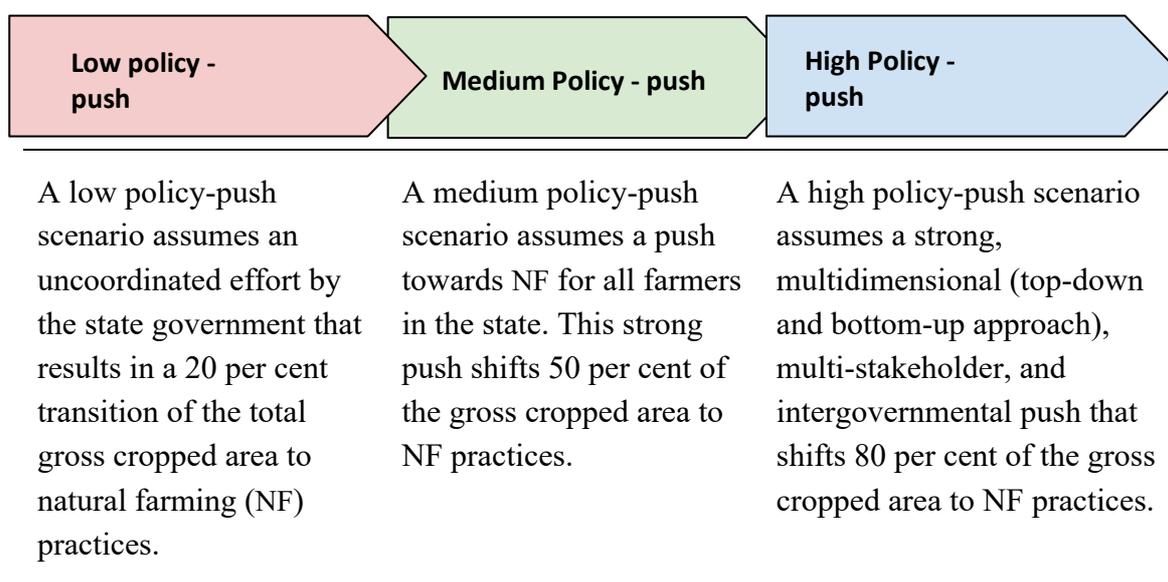
⁹ The annual subsidy is the difference between the cost of power generation and the revenue generated by power distribution for agriculture.

demand for irrigated water decreases power consumption and reduces the state’s burden of power subsidy.

This potential reduction in electricity consumption resulting from an NF-driven decrease in water requirement also depends on the crop and the region (rainfed or irrigated) focused on for the NF scale-up. In survey data, two of three CSOs reported that *chana* (gram) exhibited a reduction in electricity consumption in the range of 25–50 per cent when compared to conventional farming. Similarly, five of six CSOs reported that wheat exhibited an average reduction of 0–25 per cent in electricity consumption.

Therefore, NF provides an opportunity to transition towards a more water- and power-efficient agricultural system and potentially save power subsidy costs for the state government. We have considered three different policy-push scenarios, as explained in Figure 4. For each scenario, we assume reductions in electricity consumption of 10, 20, and 30 per cent.

Figure 4: Scenario analysis to evaluate the potential power subsidy reduction (NF to non-NF)



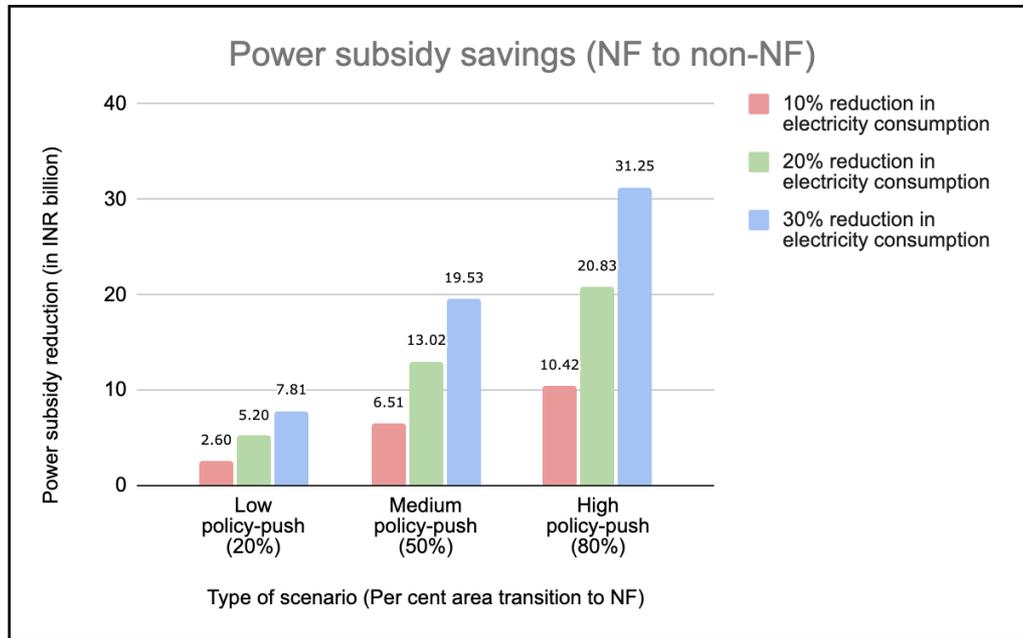
Source: Authors’ analysis

Even if, *ceteris paribus*, only 20 per cent of farmers across Rajasthan switch to NF, it would reduce their average water consumption by 30 per cent, which would save approximately INR 7.81 billion annually.¹⁰ Such subsidy savings could

¹⁰ Assumptions: (a) area under cultivation and cropping intensity remains the same, and (b) the same proportion of farmers switch to NF across rainfed and irrigated regions.

strengthen the agricultural ecosystem in the state by diversifying investments into other activities.

Figure 5: Potential power subsidy savings under different policy scenarios



Note: Scenario analysis for the potential reduction in power subsidy under different regimes of natural farming (NF)

Source: Authors' analysis

4.2. Potential reductions in fertiliser consumption

One of the key principles of NF is discouraging/stopping the use of chemical fertilisers, which reduces the cost of cultivation and the dependence on the market supply of these fertilisers. The cost reduction also depends on whether the bio-inputs are produced on the field or purchased.

A study in Andhra Pradesh reported that reducing fertiliser use (urea and diammonium phosphate (DAP) application) could save fertiliser subsidies worth around INR 20 billion (Gupta et al. 2020). Hence, a successful scale-up of NF could reduce the use of fertilisers and the subsidy burden, estimated nationally to be around INR 138.5 billion for 2021–2022 (Department of Fertilizers 2022). For Rajasthan, we estimate that the total fertiliser subsidy amounts to around INR 79 billion for 2021–2022.¹¹

8 of 13 CSOs reported a reduction in fertiliser use for wheat (4 of 8 CSOs

¹¹ Based on the yearly average fertiliser subsidy data (central government) and the total fertiliser subsidy allocated by the GoI for the year 2014–2016 compared with 2021–2022 data.

observed a reduction of more than 50 per cent) (Table 3). One of 13 CSOs reported a decrease in fertiliser use of more than 50 per cent in groundnut cultivation. To put things in perspective, a complete transition to NF (adoption of the entire PoP) of 25 per cent of the gross cropped area in Rajasthan could save more than INR 19.75 billion in central government fertiliser subsidies yearly.¹² The central government should consider redirecting such potential savings to incentivise an accelerated transition to sustainable agriculture in Rajasthan.

Table 3: Reduction reported in fertiliser use for NF compared to non-NF practices

Data sources	Reported reduction in fertiliser use in NF			
	Fertiliser	Maize	Wheat	Groundnut
Literature (Gupta et al. 2020; data from APCNF)	Urea	84.8%		69.4%
	DAP	78.4%	—	90.9%
	Complexes	67.3%		44.3%
CSO survey, Rajasthan (number of responses out of 13)	Overall ¹³	25% (2)	46.8% (8)	75% (1)

Source: Gupta et al. (2020); authors' analysis based on the CSO survey

Abbreviations: NF, natural farming; APCNF, Andhra Pradesh Community Managed Natural Farming; CSO, civil society organisation

4.3. Expected reduction in cost of cultivation

One of the significant potential benefits of NF is the reduction in cultivation costs. A comparative study of three states, Andhra Pradesh, Karnataka, and Maharashtra, by the Indian Council of Agricultural Research (ICAR), evaluated the cost of cultivation (Kumar et al. 2020). The study also estimated the yields for specific crops and compared the benefit-to-cost ratios (B:C) for NF and non-NF (Table 4).

¹² Assumptions: (a) All other variables are kept constant; (b) complete transition to NF is defined when no chemical fertiliser is applied to the field.

¹³ The overall reduction is calculated using a weighted average methodology with the number of CSO responses as the weights for each crop.

Table 4: Comparison of benefits to cost ratio (B:C) for multiple crops in different states

	Benefits to cost ratio for NF and non-NF (%)		
	Andhra Pradesh	Karnataka	Maharashtra
Paddy	123.4	370.7	—
Sugarcane	95.8	270.7	—
Sorghum	—	—	140.7
Cotton	—	—	117.2
Finger millet	—	279.9	—

Source: Kumar et al. (2020)

Abbreviation: NF, natural farming

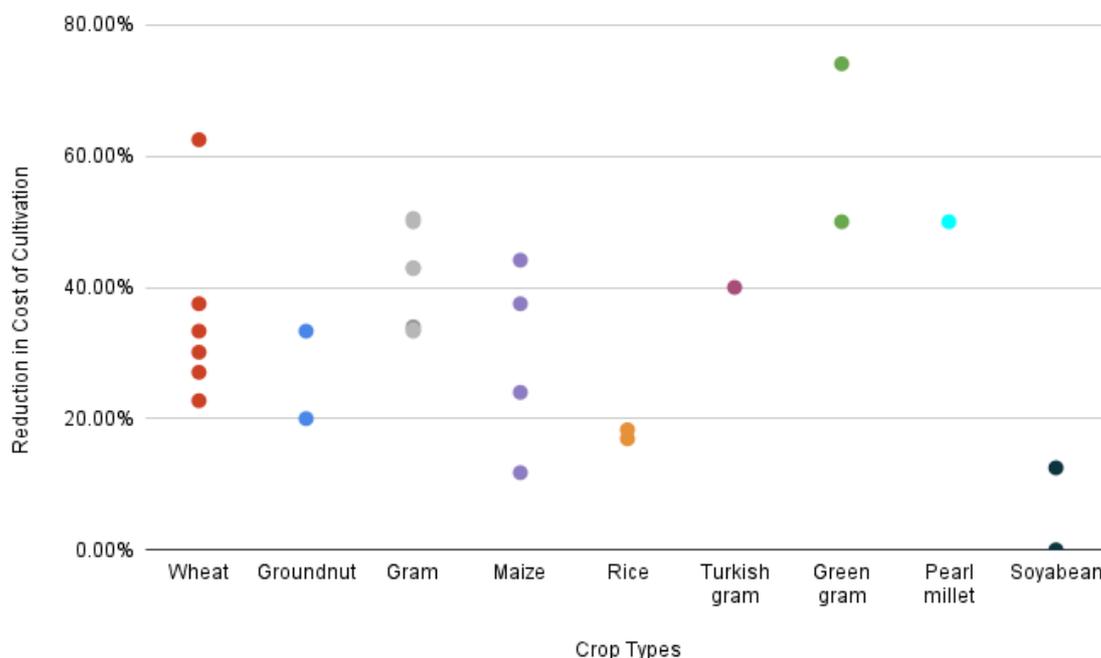
Generally, NF exhibits a better B:C, driven by the reduced variable costs (including material¹⁴ and operational¹⁵ costs). ZBNF practices potentially reduce farm expenditure significantly and decrease the dependence on external loans by promoting the use of local indigenous seeds while maintaining soil health through natural bio-inputs (Press Information Bureau 2021). The operational costs (including costs for labour) for NF decrease slightly or remain the same (Kumar et al. 2020; CSO survey). This reduction in operational costs also depends on the availability of bio-inputs if any are used. In parts of Andhra Pradesh, farmers are still dependent on purchased bio-inputs because only 40 per cent of NF farmers own indigenous cattle, whereas, in Karnataka, most NF farmers produce the bio-inputs in their fields, reducing the material costs significantly (Kumar et al. 2020).

In the case of Rajasthan, the CSOs surveyed during this study observed that for *moong* (green gram), the cost of cultivation decreased by more than 60 per cent (Figure 6). Nevertheless, the lack of premium price (or low premium price) and the lower yield during the transition period are the reasons for the limited increase in the uptake of NF by farmers.

¹⁴ Material costs include costs incurred in seed, input preparation (*jeevamrit*, *beejamrit*), FYM, pest controlling solution for NF farmers, and costs associated with seed, fertiliser, FYM and pesticide, for non-NF farmers.

¹⁵ Operational costs include the cost associated with land preparation labour, including harvest.

Figure 6: Reduction in the cost of cultivation for NF as compared to non-NF



Source: Authors' analysis based on the CSO survey

Notes: The number of points in each crop represents the percentage reduction in the cost of cultivation as reported by each CSO

4.4. Expected reduction in farmer indebtedness and state expenditure on debt waivers

The 77th National Sample Survey (NSS) reported that 50.2 per cent of all agricultural households were in debt, with a national average outstanding loan of INR 74,121 per agricultural household. The survey also found that 57.5 per cent of the loans were for agricultural purposes such as expenses associated with inputs. The report also highlighted the fact that Rajasthan's average outstanding loan per agrarian house was INR 113,865, which was higher than the national average (MOSPI 2019).

One strategy that could be used to reduce farmers' indebtedness is reducing input costs. Therefore, because NF has the potential to reduce cultivation costs, it could ameliorate farmers' indebtedness. NF practices and associated interventions (365 days of green cover, pre-monsoon dry sowing (PMDS), and community water harvesting) can unlock additional cropping cycles in rainfed areas. This will significantly increase the net farm output per hectare and farm incomes. The reduced farmer indebtedness will directly impact the GoR's budget – the GoR spent INR 75.50 billion on farmer loan waivers till December 2020 since the initiation of

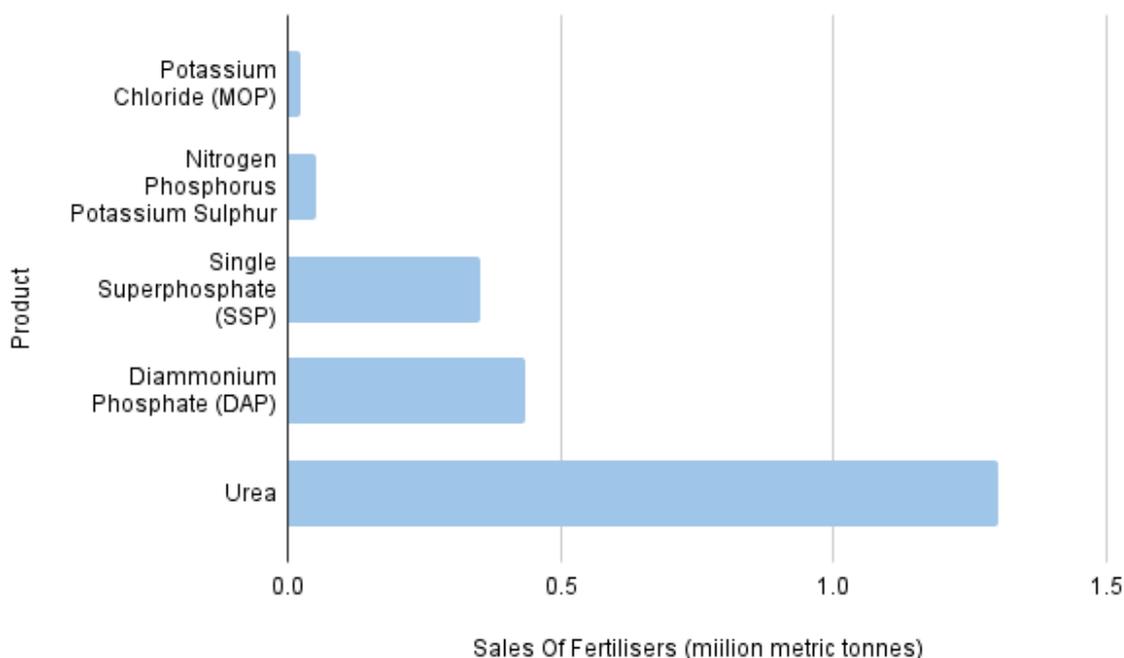
the Rajasthan Crop Loan Waiver Scheme in 2018 (Economic Review 2020).

A study of NF in 122 self-help groups (SHGs) in Andhra Pradesh reported that transitioning to NF increased the net income by 30–40 per cent (RySS, n.d.). It notes that this enhanced income has helped NF adopters pay back their outstanding loans with relative ease and enabled them to simultaneously invest in their children’s education, asset purchases, and other domestic activities.

4.5. Beyond direct economic benefits (health, ecosystem, and climate)

The excess use of fertilisers, especially urea (Figure 7), has significant implications for soil and ecosystem health, groundwater pollution, and greenhouse gas (GHG) emissions. Moreover, the fertiliser subsidy favours urea disproportionately compared to other fertilisers such as single superphosphate (SSP) and DAP (around 71 per cent) (Economic Survey 2021–2022). This skewed subsidy for urea leads to excess nitrogen (N) leaching into water and soil. The Indian Nitrogen Assessment report by the Indian Nitrogen Group (ING) under the Society for Conservation of Nature (SCN) reports that around 67 per cent of N applied leaches into the soil and water, resulting in N pollution.

Figure 7: Disproportionate sales of fertilisers in Rajasthan (2021–2022)



Source: Fertiliser sales, Directorate of Economics and Statistics 2022

N pollution caused by inefficient N use and management results in costs of around US\$ 75 billion (INR 5,601.33 billion)¹⁶ nationally per year (ING Report

¹⁶ Societal cost of N pollution accounts for the cost of N pollution on human health, ecosystem, and the climate based on the amount of excess reactive N (NO_x, N₂O, and NH₃) leaching into the air and water.

2019). This includes the costs associated with cleaning NO₃ polluted groundwater, restoring soil health, recouping yield losses, climate change mitigation and adaptation, human health costs, and so on. Assuming the same nitrogen use efficiency (NUE), as defined in the report, of 67 per cent in Rajasthan, we estimate that it incurs an expense of US\$ 3.5 billion (INR 261.40 billion) per year to deal with the effects of N pollution on health, the ecosystem, and the climate.

The inefficient and excessive use of pesticides in agriculture adversely impacts the environment and human health (Gill and Garg 2013; Abhilash and Singh 2009). Numerous studies have highlighted the impact of pesticides on human health in Punjab (Table 5). Studies have attributed the excess use of pesticides to a substantial increase in the incidence of cancer, kidney failure, stillbirth, infertility, and so on (Varghese et al. 2021; Kaphalia and Seth 1983; Singh and Chawla 1988; Kalra, Singh, and Battu 1994; Battu et al. 2005). One study estimated that Rajasthan incurred an expense of INR 46 billion per year as a result of farmers' ill health caused by pesticide exposure (Devi 2007), including the cost of medicines, laboratory expenses, lost working days, and so on. Additionally, the authors found that by reducing the pesticide doses by 25 per cent, these costs could be reduced by 24 per cent (Devi 2007).

Table 5: Synthesis of economic costs for nitrogen and pesticide pollution

Type	Impact on health, the ecosystem, and the climate	Sources	Costs incurred
Nitrogen pollution	Groundwater pollution, degradation of soil health, crop yield loss, GHG emissions	Indian Nitrogen Assessment (2019)	US\$ 75 billion (INR 6.2 lakh crore) per year nationally (Indian Nitrogen Assessment 2019)
Pesticide pollution	Increase in cases of cancer, infertility, kidney failure, loss of biodiversity, groundwater pollution, contamination of human breast milk	Devi (2007); Abhilash and Singh (2009); Kaphalia and Seth (1983); Singh and Chawla (1988); Kalra, Singh, and Battu (1994); Battu et al. (2005)	Cost of illness ¹⁷ of US\$ 104.52 (INR 8,652) per farmer per year (Devi 2007)

Source: As mentioned in the table

¹⁷ Cost of illness includes the doctor fees, medicine costs, laboratory expenses, expenses related to transportation (for the applicator and companion), hospital fees, dietary expenses, and earnings lost as a result of missed workdays (wages multiplied by time lost on account of sickness and time taken to travel to seek medical help; Devi 2007).

NF practices reduce the costs associated with N and pesticide pollution because of the reduced (or no) use of chemical fertilisers and pesticides. The savings from these reductions and others discussed before, such as reductions in the cost of cultivation, irrigation water consumed, and fertiliser applied, could be used for incentives and investments to promote sustainable agriculture. During the consultations with stakeholders, multiple suggestions regarding such incentives and investments emerged, including price premiums for NF produce, subsidies on bio-inputs purchase, income support against lost income while switching to NF, and payment for ecosystem services (e.g., sequestering organic carbon in the soil, improving soil health, enhancing biodiversity in the farm). Identification of optimal portfolios and the design of these mechanisms and incentives are beyond the mandate of this report and should be the logical next step.

4.6 Risk of not realising the expected benefits and risk of realising unintended impacts

The preceding sections provided a detailed discussion of the range of potential benefits expected from NF for farmers, consumers, the state government, and the environment. However, the risks of not realising the expected benefits and the risks of realising unintended impacts prevail because conclusive evidence regarding the impact of NF in Rajasthan is still lacking (Gupta et al. 2021). The uncertain impact of NF on crop yields, and thus food security, is considered to be the main risk.

Despite many benefits, there remain concerns regarding the inability of NF to keep pace with the rising food demands of the nation (Kumar et al. 2020; Smith et al. 2020). The generic narrative brands NF as a farming system that has no scientific backing and that may not bring tangible benefits to farm yields (Kumar et al. 2020). The motive of this section is not to refute any such claims; nonetheless, we briefly quote some studies that indicate divergent findings regarding crop yields from NF.

A literature review suggests that most short-term studies conducted on NF over one or two cropping seasons show increases or reductions in yields depending on the crop studied (Gupta et al. 2021). Yields also vary depending on the region where the crop is produced (Rose et al. 2021). This is substantiated by a recent study by ICAR–National Academy of Agricultural Research Management (NAARM), which reports that the impact of NF on crop yield cannot be gauged for all crops in all types of ACZ conditions (Kumar et al. 2020).

ICAR–NAARM undertook a field survey of NF adopters in three states (Andhra Pradesh, Karnataka, and Maharashtra) using *Jeevamrit* and *Beejamrit* and non-NF adopters. It concluded that crop yields with NF, on average, were less than

yields obtained using conventional methods. However, improvements were seen when the fertiliser was augmented with smaller quantities of farmyard manure (FYM) and *Ghanajeevamritha* (organic fertiliser) (Kumar et al. 2020; Khurana, Halim, and Singh 2022). A survey conducted by the Center for Study of Science, Technology and Policy (CSTEP) showed negligible yield differences for chilli and paddy under ZBNF and non-ZBNF, whereas certain crops (groundnut, cotton, and maize) showed higher yields when non-ZBNF practices were used (CSTEP 2020). However, this survey was limited in terms of sample size (120 farmers), and only four districts of Andhra Pradesh were covered.

A review of 6 studies on paddy found decreases in yields in 5 of the studies to the tune of 1, 6, 7, 8, and 33 per cent when compared to conventional methods, whereas one study showed a yield increase of 10 per cent. Crops such as groundnut, maize, and black gram showed better yields in NF than non-NF plots (Rose et al. 2021). There is also variation in yields depending on climatic zones and districts. For instance, crop-cutting experiments conducted in more than 13 districts of Andhra Pradesh found ZBNF crop yields to be higher in all districts except West Godavari, where waterlogging resulted in low yields.

Most of the literature until now has failed to validate certain hypotheses; for example, in an intercropping system, the total output may improve even when the yield from a single crop has decreased (Rose et al. 2021). Recent literature (Deb 2021) is starting to show that overall crop yields of mixed cropping farms are decidedly superior to those of single cropping farms and mixed cropping with row intercropping is scarcely more productive than monocultures and recommends mixed cropping without row intercropping.

Most studies evaluate changes over a year, even though a complete transition to NF typically takes three years. The methodology used in these studies also ranges from primary surveys with farmers to crop-cutting experiments. Such heterogeneity in research methods makes the overall evidence even more inconclusive. There is also a lack of studies that explicitly evaluate the impact of NF on food and nutrition security at the household or state levels (Rose et al. 2021). Overall, this highlights the need to conduct holistic longitudinal impact studies across the state in low-input as well as in intensive agricultural regions.

Although there is a plethora of Rajasthan-specific research and evidence on some NF PoPs developed at institutions like MPUAT, there is a lack of necessary local evidence to enable an informed state-wide scale-up. This contributes to the risk of not realising the expected benefits and risk of unexpected impacts.

5. Ease of adoption of scaling natural farming

5.1. What drives the ease of adoption of scaling natural farming?

As discussed in Chapter 4, NF promises various benefits to farmers, consumers, the state government, and the environment. However, first, Rajasthan's farmers must be convinced to adopt NF. Assessing the ease of adoption of NF in Rajasthan will require (a) identifying the 'success factors' that drive the adoption and scale-up of an NF programme and (b) assessing whether Rajasthan can create a congenial environment to realise these success factors.

Lessons can be learnt from large-scale state programmes on NF and sustainable agricultural practices outside Rajasthan as well as from the existing NF projects in Rajasthan. From this, we can identify the factors necessary for successful NF adoption (Table 6).

Table 6: Transferable learning from large-scale state programmes outside Rajasthan and existing projects on NF in Rajasthan

1. Institutional structure
1.1. Hybrid model for the institutional structure
<ul style="list-style-type: none">● Because it will take time to set up a new dedicated institution such as RySS for scaling NF, creating a new sub-department within the DoA is potentially a faster option.● The most suitable model for Rajasthan will need to hybridise the following two governance approaches:<ul style="list-style-type: none">○ A dedicated hierarchy of officers parallel to the existing sub-departments within the DoA, such as the structure in PK3Y, is needed, who will be solely responsible for driving NF scale-up, which will ensure the required focus.○ A structural embedding of CSOs into the institutional structure and programme implementation, such as in the OMM, to capitalise on and support the capacities of the CSOs and benefit from their on-ground experience. Rajasthan has a successful and rich tradition of Government–CSO collaboration.

1.2. Convergence

- A convergence of funds; infrastructure, institutional, and technical expertise; and social mobilisation efforts of relevant departments and directorates (Directorate of Horticulture, *Rajeevika*, Department of Rural Development and *Panchayati Raj*, Tribal Area Development (TAD), Department of Watershed Development and Soil Conservation, Department of Food and Civil Supplies, Department of Education, Integrated Child Development Services (ICDS), Rajasthan State Seed Corporation, Department of Animal Husbandry and Directorate of Gopalan) with the potential NF programme can improve the efficient use of the resources (available with different departments) and thus amplify the scale and momentum of the programme within the available budget. For instance, RySS has successfully leveraged SRLM's 'social infrastructure', particularly women's self-help groups (WSHGs), as a point of entry for NF introduction into farming households.
- Similarly, a convergence of Rajasthan's NF programme with *Rajeevika*'s network of SHGs, *mahila kisans*, and the *Krishi* and *Pashu Sakhi* cadres should be explored.

2. Programme design

2.1. Need for a phased approach

- For a successful NF scale-up, the process needs to be multi-phased, with each phase building the momentum and platform required for the success of the subsequent phase.
- Targeting entry points with high ease of adoption is essential for ensuring the success of the programme's first phase. There are three such entry points: regions (rainfed regions), farmer segments (smallholder, tribal, and women farmers), and crops (resilient crop varieties with more demand/cultural legacy, such as millets, pulses, etc.), where chances of adoption of NF are higher.
- Saturating the first set of intervention villages, that is, transforming 60–80 per cent of farmers into NF farmers, is essential before concluding the intervention programme. Otherwise, farmers can tend to shift back to the old means of conventional agriculture, driven by the social network effects and familiarity with old habits.

2.2. Access to markets

- Rajasthan, in general, requires market-related interventions to improve the

overall state of agriculture.¹⁸ However, specific interventions for developing and enabling access to special NF markets only need to be taken up when the NF production grows to a sufficient scale. The production scale may be considered sufficient if it has started attracting entrepreneurs, service providers, and other economic actors. The same strategy was implemented in programmes such as OMM and APCNF, which introduced market-side interventions only in phase 2.

- The programme can also use public-sector procurement for the Public Distribution System (PDS), Midday Meal (MDM) scheme, and ICDS to create the demand to support NF production when it reaches a reasonable scale. OMM has successfully integrated millet varieties into public procurement programmes along the same lines. Such integration also enables nutrition security among the beneficiaries of these public programmes.

2.3. Financing

- Ensure financial sustainability of the programme by securing funding from multiple sources, for example, central government schemes (e.g., RKVY schemes), development banks, multilateral/bilateral institutions, foundations, and so on.

2.4. Incentives and input support

- Provide input support to farmers to ease the transition to NF (seeds, livestock, bio-inputs, and access to finance/credit and resources).
- Support farmers to promote/breed more indigenous livestock species, which generally are more resilient to climate risks and diseases and have lower maintenance needs, by setting up enabling infrastructure (animal veterinary facilities, fodder provision, etc.). Indigenous breeds are also an important source (the only source as per some schools of NF such as PK3Y) for NF inputs (cow dung and urine).
- Lack of public awareness of benefits, complicated bureaucratic process to apply for benefits, and delays in benefit transfers are some of the key issues to track and address.

2.5. Green targets

- SOM has been successful in increasing forest cover to an extent, and the mission

¹⁸ Such interventions are beyond the scope of the NF programme.

itself was an offshoot of green initiatives such as biodiversity conservation in Sikkim.

3. Political economy

3.1. Buy-in and capacity building of government officials

- Government officials' training, including exposure visits, orientation programmes, and refresher sessions, are essential to keep the officials motivated and engaged. As also seen in OMM, exposure visits to ongoing pilots and projects ('seeing is believing') are essential for developing trust in interventions and implementing CSOs.

3.2. Social capital

- Identify/develop and capitalise on the local formal/informal networks (e.g., champion farmers' network with peer farmers) and associations (e.g., WSHGs, common interest groups) to amplify the outreach to the target farming households. For instance, since APCNF learnt that women are much more appreciative of the benefits of NF, particularly with regard to nutritional and health impacts, they have made WSHGs the key entry point to recruit new farming households.
- Identifying and developing local resources such as champion farmers and community resource persons (CRPs) is essential to complement the capacity of the local extension and agricultural officers, whose capacity is generally constrained by their prevailing responsibilities and the extent of the geographical area that they look after. For instance, in the PK3Y programme, progressive farmers were chosen as master trainers to work closely with block technology. This also created trust between farmer groups and those implementing the programmes.

3.3. Consumers

- As the NF economy scales up gradually, third-party certifications, product traceability in the supply chain, and branding will become important to build trust among consumers and enable market development. The same is being attempted by SOM, which has initiated product tracing to ensure product quality and help consumers trace their products back to the cultivator.

3.4. Adoption by farmers

<ul style="list-style-type: none"> ● Evidence demonstration is necessary to build trust among farmers, as shown by SOM and OMM. Soil health cards played a crucial role because they constituted concrete evidence of improvements in soil nutrient content after the adoption of organic practices in SOM. OMM and APCNF used the (demonstration) farms of champion farmers for this purpose.
4. Data and evidence: Generation, research, and innovation
4.1. Package of practices (PoP) development across ACZs
<ul style="list-style-type: none"> ● Consultations with APCNF stakeholders particularly emphasised that transferring NF PoPs from other states to Rajasthan will not work. Context-specific PoPs need to be identified/developed across the ACZs in Rajasthan.
4.2. Top-down and bottom-up innovation
<ul style="list-style-type: none"> ● APCNF has developed a programme that engages farmers as innovators whom the CRPs mentor in a participatory research process. PMDS, which is now a core practice promoted under APCNF, emerged from this bottom-up innovation model. Such bottom-up participatory research, in addition to the standard top-down research (via SAUs/KVKs/ATCs), will be key to developing/tailoring Rajasthan-specific NF PoPs and driving overall innovation.

Source: Authors' analysis based on consultations from relevant state programmes, CSO FGDs, and field visits
Abbreviations: NF, natural farming; RySS, Rythu Sadhikara Samstha; APCNF, Andhra Pradesh Community Managed Natural Farming; CSO, civil society organisation; SRLM, State Rural Livelihood Mission; RKVY, Rashtriya Krishi Vikas Yojna; SOM, Sikkim Organic Mission; OMM, Odisha Millet Mission; PK3Y, Prakritik Kheti Khushal Kisan Yojana; PMDS, pre-monsoon dry sowing; SAU, state agricultural universities; KVK, Krishi Vigyan Kendras; ATC, adaptive trial centre; FGD, focus group discussion

5.2 What are the risks that may deter the adoption of natural farming? How can such risks be managed?

Like any other programme, the scale-up of NF in Rajasthan is not devoid of risks. Potential risks at the farm level (Table 7) and programme level (Table 8) must be properly understood to implement appropriate risk management strategies.

Table 7: Risk management strategies to address 'farm-level' risks

Farm-level risks	Management strategies
Production risks	
<ul style="list-style-type: none"> ● Yield decline 	<ul style="list-style-type: none"> ● First scaling NF in those regions where the yields are already low, so that risk of yield decline remains low.

- A gradual conversion to NF (limited part of a farmer's land added to NF every year) will need to be built into the programme as a key tactic.
- Adoption of a comprehensive PoP, techniques, and principles essential for the timely recovery of yields will need to be heavily emphasised.

Lack of input availability

- Problems faced in accessing NF inputs
- Reduced availability of indigenous seed varieties over time
- Labour requirements and availability
- Lack of fodder access for livestock
- In the initial years of the programme, farmers with access to livestock or NF inputs need to be targeted to reduce this risk.
- In the mid- to longer-term, community models for aggregation and provision of inputs will need to be established: for example, *gaushalas* or SHGs could be supported towards setting up bio-input resource centres/*sansadhan bhandars* or provision of dung, urine, and so on to farmers could be facilitated.
- Preservation of local seeds through seed banks and other community-level initiatives will need to be promoted.
- The crop diversity on the NF farm structurally ensures that the labour-requirement calendar for different crops remains staggered, thus not peaking together for the entire farm.
- Strengthening common pasture land development and management will be essential to mitigate fodder shortages.

Natural resources

- Drying up of local water resources and depleting groundwater levels as a result of overuse
- Lack of regular availability of input resources in peak seasons hinders the adoption of practices such as kitchen
- Strategise to shift away from water-intensive crops to coarse cereals, pulses, and so on, which are ecologically less demanding and more resilient.
- Provisions to build rainwater harvesting structures for water conservation need to be made.
- The crop diversity on the NF farm structurally ensures that the resource requirement calendar for different crops remains staggered, thus not peaking together for the entire farm.

gardens

Livestock diseases

- Livestock are prone to diseases (death) as a result of poor nutrition and non-awareness of diets
- Organise awareness camps and advisory sessions besides facilitating veterinary hospitals.

Crop damage

- Crops prone to encroachment and damage by stray animals
- Facilitate fencing around farm plots to avoid crop damage and losses.
- Joint research work for agricultural university scientists with CSOs is needed to develop innovative solutions.

Behavioural risk

- Peer pressure from conventional farmers may be a deterrent
- Sustained engagement with farmers is needed to enable saturation of a village (60–80% of farmers shifted to NF) before ramping down the NF programme efforts in that village.
- Focus on reducing the cost of cultivation.
- Prioritise (for more intensive intervention) those regions where the behavioural shift towards NF is already gaining momentum or seems more probable. Indicators, such as the number of participatory guarantee system farmers and number of *mahila kisans* trained in agroecology in a district, can be used to screen such districts.

Source: Authors' analysis based on consultations from relevant state programmes, CSO FGDs, and field visits
Abbreviations: NF, natural farming; SHG, self-help group; CSO, civil society organisation; FGD, focus group discussion

Table 8: Management strategies to address ‘programme-level’ risks

Programme-level risks	Management strategies
Gaps in state-specific evidence	
<ul style="list-style-type: none"> ● Gaps in local evidence for NF PoP ● Limited studies on NF in the context of Rajasthan ● Limitations in data collected by local CSOs on NF 	<ul style="list-style-type: none"> ● Consolidate existing evidence and dedicated investment for local evidence generation (impact assessments) and PoP development. ● There is a significant need to invest in evidence-building in the state.
Challenges in coordination	
<ul style="list-style-type: none"> ● Challenges may emerge in coordination amongst all the relevant government departments and also between the government and external organisations ● Involving multiple agencies can also lead to confusion, lack of ownership/commitment, and/or inaction 	<ul style="list-style-type: none"> ● A multi-departmental institutional structure is needed to allow convergence in schemes and co-ownership. Clarity in department roles and responsibilities will be essential for its effectiveness. ● Necessary mechanisms will need to be used to ensure that engaged departments honour their respective commitments; for example, clear top-down transmission of mandate to responsible officers of the relevant departments at all levels of governance, inclusion of respective roles and responsibilities into departments’ annual plans/budget, and provision of suitable disincentives (e.g., reduction in fund allocation) to discourage slackening in commitment/delivery. One effective way to achieve this will be to implement the NF programme under the chairmanship of the chief secretary at the state level and the district collector/magistrate at the district level. ● Dedicated project management units tasked to drive the project should be developed at the state and district levels. ● A clear calendar of programme activities and milestones should be developed for the first year so that action and momentum are established from day one. ● There should be a mechanism that enables the identification and employment of an effective and

agile leadership to drive the programme.

Securing programme funds and allocation

- Acquiring sustained funding for programme longevity can be challenging
- Declining allocation levels in central schemes (e.g., declining allocation to Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)) may have a cascading/dampening effect on state allocation for the programme
- The financing of the programme should be diversified by securing funds from sources beyond the schemes of the central government (e.g., RKVY schemes) and particularly include long-term funding from development banks, multilateral/bilateral institutions, foundations, and so on. Because they are not dependent on the annual release of budgets/decision-making, long-term funds can ensure continuity and predictability.

Inadequate demand

- Inadequate demand on the consumption side may keep farmer motivations low
- Non-lucrative prices of NF produce can demotivate farmers
- Markets that cater specifically/preferably to NF produces are lacking
- The numerous small outlets or informal sales of NF products do not come with certification or laboratory tests but are purely built on 'trust'
- Becomes a risk only once the production scale becomes significant.
- Develop FPOs for aggregation.
- Develop local markets/*haats* (fair)/festivals.
- Commission studies focused on NF market development.
- Preferred procurement of NF produce should be done through local government channels (PDS, ICDS, MDM, government institution canteens) to create the demand for NF produce.
- The local market needs a different kind of strategy; specifically, local circular economies can be explored, which will generate greater value for farmers and create a multiplier effect.

Institutional capacity and governance risks

- Working in 'project mode', because once the project cycle is completed, the institutional capacity will be lost because contractual staff and other invited members have to leave
 - Reliance on external capacity
 - Avoid engaging/recruiting officers and experts for filling in positions for the short term.
 - Capacity building needs to happen at different levels across the departments that need to be engaged for programme implementation (refer to Annexure 8).
 - Cluster-level (4–5 *gram panchayats*)
-

(CSOs, etc.) to implement the programme may lead to limited capacity building within the government

- Involvement of CSOs may be poor if they are not the implementing partner
- Untimely payments to CRPs and CSOs
- The current scientific and research systems (KVKs, ATCs, etc.) may have less capacity to develop evidence

implementation units are needed to have balanced representation and contribution from the government as well as external organisations.

- Directly involve CSOs in implementation by proposing a hybrid cluster-level implementation structure (refer to Chapter 8).
- Ensure timely payment.
- Region-specific PoP development, contextualisation via engagement of farmer innovators and CSOs in PoP development.
- Encourage bottom-up innovation (farmers experimenting) via appropriate mechanisms.
- Innovate ways to build the evidence base in a bottom-up manner, that is, capitalising on the existing pilots, innovative farms/farmers.

Political economy

- Evolving nature of the political economy could impact programme resilience
- Ensure that the programme is not vulnerable to changing political situations by continuously building robust evidence modelling tools. This could persuade newer audiences/stakeholders about the benefits of the programme and help counter any pressure from vested interests.
- Create a democratic demand through demonstration farms to create buy-in among officials. Peer-to-peer learning among farmers can generate a healthy demand for NF.

Behavioural risk

- The line departments are mostly trained to undertake technical extensions tied to Green Revolution technology and may not have protocols defined for NF
- All officials may not be motivated to engage in the programme
- There should be targeted and institution-wide capacity building, with a strong focus on real exposure to make farmers confident about NF; dedicated officers to reduce distraction; and preferred selection of those officers who show genuine interest.

Source: Authors' analysis based on consultations from relevant state programmes, CSO FGDs, and field visits
Abbreviations: NF, natural farming; CSO, civil society organisation; RKVY, Rashtriya Krishi Vikas Yojna; FPO, farmer producer organisation; PDS, public distribution system; ICDS, Integrated Child Development Services; MDM, midday meal; CRP, community resource person; KVK, Krishi Vigyan Kendras; ATC, adaptive trial centre; FGD, focus group discussion.

6. Assessing the suitability of natural farming for Rajasthan

Scaling NF is suitable for Rajasthan if (a) it offers significant expected benefits to farmers, the state government, and the environment; (b) it carries a low risk of not realising the expected benefits or of unintended impacts; and (c) the ease of adoption for farmers is high.

There are significant potential benefits for every region of Rajasthan, but the extent of the benefits would vary across regions and cropping systems. For instance, whereas irrigated areas will benefit more in terms of reduced expenditure on power for irrigation, mitigating effects of groundwater pollution and so on, rainfed regions will benefit more in terms of cropping intensity increase, and thus, improvements in income and resilience.

Exposure to the risk of unfavourable impacts of NF on crop yields, and therefore on food security, also varies across Rajasthan. It would be much higher for eastern and northern Rajasthan because of the irrigation-led high-yielding farming systems. We propose two clear approaches to manage this risk. Firstly, in the short term, the NF programme should focus on regions with lower yields (e.g., rainfed regions), thus reducing the risk exposure; secondly, the programme should, from the very beginning, invest in impact assessments to alleviate evidence gaps across Rajasthan and hence the uncertainties that would arise in the medium term.

The ease of adoption and scale-up of NF is also context-specific and varies across the state. As discussed in Chapter 5, the ease of adoption depends on whether the state can ensure the success factors that drive the adoption and scale-up of an NF programme and whether it can mitigate risks to scaling NF.

Keeping in mind the three factors promoting scaling up in Rajasthan enumerated earlier, we identified a list of indicators to assess the suitability of NF for various districts of Rajasthan and pick out priority districts for NF promotion (Table 9). Annexure 4 lists the indicators excluded from the selection after consideration.

Table 9: Indicators and components selected for prioritisation of districts

Indicators identified	Why is the indicator critical for scaling NF?	Informs assessment of
Agricultural indicators		
Fertiliser consumption per unit gross cropped	Farmers with lower fertiliser consumption have a higher likelihood of adopting NF and	<ul style="list-style-type: none"> ● Potential benefits ● Risk of unintended

Indicators identified	Why is the indicator critical for scaling NF?	Informs assessment of
area (kg/ha)	face a lower risk of yield reduction from NF. On the other hand, high fertiliser users stand to save a lot in terms of cost of cultivation when they shift to NF.	<ul style="list-style-type: none"> ● impact ● Ease of adoption
Crop yield index	Farmers with high yields perceive/face a higher risk of yield reduction in switching to NF.	<ul style="list-style-type: none"> ● Risk of unintended impact ● Ease of adoption
Average depth of the water level in mbgl (metres below ground level)	Farmers experiencing low water availability stand to benefit from efficient water use that is expected to emerge from adopting NF and associated water harvesting interventions.	<ul style="list-style-type: none"> ● Potential benefits ● Ease of adoption
Social indicators		
Share of scheduled tribes in the rural population	Tribal farmers are more accepting of traditional practices. NF PoPs, which generally include multiple local traditional practices, are therefore expected to be well received among the tribal communities.	<ul style="list-style-type: none"> ● Ease of adoption
Number of SHGs per thousand people	SHGs can play a key role in making women of farming households aware of NF and become champions of and/or service providers to NF.	<ul style="list-style-type: none"> ● Ease of adoption
Number of kitchen gardens per thousand people	Kitchen gardens are considered a vital entry point for promoting NF among households.	<ul style="list-style-type: none"> ● Ease of adoption
Number of farmers certified by the Participatory Guarantee Systems per million rural people	The existing number of certified farmers in a district is expected to be a reasonable proxy to assess the level of acceptance and ease of adoption of NF.	<ul style="list-style-type: none"> ● Ease of adoption
Number of <i>mahila kisans</i> per million rural people	Under the <i>Mahila Kisan Sashaktikaran Pariyojana</i> (MKSP) of National Rural Livelihood Mission (NRLM), <i>mahila kisans</i> have been trained in agroecology in many districts of Rajasthan. These <i>mahila kisans</i> can become the champions/CRPs for driving NF adoption.	<ul style="list-style-type: none"> ● Ease of adoption

Indicators identified	Why is the indicator critical for scaling NF?	Informs assessment of
Economic indicators		
Number of <i>Krishi Upaz Mandi Samitis</i> per 1,000 sq km.	Access to markets is essential for securing the sale of future NF produce.	<ul style="list-style-type: none"> ● Potential benefits ● Ease of adoption

Source: Authors' analysis based on consultations with relevant state programmes, CSO FGDs, field visits
Abbreviations: NF, natural farming; CSO, civil society organisation; CRP, community resource person; FGD, focus group discussion

Although all nine indicators inform the assessment of various aspects of suitability, the indicators based on the number of certified farmers and *mahila kisans* are particularly useful to assess the already existing momentum towards a behavioural shift in line with the NF programme.

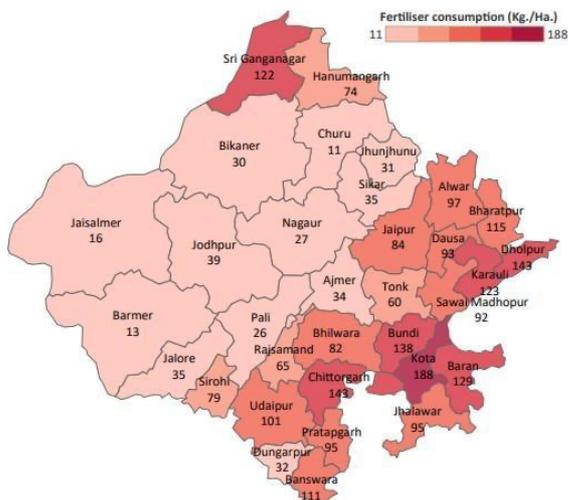
6.1. Which regions can be prioritised for NF scale-up?

Assessing each district of Rajasthan based on the identified indicators (Table 9) brings out the diversity in the state. Comprising 10 different ACZs, Rajasthan contributes to 61 per cent of India's total arid area. It has a significant bovine population of around 27.6 million (2.76 crore) (DAHD 2019), making bio-input availability easy, at least for the initial phases of a potential NF programme. Overall, there is a higher population density of livestock in the dry western and southern tribal districts, which assumes importance as a coping mechanism during droughts. The availability of groundwater and share of irrigated area increases as we move towards the northern and eastern sides, which explains the elevated crop index and relatively higher use of fertilisers in these areas. There is also a higher density of markets or *Krishi Upaz Mandi Samiti* (KUMS) in the fertile northern/eastern areas.¹⁹ The southern parts also have a much denser tribal population. Table 10 shows a district-wise assessment with respect to each of the suitability indicators listed in Table 9.

¹⁹ *Krishi Mandi, KUMS: Krishi Upaz Mandi Samiti have infrastructural facilities for inducing purchasing and selling of agricultural commodities, besides providing a place for genuine business*

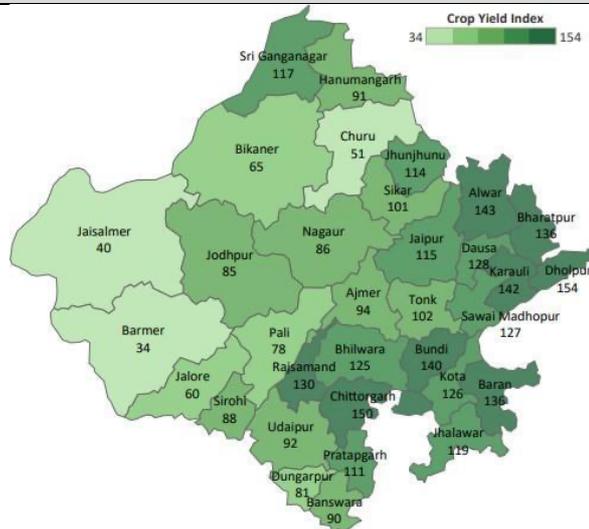
Table 10: Maps highlighting the selected indicators for Rajasthan

Fertiliser consumption per unit gross cropped area (kg/ha)



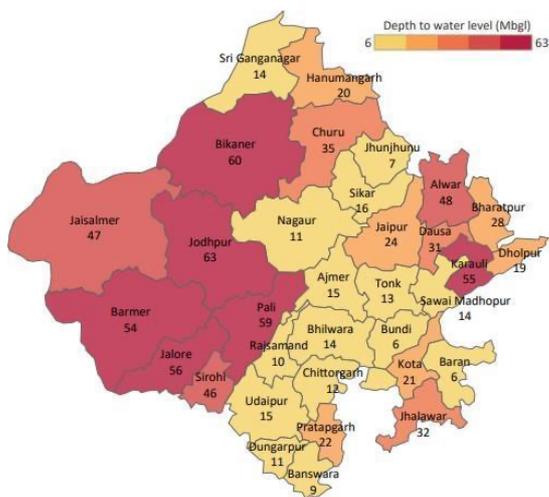
Source: Rajasthan agricultural statistics at a glance

Crop yield index



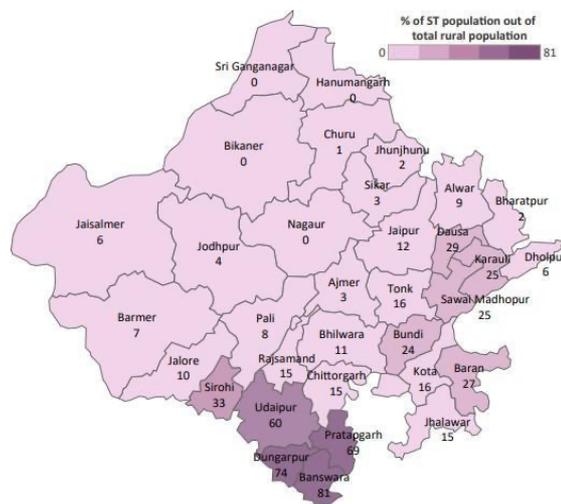
Source: Authors' analysis based on Department of Agriculture data

Average depth of the water level in mbgl

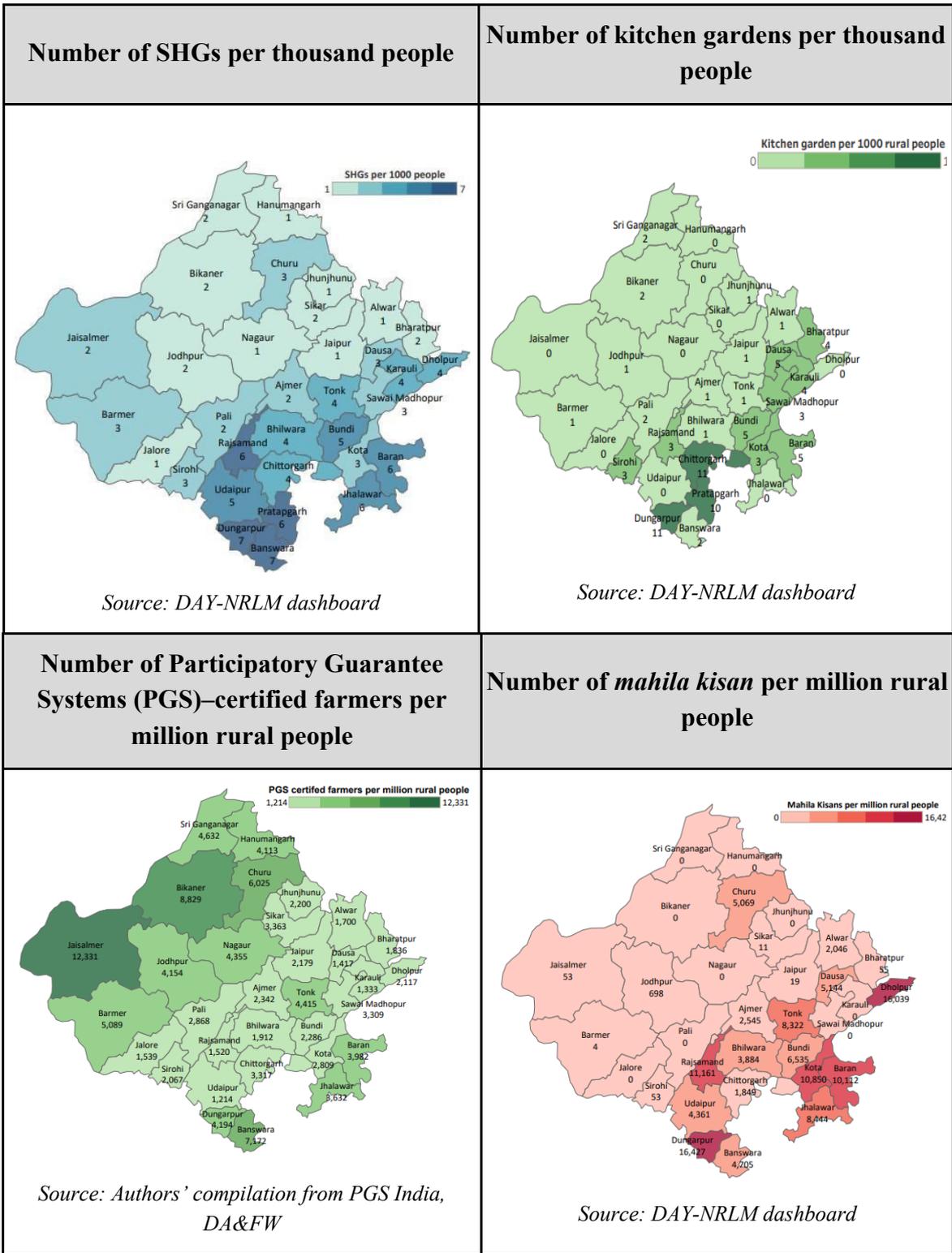


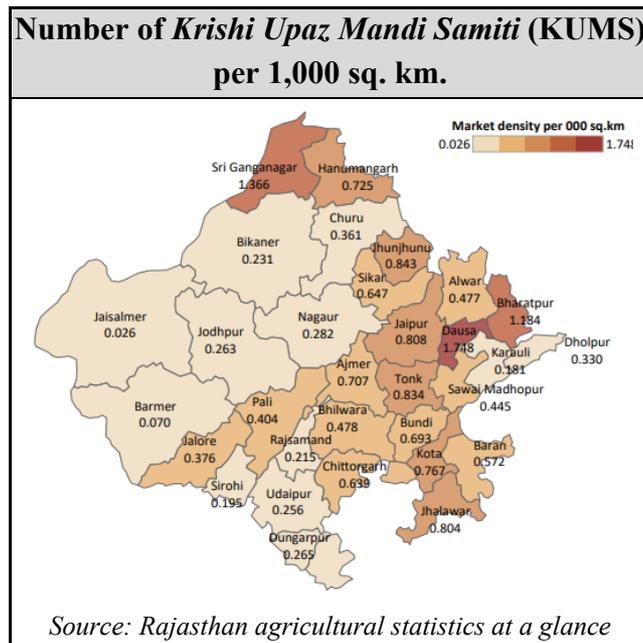
Source: Groundwater yearbook 2018–2019

Share of scheduled tribes in the rural population



Source: Census 2011





Although gaps exist in each of the districts with respect to one or the other indicator used for prioritisation, some districts score reasonably well on most indicators. Such districts should be chosen for the initial scale-up of NF. Among the districts, the two regions of western and southern Rajasthan show higher suitability and therefore need to be prioritised for promoting NF in the initial phases.

6.1.1. Prioritised regions for scaling up NF in Rajasthan

Western zone: The depth of the water levels is around 60 mbgl in the western districts, for example, Jodhpur and Bikaner (refer to Table 10), leading to limited potential for irrigation, which results in insignificant usage of chemical fertilisers. These conditions contribute to low productivity, which shows a strong correlation with irrigation and fertiliser use in Rajasthan. Because of the rainfed nature of these regions and the highly saline groundwater, farmers are more inclined to consider practising NF, as observed in Bikaner, Barmer, and Jodhpur where the number of PGS-certified farmers is high.

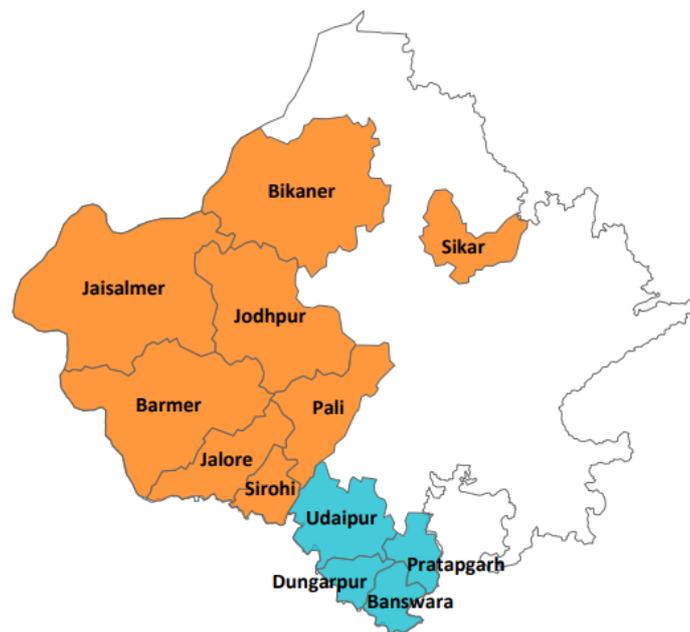
The western districts found to be relatively more suitable for the NF programme are Barmer, Bikaner, Jaisalmer, Jodhpur, Pali, Sikar, Jalore, and Sirohi as shown in Figure 8.

Southern zone: The southern region is largely inhabited by tribal populations who have adopted integrated farming practices and kitchen gardens even though their farms are smaller when compared to those of farmers in western Rajasthan. This has also resulted in greater biodiversity in the farm plots and a higher

population of bovines and indigenous cattle. A reasonably higher number of *mahila kisans*, SHGs, and kitchen gardens means that these districts are in a favourable position for NF scale-up.

The southern districts found to be relatively more suitable for the NF programme are Banswara, Dungarpur, Pratapgarh, and Udaipur as shown in Figure 8.

Figure 8: Regions selected for scale-up of NF



Source: Authors' analysis from the literature review, consultations, and field observations

We propose a phased approach to scaling up NF in Rajasthan. The first phase should focus on scaling NF in these 12 prioritised districts. The scale-up in other regions should happen once the potential benefits, risks, and ease of adoption are assessed for the districts identified for later phases. The detailed methodology followed for prioritisation and the selection of the districts for phase 1 are provided in Annexure 5.

7. How to scale up natural farming?

This section outlines the strategy and roadmap for scaling up NF in the state. We first present the foundational principles that should guide the programme design, followed by a high-level multi-phased road map for NF scale-up. We then discuss phase 1 in detail.

A summary of the principles that a successful scale-up strategy must incorporate is given here:

- 1. A phased and targeted approach:** Not all of Rajasthan's regions, crops, population segments, and so on are equally suited for scaling up NF initially. A targeted and phased approach will maximise ease of adoption and potential benefits and minimise risks; hence, the scale-up will initially target eight districts in western Rajasthan and four in southern Rajasthan. The decision to scale up in other regions should happen after assessing the potential benefits, risks, and ease of adoption of NF in those regions during phase 1. The priority districts will be further differentiated based on the ease of adoption of NF in these regions and targeted with high, medium, and low intensities of intervention. Refer to Table 1 for the scope of intervention and penetration levels for these districts.
- 2. Convergent plan:** Active engagement and convergence with multiple departments, particularly with the Department of Rural Development and *Panchayati Raj*, are important for successfully scaling up NF. Broader participation can lead to pooling resources and capacity, synergies, and broader ownership. Annexure 6 details the opportunities for convergence identified in consultation with the relevant state departments.
- 3. Strengthen and generate robust, local evidence:** Current evidence from NF pilots and universities, such as MPUAT, looks promising. However, there is a requirement for more conclusive, holistic, and context-specific evidence for different ACZs and farm sizes across Rajasthan. Continuous investment will be required for evidence consolidation from existing and new projects, pilots, farmers, state-level research and development, state agricultural universities (SAUs), *Krishi Vigyan Kendras* (KVKs), CSOs, and so on. Furthermore, targeted evidence development to support scale-up in phase 2 districts will need to happen in phase 1.
- 4. Focus on innovation and customisation:** Replication of the success of other states or districts within Rajasthan to the target districts cannot happen by simply transferring innovations and PoPs as they are. Instead, they must be tailored to the specific ACZs and other contextual factors across the state. For

this to happen successfully at scale, both top-down (via SAUs, KVKs, etc.) and bottom-up innovation (via participatory research and innovation by progressive farmers) must be ensured.

- 5. Saturation approach:** The programme must drive saturation at two levels. First, covering a sufficient number of neighbouring *gram panchayats* (GPs) enables aggregation (for inputs, produce, or service provision) for greater commercial viability. Second, saturating a GP with a significant number of farmers (60–80 per cent) practising NF minimises the risk of farmers going back to conventional practices while also improving the economics of aggregation.
- 6. Keeping farmers at the centre of intervention design:** The programme will need to engage closely with farmers and farmer leaders/representatives to develop tailored, context-specific solutions and interventions so that the farm-level risks identified in the study are mitigated in a timely and effective manner for the farmers.
- 7. Sequentially enabling the support services:** Interventions will be introduced depending on the need and suitability for implementation. For example, the programme will need to begin with relevant capacity building of key stakeholders (such as state-, district-, and GP-level government officers from all the most relevant line departments, particularly the DoA, Department of Rural Development, *Panchayati Raj*, *Krishi* and *Pashu Sakhis*, *Anganwadi* workers (courtyard child care shelter workers) and school/MDM leaders. The farmers will also need support during the initial transition to NF in the form of incentives and support to purchase input tools such as drums, sprayers, and so on. On the other hand, transformative market-side interventions (e.g., introducing quotas for NF produce in public procurement systems, and marketing campaigns) need to be taken up in some pockets of Rajasthan once NF production becomes significant enough to be able to attract participation from relevant market actors.
- 8. Agility for course correction:** A range of important aspects such as PoPs, evidence, intervention designs, and so on, are supposed to emerge throughout the trajectory of the programme because continuous research and innovation are built into the programme. Therefore, the programme strategy, roadmap, institutional structure, and processes to drive them will need to be extremely agile to enable course correction and evolution.

7.1. Roadmap for scaling NF in Rajasthan

Based on these principles, a multi-phased programme has been envisaged. The NF scale-up in Rajasthan will require concerted and continuous effort for an extended period. Just saturating a GP with NF farmers may take 7–10 years. As

described above, the programme will also need to evolve continuously. Therefore, though this section presents a high-level multi-phased road map, only phase 1 has been discussed in further detail. We propose using the learning and evidence from phase 1 to design a customised phase 2 for the programme. The programme consists of three phases. Table 11 summarises the proposed plan for each phase.

Phase 0: This phase includes all the steps taken towards promoting NF practices until FY 2021. This phase mainly consists of the GoR programme on ZBNF and pilots established by CSOs till now. GoR trained 36,000 farmers from 15 districts and 36 *gram panchayats* in ZBNF practices through a 2-day training programme.

Phase 1: Phase 1 includes the proposed three-year NF scale-up programme (FY 2022–2024). During this phase, the proposed plan is to equip and train 305,542 farmers (around 5.2 per cent of the total), bringing 380,561 ha (about 1.4 per cent of the total cultivable area) under NF. The programme will be implemented in 12 districts and 696 GPs for three years, focusing on GP saturation through continuous engagement.

Later phases: This includes all the activities post-FY 2024. The proposed plan is to expand the NF scale-up programme in additional districts and GPs and prepare them for NF scale-up. These phases will also especially include market development and demand generation for NF products.

Table 11: Phased programme strategy for NF scale-up in Rajasthan

	Phase 0	Phase 1 (three years, starting from FY 2022)	Phase 2 and later
Research, innovation, and defining NF	<ul style="list-style-type: none"> ● The DoA designed the programme to focus on the ZBNF practices²⁰ and necessary capacity building. ● CMRETAC commissioned a study to analyse the suitability of NF for Rajasthan and develop the road map for scale-up. 	<ul style="list-style-type: none"> ● Developing a longer-term (at least five-year) phase 2 programme before the end of phase 1, informed by the lessons learnt from phase 1. ● Announcement of the ‘Organic Farming Mission’ by GoR (based on the recommendations from this study). ● Defining NF and the associated practices in the context of Rajasthan. ● Initial design (to start the capacity building) of the PoP for the regions covered in phase 1, followed by annual revision by the technical and research committee. ● Establishment and management of models and demonstration plots in the phase 1 region by farmers/champion farmers and KVKs/SAUs/ATCs for continuous innovation and PoP tailoring. ● Continued top-down (via SAUs/KVKs/ATCs) and bottom-up innovation (participatory research with progressive farmers) to identify/develop, validate, and document locally customised practices. ● Conducting research projects and initial pilots in the ACZs 	<ul style="list-style-type: none"> ● PoP development and validation for the remaining ACZs. ● Continued top-down (via SAUs/KVKs/ATCs) and bottom-up innovation (participatory research with progressive farmers) to identify/develop, validate, and document locally customised practices. ● Continuous tailoring of the existing PoPs and evolution of the programme design with the help of evidence developed and learning gathered, including that from phase 1.

²⁰ ZBNF is defined as the agricultural practice where crops are cultivated in their natural environment without the application of harmful chemical fertilisers and pesticides and encourages the use of bio-inputs from indigenous cows and natural products (Guidelines for Zero Budget Natural Farming, Government of Rajasthan).

	Phase 0	Phase 1 (three years, starting from FY 2022)	Phase 2 and later
Governance structure	<ul style="list-style-type: none"> ● ATC, DoA, carried out the NF training programme. 	<p>to be covered in phase 2 (particularly in the irrigated region) to generate the evidence and PoPs needed to support programme expansion in phase 2.</p> <ul style="list-style-type: none"> ● Establishing an interdepartmental and convergent governance structure, including the appropriate officers from the Department of Agriculture, Directorate of Horticulture, Animal Husbandry Department, Department of Rural Development, and <i>Panchayati Raj</i>, followed by its continuous evolution (i.e., the engagement of additional stakeholders when necessary). ● Establishing a multi-tier project management structure with state- and district-level project management units, coupled with implementation and monitoring units at the state and district levels. ● Active participation from CSOs across the governance and institutional structure. 	<ul style="list-style-type: none"> ● Deepening the multi-tier project management structure up to the local/cluster level (a unit of around five GPs). ● Evolution of governance structure (e.g., the inclusion of more departments) in line with the expansion and evolution of the NF programme.
Capacity development across stakeholders within and outside the	<ul style="list-style-type: none"> ● Two-day on-farm training conducted for around 36,000 farmers. 	<ul style="list-style-type: none"> ● Capacity building across stakeholders, including the state government officers from the relevant departments, particularly prioritising the Department of Agriculture, Directorate of Horticulture, Animal Husbandry Department, Department of Rural Development, and <i>Panchayati Raj</i>. ● The capacity-building modules to be customised and curated 	<ul style="list-style-type: none"> ● Capacity building of the relevant department officers/farmers/CRPs from the additional GPs/districts. ● Capacity building of additional schools, <i>Anganwadis</i>, and so on

Phase 0	Phase 1 (three years, starting from FY 2022)	Phase 2 and later
government	<p>according to the targeted stakeholders' envisaged role in the NF scale-up.</p> <ul style="list-style-type: none"> ● Two-level training: State-level training for the state government officers and district-level officers from all the relevant departments. ● District-level training for the relevant agriculture supervisors, CRPs, <i>Krishi</i> and <i>Pashu Sakhis</i>, and so on. ● Capacity building of SHG groups through <i>Krishi</i> and <i>Pashu Sakhis</i> at the GP/block/district level. Women SHGs can act as a key entry point for the adoption of NF among farmers. ● Capacity building of <i>Anganwadi</i> workers and school/MDM leaders at the district level to develop NF kitchen gardens/<i>poshan vaticas</i>. ● Creation and strengthening of common interest groups for NF to enable faster knowledge dissemination and foster peer-to-peer learning. ● Creation of NF SHGs and FPOs in the relatively established regions concerning NF adoption. ● On-farm training for farmers with continued engagement. ● Selection, engagement, and development of resource organisations, including CSOs. ● Identification and development of champion/lead farmers 	<p>to transition to NF.</p> <ul style="list-style-type: none"> ● Expansion of the scope of training to cover the strategic market-side interventions launched in phase 2. ● Continuous evaluation of the capacity-building structures and development of innovative models supported by the government.

	Phase 0	Phase 1 (three years, starting from FY 2022)	Phase 2 and later
Data collection and management		<ul style="list-style-type: none"> ● Development of a database of existing NF farmers across Rajasthan and consolidation of the existing context-specific evidence base for NF in Rajasthan. ● Rigorous data collection (including the number of farmers, the total area under NF, practices followed, yield levels, crop types, etc.) and management in a decentralised structure under the PMU in phase 1 regions. ● Continued monitoring and evaluation of the progress of the programme. 	<ul style="list-style-type: none"> ● Developing a one-stop online dashboard for easy data access, navigation, analysis, and dissemination.
Market development		<ul style="list-style-type: none"> ● Creation of NF FPOs to aggregate production in the relatively established NF regions from the third year onwards. ● NF production incentivisation through reservations, subsidies, and so on in the Agriculture Produce and Livestock Market Committee services and schemes. ● Promotion of the NF produce and market linkage development through fairs, recipe demonstrations, and so on. ● Supporting the development of new business models, start-ups, and tech solutions for the development of the local economy and market for NF produce. ● Commissioning research a study to identify strategies (including NF certification, campaigns, etc.) and develop the 	<ul style="list-style-type: none"> ● Phase 2 will conduct studies on strengthening the NF market, using the roadmap identified in the study. This roadmap will include interventions such as certification mechanisms and market campaigns for driving effective quality control and traceability, stronger branding, and enhanced demand. ● Engaging the public demand centres (e.g., PDS, ICDS, and MDM) to procure the NF

	Phase 0	Phase 1 (three years, starting from FY 2022)	Phase 2 and later
Infrastructure development		<p>roadmap for market development for NF produce.</p> <ul style="list-style-type: none"> ● The programme recommends establishing research laboratories to increase the capacity for residual pesticide testing through other state or national funding. ● Development of protocols for elemental analysis of NF produce. ● Encouraging PGS certification and strengthening quality assurance tracking and monitoring. ● Commissioning a research study to develop the roadmap to address the gaps in infrastructure towards driving the next phase of scale-up. 	<p>produce.</p> <ul style="list-style-type: none"> ● Build and scale community-based certifications. ● Create bio resource units (through <i>gaushalas</i>, SHGs, entrepreneurs, etc.) to further facilitate the availability of bio-inputs. ● Support farmers, entrepreneurs, FPOs, SHGs, and so on in setting up enterprises focused on value addition to NF produce. ● Phase 2 will establish the necessary infrastructure to address the gaps identified in the study.
Multifaceted support to farmers for transition to NF	<ul style="list-style-type: none"> ● Provision of tools such as drums, sprayers, and so on for NF input generation. 	<ul style="list-style-type: none"> ● Prioritise the inclusion of the farmers with easy access to the bio-inputs in the first phase, particularly farmers with animals. ● Supporting farmers in access to inputs/tools required for NF to ease initial hurdles, depending on the region, demand, and so on. 	<ul style="list-style-type: none"> ● Continue to provide multifaceted support to farmers based on learning from phase 1. ● Implement the incentives and mechanisms designed via studies conducted in phase 1.

Phase 0	Phase 1 (three years, starting from FY 2022)	Phase 2 and later
	<ul style="list-style-type: none"> ● Depending on the availability of bio-inputs, provision of subsidised input from <i>gaushalas</i> could be included in some regions in the latter part of phase 1. ● Driving convergence to reorient relevant schemes of other departments to target the farmers covered under the NF programme, as explained in Annexure 6. ● A research study to (a) design an optimal incentive structure (subsidies, direct payments, insurance, etc.) for farmers to enable the transition to NF and (b) develop mechanisms to redirect the potential state-level benefits from NF (e.g., saving in power subsidies possible in irrigated regions) via the aforementioned incentive structure. Such a study will need to explore innovative mechanisms such as payment for ecosystem services. 	

Source: Authors' synthesis

Abbreviations: NF, natural farming; ZBNF, zero budget natural farming; GoR, Government of Rajasthan; PoP, package of practices; ACZ, agro-climatic zone; CMRETAC, Chief Minister's Rajasthan Economic Transformation Advisory Council; CSO, civil society organisation; FPO, farmer producer organisation; PDS, public distribution system; ICDS, Integrated Child Development Services; MDM, midday meal; CRP, community resource person; GP, gram panchayat; SAU, state agricultural university; KVK, Krishi Vigyan Kendras; ATC, adaptive trial centre; SHG, self-help group

Given the evolutionary nature of the programme, the design of phase 2 will significantly depend on the experience and learning gained from phase 1. Therefore, the recommendations for phase 2 will need to be revised in light of new information before being taken into consideration for implementation.

7.1.1. Further details on programme design and strategy in phase 1

The NF scale-up programme has multiple phases. The duration of phase 1 is three years, but NF penetration in any GP, block, or district will require a concerted and continuous effort for a longer period. We propose using the knowledge and evidence gained from phase 1 to tailor phase 2 for the scale-up.

Phase 1 will see the implementation of the programme in 12 districts (Barmer, Bikaner, Jodhpur, Jaisalmer, Pali, Sikar, Jalore, Sirohi, Banswara, Dungarpur, Pratapgarh, and Udaipur). These districts have been divided into three categories, as shown in Table 1. Tables 14 and 15 highlight the district-wise targets for the progra

High-penetration districts: These districts will target a higher percentage and number of farmers for NF adoption. Phase 1 will cover 20 per cent of the total GPs in such districts.

Medium-penetration districts: These districts will target a lower percentage and number of farmers than the high-penetration districts for NF adoption. Phase 1 will cover 10 per cent of the total GPs in such districts.

Low-penetration districts: These districts will target a low percentage and number of farmers for NF adoption. Phase 1 will cover 5 per cent of the total GPs in such districts.

Tables 12 and 13 highlight the expected reach in each identified district.

Table 12: Three-year programme strategy

Categories	Coverage
Total districts covered	12
Total GPs covered	696
Total farmers covered	305,542
Year 1 (Y1; additional)	95,794
Y2 (additional)	95,794
Y3 (additional)	113,954
Total area covered	380,561
Y1 (additional)	119,233
Y2 (additional)	119,233
Y3 (additional)	142,095

Source: Authors' estimates

Table 13: Level of programme coverage in the three categories of districts in phase 1

	High	Medium	Low
GPs in district	20%	10%	5%
Blocks in district	80% (or more)	50% (or more)	20% (or more)
Total number of districts	5	5	2
Farmers per GP Y1			
Y1 (additional)	10%	7.5%	5%
Y2 (additional)	10%	7.5%	5%
Y3 (additional)	12%	9%	7%

Source: Authors' estimates

Abbreviations: GP, gram panchayats; Y, year

Table 14: Targeted coverage strategy for farmers and areas for the western districts

	Penetration intensity of the programme								Total
	High			Medium			Low		
Name of districts	Barmer	Bikaner	Jodhpur	Jaisalmer	Pali	Sikar	Jalore	Sirohi	
Number of GPs covered in Y1	138	73	126	21	34	38	15	9	453
Number of farmers in Y1	20,670	11,010	18,870	2,318	3,836	4,219	1,151	641	62,715
Total area in Y1 (ha)	32,968	17,561	30,097	2,192	3,629	3,991	1,070	596	92,104
Number of farmers in Y2* ²¹	20,670	11,010	18,870	2,318	3,836	4,219	1,151	641	62,715
Total area in Y2 (ha)*	32,968	17,561	30,097	2,192	3,629	3,991	1,070	596	92,104
Number of farmers in Y3*	24,804	13,212	22,644	2,627	4,348	4,781	1,612	898	74,925
Total area in Y3 (ha)*	39,562	21,073	36,117	2,485	4,113	4,523	1,498	834	110,204
Total number of farmers (by									200,355

²¹ *Targeted over and above that covered by the end of the last year (Tables 14 and 15).

the end of Y3)	
Total area (ha)	294,413

Source: Authors' estimates

Abbreviations: GP, gram panchayats; Y, year

Table 15: Targeted coverage strategy for farmers and areas for the southern districts

Name of districts	Penetration intensity of the programme				Total
	High		Medium		
	Banswara	Dungarpur	Pratapgarh	Udaipur	
Number of GPs covered in Y1	83	71	24	65	243
Number of farmers in Y1	12,510	10,590	2,644	7,335	33,079
Total area in Y1 (ha)	9,294	7,868	2,641	7,327	27,129
Number of farmers in Y2*	12,510	10,590	2,644	7,335	33,079
Total area in Y2 (ha)*	9,294	7,868	2,641	7,327	27,129
Number of farmers in Y3*	15,012	12,708	2,996	8,313	39,029
Total area in Y3 (ha)*	11,153	9,441	2,993	8,304	31,890
Total number of farmers (by the end of Y3)			105,187		
Total area (ha)			86,149		

Source: Authors' estimates

Abbreviations: GP, gram panchayats; Y, year

7.2. Budget for the NF programme in Rajasthan

Based on the programme strategy emerging from the study and continuous engagement with the DoA, GoR, we designed a programme budget for NF scale-up in Rajasthan. Please refer to the detailed budget sheet attached for further details on the budget estimates.²²

The following are the highlights of the proposed budget for the NF scale-up programme in Rajasthan.

- The total budget for three years of the programme is about **INR 6 billion (INR 600 crore)**. It would cover 12 districts (8 in the western zone and 4 in the southern zone), ~700 GPs, and ~3 lakh farmers, with a total area of 380,000 ha in three years.
- The total budget for the programme's first year is about **INR 1 billion (INR**

²² <https://tinyurl.com/ceew-rjcnf>.

100 crore). This estimate for year 1 also includes the time required for ramping up the programme.

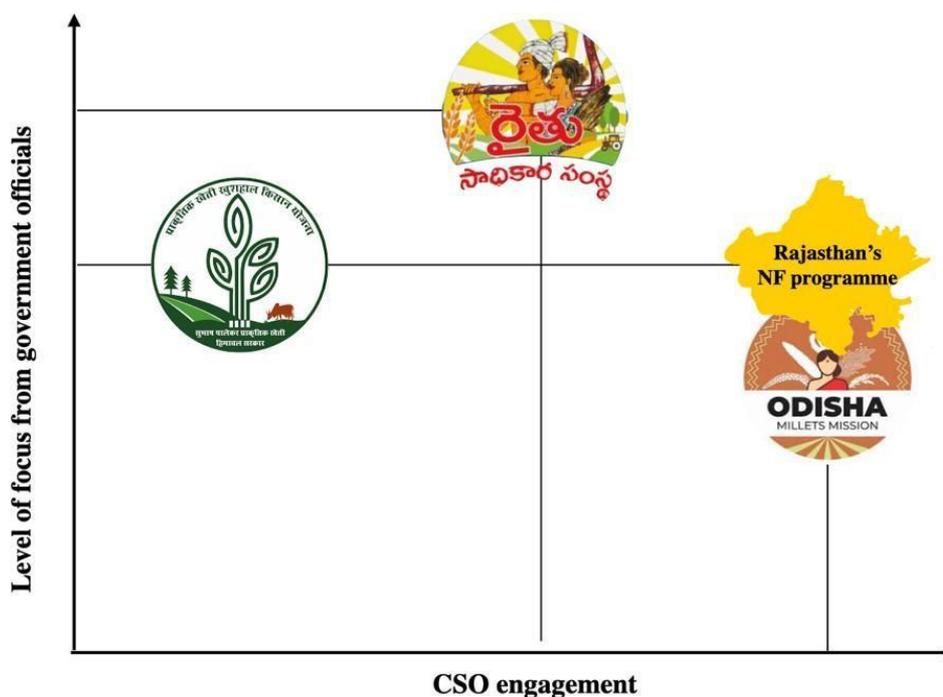
- The proposed budget for year 1 covers 12 districts, 696 GPs, and 95,794 farmers, with a total area of 119,233 ha covered in the first year.
- The total cost per farmer for year 1 is **INR 10,474**.
- Around 63 per cent of the total cost is allocated for capacity building (including government officers, *Rajeevika* CRPs, farmers, *Krishi/Pashu Sakhis*, etc.); the capacity building plan is explained in Annexure 8.
- The total cost is the sum of fixed costs (costs associated with project management units (PMUs), state-level capacity building, innovation fund, etc.) and variable GP-level costs (costs associated with GP-level capacity building, input support, etc.). For year 1, around 80 per cent of the total costs are associated with variable GP-level costs.

8. Institutional structure

Based on relatability to the Rajasthan context, we considered three relevant programmes – APCNF, OMM, and PK3Y – that would help transfer learning regarding the institutional structure. A comparative analysis of these programmes helped us identify the key features necessary in the institutional structure to drive Rajasthan’s NF programme (Table 16). These three programmes take entirely different approaches (Figure 9) towards:

- the level of CSO engagement, which is a spectrum from low or no engagement to medium (when CSOs engage as external participants) to high (when CSOs are embedded within the institutional structure of the government programme), and
- the level of focus of government functionaries, which is also a spectrum from low (when a new programme leads to additional responsibilities for the existing hierarchy of officers) to medium (when institution of a parallel hierarchy of officers dedicated to the new programme exists within a relevant department) to high (establishment of an entire parallel department dedicated to a new programme).

Figure 9: Mapping of the institutional structures of large-scale sustainable agricultural programmes



Source: Authors' analysis

Notes: Mapping of the institutional structure done through literature review and a series of stakeholder engagements

Abbreviation: CSO, civil society organisation

Table 16: Key features of the three programmes studied

Andhra Pradesh Community Natural Farming	<i>Prakritik Kheti Khushal</i> <i>Kisan Yojana</i> in Himachal Pradesh	Odisha Millet Mission
<ul style="list-style-type: none"> ● <i>Rythu Sadhikara Samstha</i> is a parallel entity to the agricultural department (working primarily via SRLM), dedicated to driving NF in Andhra Pradesh. ● Strong collaboration with CSOs for implementation. 	<ul style="list-style-type: none"> ● The State Project Management Unit consists of a dedicated parallel hierarchy of officials responsible for NF within the agriculture department. ● Involvement of CSOs was limited. 	<ul style="list-style-type: none"> ● Multi-departmental high-power committee led by the development commissioner, Government of Odisha. ● The Odisha government has a strong culture of partnering with civil societies within their government programmes; for example, <ul style="list-style-type: none"> a. WASSAN has entered a partnership with the Department of Agriculture, Odisha. b. The Odisha Livelihood Mission has strong collaboration with CSOs like <i>Pradan</i>, Living Farms, and the Harsha Trust.

Source: Authors' analysis

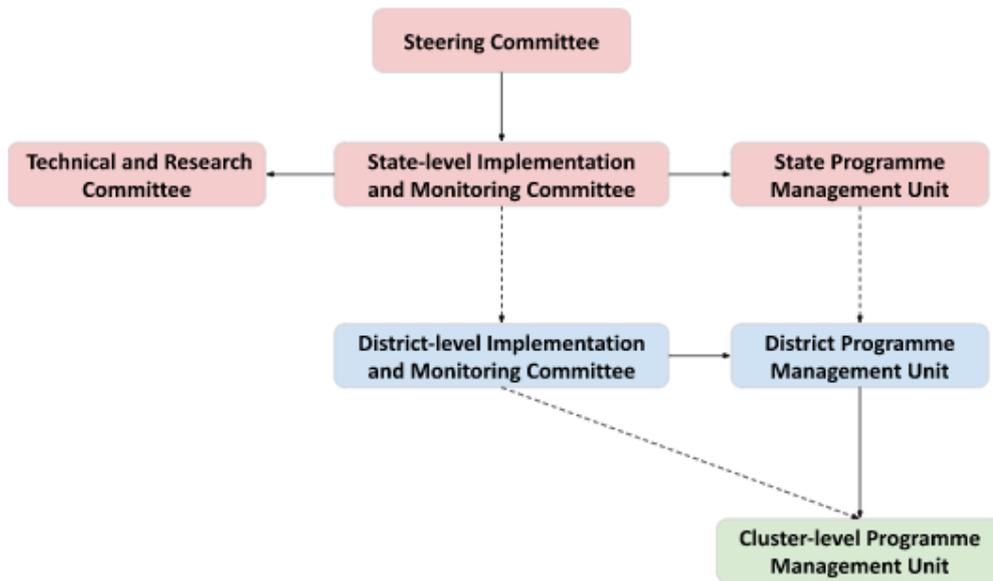
Abbreviations: SRLM, State Rural Livelihood Mission; NF, natural farming; CSO, civil society organisation; WASSAN, Watershed Support Services and Activities Network

As per the stakeholders consulted in the GoR, the ideal scenario for Rajasthan would be a model that brings together the following (as shown in Figure 9):

1. a dedicated hierarchy of officers, as in the PK3Y in Himachal Pradesh, solely responsible for driving NF scale-up to ensure focused efforts, and
2. an embedding of CSOs into the programme, as in OMM, to capitalise on the capacity and on-ground experience of CSOs because there is a thriving and rich tradition of government–CSO collaboration in Rajasthan.

Figure 10 shows the proposed institutional structure based on this learning and further stakeholder consultations. Annexure 7 provides a detailed description of the institutional structure.

Figure 10 Organogram of the proposed institutional structure



Source: Authors' recommendations

8.1. Steering committee

An overarching steering committee will monitor the progress of the NF scale-up programme. The committee would comprise of secretary- and commissioner-level officials from multiple government departments (including those identified for convergence) as well as senior experts and representatives from relevant national institutions, CSOs, research institutions, and so on.

8.2. Technical and research committee

The technical and research committee will be responsible for providing technical recommendations to guide the entire programme. This committee will be responsible for developing relevant PoPs for Rajasthan, top-down and bottom-up innovations, customisation of NF practices, documentation and publication of NF evidence, and development of protocols for residual pesticide testing, among others. The programme will establish two units for each of the two target regions, western and southern Rajasthan. The unit will consist of research scientists from leading agricultural universities, ICAR-Central Arid Zone Research Institute (ICAR-CAZRI), relevant KVKs, experts from the RySS, and so on. This committee will ensure a bottom-up approach by including NF CSOs and progressive champion farmers as members and facilitate research through studentships, innovation competitions, and so on.

8.3. Implementation and monitoring committees

The implementation and monitoring committees at each of the three levels will consist of officials from the relevant levels of line departments from multiple government departments, CSO engagement partners, departments of other states driving similar programmes, and key national entities such as the National Rainfed Area Authority (NRAA), ICAR, National Institute of Agricultural Extension Management (MANAGE), and so on, at the state level. They include the following:

- State-level implementation and monitoring committees
- District-level implementation and monitoring committees

8.4. State programme management unit (SPMU)

A nodal officer from the DoA (e.g., joint director, adaptive trial centre (ATC)) from the designated sub-department will potentially lead the SPMU. The SPMU will be responsible for the coordination and successful implementation of the programme. Coordinators from institutions such as the NCNF can potentially be technical partners who play an essential role at this level.

8.5. District programme management unit (DPMU)

The district deputy director from the DoA (nodal department) will head the DPMU, which will consist of officials from the Agricultural Technology Management Agency (ATMA) and CSO representatives from the respective districts. The DPMU will also be responsible for coordinating with the SPMU, driving the programme's progress at the district level.

8.6. Cluster-level programme management unit

At the cluster level, we can start by creating a cluster-level programme management unit responsible for the on-ground implementation of the project. This unit or '*toli*' for a cluster will consist of an agricultural supervisor (who will be accountable for that cluster) and CRPs from *Rajeevika* or a field functionary engaging with the CSOs. Cluster-level PMUs will report to the DPMU. As the programme advances, two committees can look after the project management.

Implementation roles of the government and CSOs at the cluster level: At the cluster level, there are three ways to allocate the responsibility of implementation:

1. a model where the DoA takes complete responsibility and engages interested CSOs for support;
2. a model where CSOs take full responsibility and the DoA officer provides support; and
3. a model where CSOs and the DoA jointly own implementation.

The study, therefore, recommends a hybrid model that depends on the region:

Option 1 is to be used where the DoA has better leverage and influence on the ground than CSOs towards empowering farmers, option 2 is feasible when CSOs have more influence, and option 3 involving shared responsibility could be used in those regions where the government and CSOs have similar levels of influence.

Annexures

Annexure 1: List of stakeholders and departments involved

Table A1: Departments that facilitated data provision for the study

Name of the department	
1. Rajasthan State Agriculture Marketing Board, Jaipur	7. Directorate of Horticulture, Jaipur
2. Department of Agriculture, Jaipur	8. Directorate of Watershed Development & Soil Conservation, Jaipur
3. Extension, Agriculture Department	9. Forest Department, Rajasthan
4. Directorate Animal Husbandry, Jaipur	10. Jaipur Vidyut Vitran Nigam Limited (Jaipur Discom)
5. Planning Department, Jaipur	11. Water Resources Department, Jaipur
6. Rajasthan State Seed and Organic Certification Agency, Jaipur	

Source: Authors' compilation

Table A2: Stakeholders consulted from relevant state-driven initiatives and other relevant organisations

Name		Designation
Stakeholders consulted from relevant state-driven initiatives		
Shri Muralidhar G.	Senior Consultant, RySS	
Dr Rajeshwar Chandel	Executive Director, <i>Prakritik Kheti Khushhal Kisan Yojna</i> , Himachal Pradesh	
Dr S. Anbalagan	Executive Director, Sikkim Organic Mission, Government of Sikkim, Gangtok	
Shri Dinesh Balam	Associate Director WASSAN and State Consultant Odisha Millets Mission	
Shri Mahendra Dahal	President, Organic Producer Cooperative Society Ltd, Soreng, West Sikkim	
Ms Swati Renduchintala	Associate Scientist, ICRAF, and Project Manager, Andhra Pradesh Community Managed Natural Farming	
Stakeholders consulted from other relevant organisations		
Ms Kavitha	Founder, Alliance for Sustainable & Holistic Agriculture	

Kuruganti	(ASHA)
Shri A. K. Pachori	Joint Director (Chemistry), Department of Agriculture, Rajasthan
Dr N. Balasubramani	Director, National Institute of Agricultural Extension Management (MANAGE)

Source: Authors' compilation

Table A3: Local CSO stakeholders involved in FGDs and CSOs who participated in the survey

CECOEDECON	<i>Udyogini</i>	Prakriti Foundation	<i>Unnati</i>
Centre for Microfinance (CmF)	<i>Jan Jagriti Samiti</i>	<i>Prayatna Samiti</i>	<i>Urmul</i>
Development Support Centre (DSC)	<i>Jamnalar Kaniram Bajaj Trust (JKBT)</i>	<i>Seva Mandir</i>	<i>Vaagdhara</i>
Foundation for Ecological Security	Manjari Foundation	Sir Syed Trust	Watershed Organisation Trust (WOTR)
<i>Gramshree</i>	PEDO	Srijan	<i>Ibtada</i> ²³
Gravis	PRADAN	<i>Jan Shiksha Vikas Sangathan Mada</i> ²⁴	

Source: Authors' compilation

CSOs who participated in the survey

Table A4: Participants of state-level round-table on 24 December 2021 in Jaipur, Rajasthan

Name	Designation
Dr Arvind Mayaram	Vice Chairman, CMRETAC
Shri Arjun Lal	Joint Director of Agriculture (Agro-ATC), Commissionerate of Agriculture
Dr Om Prakash	Commissionerate of Agriculture
Shri S. P. Gupta	CEO, <i>Jaipur Vidyut Vitran Nigam Limited</i> (Jaipur Discom)

²³ CSO only participated in the survey.

²⁴ CSO only participated in the survey.

Name	Designation
Dr Anand Sejra	Additional Director
Shri K. K. Pathan	Department of Animal Husbandry
Shri Abhimanyu Kumar	Commissioner, Horticulture
Shri Nawan Jain	Secretary of Planning
Dr Prithvi Raj	Secretary, Water Resource Department
Dr Bharti Dixit	Joint Secretary, Planning Department
Shri Mahesh Chandra Sharma	Managing Director, Rajasthan State Warehousing Corporation
Ms Urmila Rajorina	Director, ICDS
Dr T. Vijaykumar	Executive Vice Chairman, AP RySS
Mrs Sangeeta Agarwal	Senior Sector Specialist, Natural Resource Management, KfW Development Bank
Shri Abhishek Kumar	Head, Technical Support Unit, CMRETAC
Shri Devjit Mitra	Socratus Foundation
Shri Prachur Goel	Socratus Foundation
Shri Rohit Parakh	National Facilitator for States, NCNF
Ms Avisha Jain	Rajasthan Facilitator, NCNF

Source: Authors' compilation

Table A5: Participants of two-day state-level virtual workshop on 11 and 12 January 2022

Name	Designation
Dr Arjun Lal	Joint Director (ATC), Department of Agriculture
Shri A. K. Pachori	Joint Director, Department of Agriculture
Shri Abhishek Bagotia	Commissioner, MGNREGA, Department of Rural Development
Shri Dileep	Department of Watershed Development & Soil Conservation
Shri Dileep Kumar	ARAVALI (Association for Rural Advancement through Voluntary Action and Local Involvement)
Shri Dilip Jain	Water Resources Department
Dr Ashish Vyas	Midday Meal Scheme, School Education Department

Name	Designation
Dr Ashutosh	Superintendent Hydrogeologist, Ground Water Department
Dr P. K. Singh	Department of Horticulture
Dr S. K. Sharma	MPUAT
Shri Gajendra Verma	<i>Rajeevika</i> , Department of Rural Development
Shri Gopal Sharma	Ground Water Department
Shri H. S. Meena	Agriculture (Extension) Department
Shri Hardeep Singh	<i>Rajeevika</i> , Department of Rural Development
Shri Ishwar Yadav	Joint Director, Water Resources Department
Shri Jagpal Singh	Rajasthan State Seed Corporation Limited
Shri J. L. Kumawat	Joint Director, Agriculture Extension
Shri Laxman	Assistant Director, Department of Horticulture
Shri M. K. Jain	Deputy Director, ATC
Shri Madhusudan Sharma	Director, ATMA
Shri Mahesh	Deputy Director, Agriculture Extension
Shri Om Prakash	Commissioner, Department of Agriculture
Shri P. S. Jat	Department of Agriculture
Shri Dilip Jain	Water Resources Department
Shri P. K. Singh	Deputy Director, Department of Horticulture
Shri Prakash Kalani	Animal Husbandry Department
Shri Ram Niwas	Senior faculty, ATMA
Shri Ramesh	Joint Director, RKVY
Shri Rameshwar Prasad Meena	Joint Director, Tribal Area Department
Shri R. P. Kumawat	Additional Director, Department of Horticulture
Shri Satyanarayan	Joint Director, Department of Horticulture
Shri Shyam Lal Sharma	Director, Department of Agricultural Marketing
Shri Varun Sharma	ARAVALI
Shri Vinod Chaudhary	Water Resources Department

Source: Authors' compilation

Table A6: Participants from field visits and FGDs

Name	Designation
Shri Arjun Maheshwari	Unit In-charge, Natural Resource Department
Shri B. S. Palawat	CEO, <i>Zila Parishad</i> , Banswara
Shri Bhola Ram	Executive Engineer, Water Resources Department, Sikar
Shri Chandra Shekhar Joshi	—
Shri Deen Bandhu Bhatti	DPM, <i>Rajeevika</i> , Department of Rural Department
Shri Devi Singh	Gramshree Foundation Trust
Shri Dhulshan Meena	Farmer
Dr Anuj Baghel	Joint Director, Department of Animal Husbandry, Banswara
Dr B. Bhardwaj	Additional Director, Department of Animal Husbandry, Udaipur
Dr Bhagwat Singh Chauhan	<i>Krishi Vigyan Kendra</i> , Udaipur
Dr Braj Mohan Goyal	SVD, Department of Animal Husbandry, Jaipur
Shri Deepak Rajguru	Executive Director, Sewad Organics
Dr K. C. Sharma	Assistant Director, Horticulture, Banswara
Dr Kailash Chand Verma	ARS, Fatehpur-Shekhawati, Sikar
Dr Mahesh Choudhary	<i>Krishi Vigyan Kendra</i> , Fatehpur-Shekhawati
Dr P. C. Bhatraj	<i>Krishi Vigyan Kendra</i> , Udaipur
Dr Pramod Rokadia	Agricultural Advisor, <i>Vaagdhara</i>
Dr R. C. Dhaker	ARO, Department of Agriculture, Udaipur
Dr Rajesh Verma	Directorate of Animal Husbandry, Jaipur
Dr Rashid Ahled Chouhan	Department of Animal Husbandry, Sikar
Shri Rohit Jain	Founder, Banyan Roots
Dr Shakti Singh	Deputy Director, Department of Animal Husbandry
Dr Virendra Verma	Department of Animal Husbandry, Sikar
Dr Vishal Mehta	Department of Animal Husbandry
Dr Anjan Bal	Sr. Veterinary Officer, Animal Husbandry
Dr Harphool Singh	Director, Horticulture, <i>Krishi Vigyan Kendra</i>

Name	Designation
Dr Kailash Chand Verma	Agricultural Research Station
Dr Kishan Lal Nagada	Agriculture Officer, Commissionerate of Agriculture
Dr Mahesh Choudhary	Scientist, Department of Horticulture, <i>Krishi Vigyan Kendra</i>
Dr Rajesh Verma	Deputy Director, Department of Animal Husbandry
Dr Rashid	
Dr Sumitra Khichad	Joint Director, Department of Animal Husbandry
Dr Virendra Verma	Sr. Veterinary Officer, Department of Animal Husbandry
Shri Gulab	Farmer, Suran village, Udaipur
Shri Haddi Singh Bajiya	ARO, Agriculture Department, Sikar
Shri Hajari Lal Aloria	DSO, Banswara
Shri Hari Ram	Executive Engineer, <i>Zila Parishad</i> , Sikar
Shri Jaimal Rathore	DCPO, Udaipur
Shri Jalaj Upadhyay	Agricultural Supervisor, Horticulture, Banswara
Shri Jayesh Joshi	Secretary, <i>Vaagdhara</i> , Banswara
Shri Kamlesh Kumar Dosi	Manager, Suraj Dairy
Shri Kamlesh Kumar Meena	Seed certification officer, RSSOCA, Banswara
Shri Laxmi Thakur	Seva Mandir, Udaipur
Shri Mahendra Singh	Plant Manager, RSSCL
Shri Majid Khan	<i>Vaagdhara</i> , Banswara
Shri Mani Khinchi	Executive Officer, DSO, Banswara
Shri Manoj Choudhary	CDPO, Dantaramgarh, Department of Watershed Development and Soil Conservation
Mrs Rashmi Meena	DPM, <i>Rajeevika</i> , Department of Rural Department
Ms Avisha Jain	Rajasthan Facilitator, NCNF
Shri Natwar Lal Mahawat	Agriculture (Extension) Department, <i>Zila Parishad</i> , Banswara
Shri Paru Bai Alsighard	Farmer
Shri Pratapsi Alasighard	Farmer

Name	Designation
Shri Rajendra	<i>Mahan Seva Sansthan, Udaipur</i>
Shri Rajesh Sen	<i>Seva Mandir, Udaipur</i>
Shri Ram Kishan Verma	Department of Agriculture, Banswara
Shri Shailendra Bhatt	Department of Education, Banswara
Shri Shailendra Tiwari	<i>Seva Mandir, Udaipur</i>
Dr Arjun Lal	Agriculture Officer, Commissionerate of Agriculture
Shri Bholaram	
Shri Biharilal	BPM, <i>Rajeevika</i> , Department of Rural Department
Shri Devendrasingh Berat	Mandi Secretary, APMC
Shri Devjit	Socratus Foundation
Shri Hardev Singh Bajiya	Department of Agriculture
Shri Hari ram	<i>Zila Parishad</i>
Shri Krishna Kant	
Shri M. L. Meena	DDM, NABARD
Shri Mahendra Singh	Plant Manager, RSSCL
Shri Manoj Choudhary	
Shri Mustak Ahmad	Agricultural Research Station
Shri P. L. Patel	Theme leader–Agriculture, <i>Vaagdhara</i>
Mrs Rakhi Somkuwar	Programme Manager, Bajaj Foundation
Shri Prachur	Socratus Foundation
Shri Ramswaroop	DPM, <i>Rajeevika</i> , Department of Rural Department
Shri Suresh Kumar	CEO, <i>Zila Parishad</i>
Shri Vimlesh Kumar	Agriculture Officer, Horticulture Department
Shri Shyam Lal Salvi	Dy. Project Director, ATMA, Banswara
Shri Sundri Bai Alsighard	Farmer
Mrs Sunita Sharma	EO, Department of Food and Civil Supplies, Jaipur
Ms Varsha Rathore	<i>Seva Mandir, Udaipur</i>
Shri Vimlesh Kumar	Department of Horticulture, Sikar
Shri Vinod Parmar	Executive Officer, District supply officer

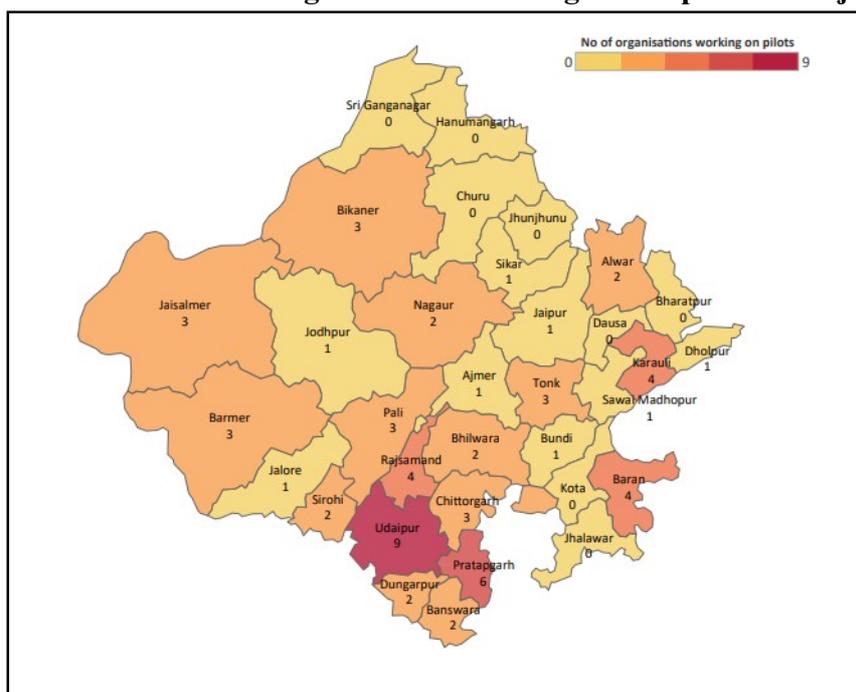
Name	Designation
Shri Yogesh Pandey	Plant Manager, RSSCL

Source: Authors' compilation

Annexure 2: Natural farming as defined by major state-level institutions and missions

- National Coalition for Natural Farming: <https://nfcoalition.in/>
- Andhra Pradesh Community Managed Natural Farming: <https://apcnf.in/>
- Prakritik Kheti Khushhal Kisan Yojana: <https://spnfhp.nic.in/>
- Odisha Tribal Development Society: https://stsc.odisha.gov.in/sites/default/files/202112/RFP%20Natural%20Farming%20FINAL%2029122021_0.pdf

Annexure 3: Number of organisations working on NF pilots in Rajasthan



Source: Authors' observations from the literature, stakeholder consultations, and field observations

Annexure 4: Indicators considered but not included for prioritisation

Theme	Indicator	Why is the indicator critical for scaling NF?	Why was it not included?
Agricultural indicators	Average landholding size	Generally, NF has found easy adoption among small landholding farmers.	In the context of Rajasthan, large landholdings do not necessarily mean higher use of fertilisers or higher cropped land. Therefore, the use of this indicator may be misleading.
	Net irrigated area	Correlated with the use of extensive inputs (fertilisers, water, power, etc.), and thus, informs about the ease of NF adoption.	Irrigated area is highly correlated with fertiliser use, which is already included in the list of selected indicators.
	Average rainfall on a decadal basis	Informs about the potential of surface and groundwater recharge.	Average depth of the groundwater level – a crucial outcome/result of rainfall – has already been included in the selected indicators.
Social indicators	Number of information and research centres (IRCs)	Informs about the capacity of extension systems present in a district to conduct research and disseminate scientific evidence of NF to farmers.	The presence of IRCs seems to be correlated with the presence of irrigated areas, thus not adding additional nuance to the list of selected indicators.
Economic indicators	Bovine population	Livestock availability (cattle/buffalo) is critical for the provisioning of	Rajasthan already has a significant bovine population to the tune of 27.6 million (2.76 crore). So, its availability is not expected to

Theme	Indicator	Why is the indicator critical for scaling NF?	Why was it not included?
		inputs.	become a bottleneck in phase 1 in most parts of Rajasthan.
	Number of farmer producer organisations (FPOs)	FPOs can increase the scope for the provision of inputs and marketing of NF produce.	NF-dedicated FPOs, which do not exist in Rajasthan as of now, are planned to be created in this programme itself; therefore, the number of existing FPOs is expected to have limited effect on the ease of adoption of the NF programme.
	Availability of agricultural labour	NF is labour-intensive and therefore the availability of labour is an important driver for NF adoption.	Labour availability is not considered a significant issue by stakeholders in the short term.

Source: Authors' analysis

Annexure 5: Methodology for selecting the districts for phase 1

The following methodology was implemented for the prioritisation and selection of districts for phase 1.

1. We collected data on the indicators selected in Table 9 (i.e., groundwater availability; crop yield index; fertiliser consumption; number of PGS farmers, KUMS, and *mahila kisan*; size of the ST population; SHGs; and kitchen gardens) at the district level.
2. A different set of primary indicators²⁵ was identified for western (groundwater availability, crop yield index, and fertiliser consumption) and southern (size of the ST population, SHGs, and kitchen gardens) regions. We selected these indicators based on expert consultation to identify the most suitable districts for

²⁵ Primary indicators: Those indicators that are the most important for suitability.

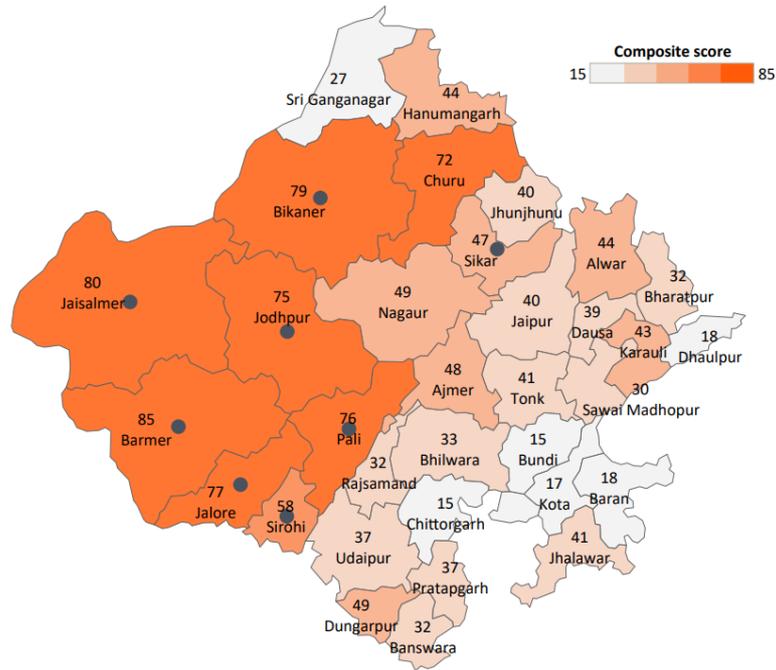
the programme.

3. Each district was scored based on its ranking on the primary indicators selected for the respective regions. In other words, we used this scoring method to identify the western districts with lower groundwater availability, lower fertiliser consumption, and lower crop yield index. Similarly, we used this scoring method to identify southern districts with higher tribal populations, lower fertiliser consumption, a larger number of SHGs, and a larger number of kitchen gardens.
4. For each region, we calculated a composite score index by averaging the primary indicators selected for the respective regions. The districts with higher composite scores were identified as higher-priority districts in both regions.
5. To further nuance the selection of the districts, we used the data collected on the secondary indicators²⁶ (number of PGS farmers, KUMS, and *mahila kisans*) at the district level.
6. We ranked the districts according to their scores on the secondary indicators and developed a composite secondary score by averaging the scores from the secondary indicators.
7. We converted the composite secondary score to a scale of ‘High’, ‘Medium’, and ‘Low’. For example, we labelled the top 10 districts with the highest composite score ‘High’.
8. We also collected data on the total number of NF pilots in each district to assess the maturity of NF adoption (also in the ‘High’, ‘Medium’, and ‘Low’ scales) in various districts.
9. The scoring from steps 4, 7, and 8 were presented to a round table attended by the officers from the relevant sub-departments of Rajasthan’s agricultural department and chaired by the agriculture commissioner. The participants complemented the presented quantitative scoring with their perspectives regarding the on-ground programme implementation in various districts. Based on the deliberations, a consensus was developed on the districts to be prioritised for the NF programme and their further segregation into districts for high-, low-, and medium-intensity/penetration of the intervention programme. A summary of the final selection is presented in Tables 13, 14, and 15.

²⁶ Secondary indicators: Once screening/selection has been made based on primary indicators, these indicators are used to further nuance the selection on the basis of ease of behaviour shift and adoption of NF programme.

Western district prioritisation

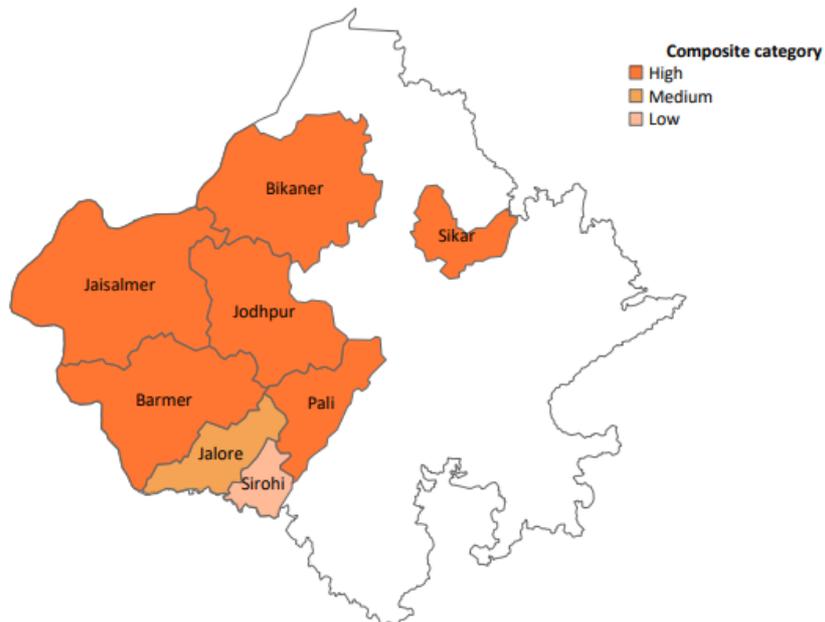
(a) Composite score using primary indicators (GWA, fertiliser, crop yield index)



Source: Authors' analysis

Notes: The dots represent the selected districts

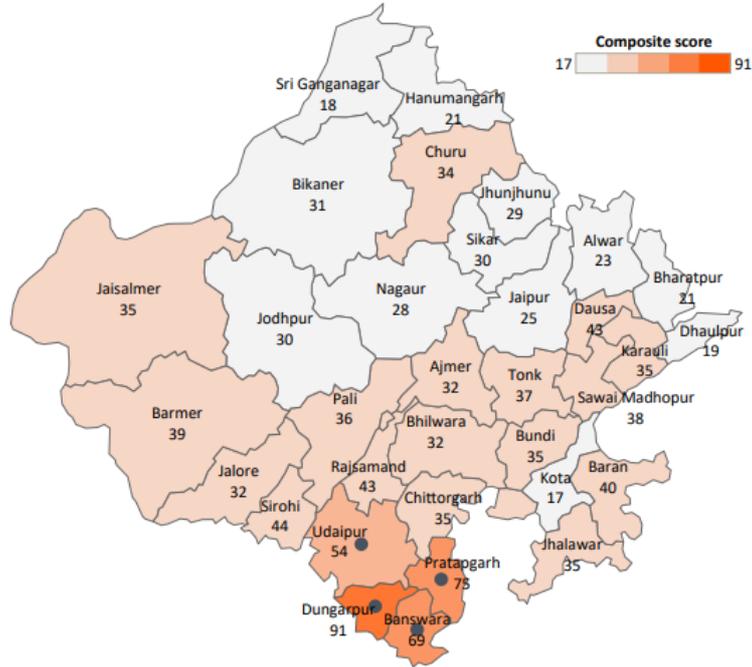
(b) Composite category using secondary indicators (PGS farmers, KUMS, mahila kisans, NF maturity)



Source: Authors' analysis

Southern district prioritisation

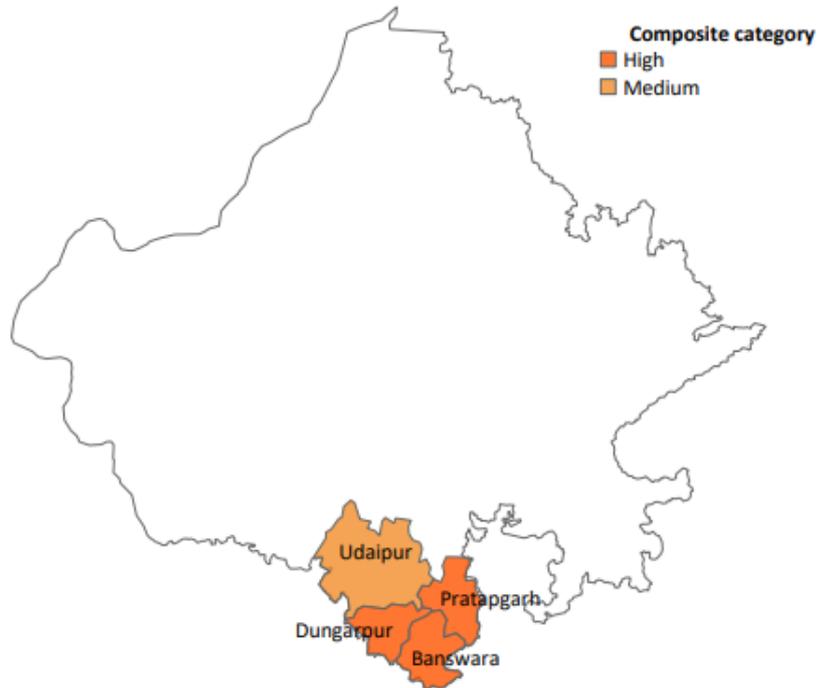
(a) Composite score using primary indicators (ST population, kitchen garden, SHGs)



Source: Authors' analysis

Notes: The dots represent the selected districts

(b) Composite category using secondary indicators (PGS farmers, KUMS, mahila kisan, NF maturity)



Source: Authors' analysis

Annexure 6: Relevant opportunities for convergence with various other departments (identified for phase 1 and later phases)

The following is the list of key opportunities/schemes identified in other relevant departments that could be leveraged by the NF programme.

Theme 1: Capacity building

Interventions identified	Department
NIAM is recommended for training government officials on the modules of marketing for NF produce.	National Institute of Agricultural Marketing
SIAM/ATMA is recommended to include a module on marketing for capacity building. They can also be leveraged to train officers with validated modules/PoPs.	State Institute of Agricultural Management
Centres of Excellence (CoEs) for Fruits could be potentially used for direct training of the farmers and government officials if well-tested NF PoPs are provided.	Directorate of Horticulture
<i>Rajeevika</i> CRPs are recommended to be engaged as trainers for the on-farm farmer-training sessions (only if they are practising NF themselves).	<i>Rajeevika</i>
<i>Rajeevika Pashu</i> and <i>Krishi Sakhis</i> are recommended to be leveraged to train and empower other SHG leaders.	<i>Rajeevika</i>
The <i>Anganwadi</i> employees are recommended to be trained to promote NF kitchen gardens in their respective <i>Anganwadis</i> .	Directorate of Integrated Child Development Services
The relevant school leaders/MDM leaders are recommended to be trained to promote NF kitchen gardens in schools.	Department of Elementary Education
The State Institute of Rural Development (SIRD) can be used to capacitate RDPR (<i>Rajeevika</i> , MGNREGA, <i>Panchayati Raj</i>) officials on NF.	Department of Rural Development
Leverage the external expertise and infrastructure of resource organisations, such as RySS, agricultural universities like MPUAT, CAZRI, and so on and local CSOs.	External organisations

Theme 2: Input support to farmers

Interventions identified	Department
Atal Bhujal Yojana can be oriented to allocate funds for groundwater recharge in the districts and areas selected under the scheme.	Ministry of Jal Shakti
National Beekeeping & Honey Mission (NBHM) is recommended to be leveraged to include beekeeping as a part of the integrated farming system to diversify incomes, especially during the transition period.	Atma Nirbhar Bharat Abhiyan
Farm ponds can be constructed in phase 1 districts at a subsidised cost for easy water access.	Department of Watershed Development and Soil Conservation
Water harvesting structures can be developed in targeted GPs/districts under the <i>Gram Panchayat</i> Development Plan (GPDP).	<i>Panchayati Raj</i> and Department of Watershed Development & Soil Conservation
SHG loans for the purchase of cattle (such loans are currently focused on poultry).	<i>Rajeevika</i>
Local seed production and distribution of subsidised seeds for NF.	Rajasthan State Seed Corporation
Subsidised cow urine and other inputs from <i>gaushalas</i> .	Directorate of Gopalan
Mukhyamantri Beej Swawalamban Yojna can provide subsidised seeds for NF.	Department of Agriculture

Theme 3: Market access and development

Interventions identified	Department
District-level fairs can be organised under the NRLM programme for the promotion of NF produce.	Ministry of Rural Development/ <i>Rajeevika</i>
SHG training sessions can include training on creating NF FPOs, marketing, and entrepreneurship, especially for NF produce.	<i>Rajeevika</i>
Integrated Post-harvest Management (National Horticulture Mission scheme) under the <i>Rashtriya Krishi Vikas Yojana</i>	Ministry of Agriculture & Farmers Welfare

could be reoriented to build cold storage units, for example, closer to the NF regions.

MNREGA can be leveraged to support farmers in developing one-time on-farm infrastructure; for example, that for composting.

Ministry of Rural Development

PM Micro Food Processing Scheme could be leveraged to provide technical, financial, and business support to micro NF food processing units.

Atma Nirbhar Bharat Abhiyan

Source: Authors' compilation

Annexure 7: Institutional framework: Recommended roles and responsibilities

Institutional entity	Level	Role	Reporting to	Members
State level				
Steering committee	Principal secretary– level officers (joined by commissioner- level officers)	<ol style="list-style-type: none"> 1. Meeting once in two months in the first year as the programme shapes up; the frequency may reduce to twice a year as it stabilises. 2. Overall governance, policy, interdepartmental convergence/coordination, and programme evolution. 3. Responsible for securing and allocating funds for the programme, including allocation/prioritisation of funds within existing schemes for NF. 4. Guide the selection of pilots in the ACZs not included in phase 1 (pilots to develop evidence for phase 2). 	Chief Secretary	All the convergence departments: The agriculture department, RDPR (<i>Rajeevika</i> , MGNREGA, <i>Panchayati Raj</i>), Animal Husbandry Department, Tribal Area Development Department, Education Department, MPUAT, State Institute of Agricultural Management (SIAM), Women and Child Department, Water Resources Department, Ground Water Department, and so on (other departments should be included with programme evolution).

5. Commissioning new studies to pave the direction of project evolution, such as impact assessment studies, studies to design and operationalise market mechanisms, payments for ecosystem services, development of phase 2 strategies, and so on.

CSO engagement partners for three target regions* who have expertise in NF programme implementation, research, and networking with the NF CSO base of Rajasthan (e.g., National Coalition for Natural Farming);

Socio-economic research and CSO capacitation: ARAVALI, Institute of Development Studies, other sizeable CSOs who can train other CSOs in NF, and so on.

Departments of other states driving similar programmes (RySS, Odisha Rainfed Agriculture Mission, HPPK3Y, etc.).

NF private sector representation from Rajasthan (e.g., Center for Natural & Organic Life), consumer voice representation (e.g., New Indian Consumer Initiative), and a think tank to provide insights into emerging

		<p>themes such as Payment for Ecosystem Services (e.g., CEEW).</p>
		<p>Key national institutions: NRAA, relevant ICAR bodies, MANAGE, NABARD, NIAM, FCI, and so on.</p>
<p>State-level implementation and monitoring committee</p>	<p>Commissioner-level officers (joined by director/joint director-level officials too)</p> <ol style="list-style-type: none"> 1. Implement, monitor, and review the programme activities. 2. Meet monthly for the first year; the frequency may be reduced to once in two months as the programme stabilises. 3. Continuous customisation of the programme to incorporate the new information/learning and course correction. 4. Identification and engagement of relevant organisations for independent impact assessment. 	<p>All the convergence departments: The agriculture department, RDPR (<i>Rajeevika</i>, MGNREGA, <i>Panchayati Raj</i>), Animal Husbandry Department, Tribal Area Development Department, Education Department, MPUAT, SIAM, WCD, Water Resources Department, Ground Water Department, and so on (other departments should be included with programme evolution).</p> <p>Principal Secretary</p>

CSO engagement partners in each of the target regions* for scale-up and piloting for evidence.

Departments of other states driving similar programmes (RySS, Odisha Rainfed Agriculture Mission, HPPK3Y, etc.).

Market body network representation in Rajasthan (e.g., Center for Natural & Organic Life), consumer body (e.g., New Indian Consumer Initiative), think tank (e.g., CEEW).

Key national institutions: (NRAA, relevant ICAR bodies, MANAGE, NABARD, NIAM, FCI etc.).

Socio-economic research and CSO capacitation: ARAVALI, Institute of Development Studies, other sizeable CSOs who can train

<p>SPMU (hosted in the DoA)</p>	<p>Led by a nodal officer (e.g., joint director, ATC) from a designated sub-department (e.g., ATC) responsible for coordination.</p>	<ol style="list-style-type: none"> 1. Coordinate with directorates within and outside the DoA for budgetary allocations and other project implementation activities. 2. Responsible for the overall implementation and management of the programme in the targeted regions.* 3. Engage with the technical and research committee and other task forces set up for technical inputs and advisory (e.g., developing the base PoP for launching the programme). 4. Responsible for developing training modules for various government departments in coordination with the technical and research committee 5. Responsible for spending allocated funds under various planned implementation activities, including payments to external individuals and organisations engaged in programme implementation 6. Drive bottom-up and top-down innovation activities, such as high- 	<p>Commissioner Agriculture</p>	<p>other CSOs in NF, and so on.</p> <p>Nodal officer supported by two to three divisional officers. At least one person/officer on full-time duty in the SPMU should have had significant prior experience in NF.</p>
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	<p>end NF model development, customising NF practices, seed conservation practices, and so on</p> <p>7. Develop proposals for new studies – for example, studies on NF certification mechanism, market development, and so on and coordinate with the external independent impact assessment agencies.</p>	<ol style="list-style-type: none"> 1. Identify suitable CSO partners, coordinate and build partnerships for programme implementation, and innovation and research activities in each region.* 2. Support the nodal sub-department with overall programme implementation and management. 3. Support the innovation activities, especially bottom-up innovation where engagement with champion farmers and CSOs is essential. 	<p>A CSO from each of the three target regions* with significant expertise in NF networking with other NF-promoting NGOs.</p>
	<p>Regional leads (CSO engagement partners from each region*)</p>	<ol style="list-style-type: none"> 1. Support in wider civil society capacity building. 2. In-house research around economic and social sciences and policy aspects of the programme. 3. Curating the learning from various monitoring and evaluation 	<p>Socio-economic research and CSO capacitation: ARAVALI, Institute of Development Studies, mature CSOs who can train smaller CSOs, and so on.</p>
	<p>State programme leads of organisations working on socio-economic research and CSO capacitation</p>		

<p>Technical and research committee</p>	<p>Head researchers from agricultural universities, research institutions, organisations with expertise in capacity building, and so on and other relevant experts.</p>	<p>activities and independent impact assessments.</p> <ol style="list-style-type: none"> 1. Research and innovation to develop relevant NF PoPs and protocols for residual pesticide testing for Rajasthan. 2. Responsible for the continuous evolution of the PoPs implemented by the programme based on emerging evidence. 3. Providing technical advice to PMUs in launching, managing, and learning from state-wide impact assessments and course correction. 4. Provide technical advice to PMUs for driving state-wide top-down and bottom-up innovation. 5. Development of the training modules for capacity building of DoA field officers, such as agricultural supervisor (AS) and assistant agricultural officer (AAO), CRPs, champion farmers, farmers, <i>Krishi/Pashu Sakhis</i>, and so on. 	<p>Commissioner agriculture</p>	<p>Two technical and research subcommittees for the two regions (western and southern), consisting of those members of the following who are relevant to the respective regions.</p> <p>Lead scientists with experience in NF from universities and organisations such as MPUAT, ICAR-CAZRI, and so on.</p> <p>Expert organisations such as the RySS and ARAVALI will assist in capacity building, developing training modules, resource support (providing CRPs, champion farmers), and so on.</p> <p>Progressive farmer representative(s) and leading CSO representative(s) for</p>
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		<p>bottom-up research and innovation.</p> <p>State- and district-level officers from the government extension system (KVK, ATC, etc.).</p>	
District level			
<p>District-level implementation and monitoring committee</p>	<p>Senior district officials from line departments engaged in the state-level implementation and monitoring committee.</p>	<ol style="list-style-type: none"> 1. Organise meetings once every month for the first year as the programme shapes up; the frequency may be reduced to once a quarter as the programme stabilises (to be held by different departments on a rotation basis). 2. Implementation and monitoring at the district and block levels. 	<p>All the convergence departments: The agriculture department, RDPR (<i>Rajeevika</i>, MGNREGA, <i>Panchayati Raj</i>), Animal Husbandry Department, Tribal Area Development Department, Education Department, MPUAT, SIAM, WCD, Water Resources Department, Ground Water Department, etc. (other departments should be included with programme evolution).</p>

	<p>District leads of the engaged CSOs, expert organisations, and so on.</p>			<p>District leads of CSOs engaged by the regional CSO engagement partners at the district level from the respective regions.</p> <p>District-level representation and Market Body Network Representation in Rajasthan (e.g., Center for Natural & Organic Life), Consumer body (e.g., New Indian Consumer Initiative), think tank (e.g., CEEW)</p> <p>District-level research and extension institutions (e.g., KVKs)</p> <p>District officials of key national institutions: NABARD, FCI, and so on.</p>
<p>DPMU</p>	<p>Led by a district-level subordinate of the nodal officer (e.g., agricultural officer)</p>	<ol style="list-style-type: none"> 1. Coordinate with other district-level departments/sub-departments for project implementation activities. 2. Responsible for the overall implementation and management of the programme in the district. 3. Engage with the Technical and Research Subcommittee or other 	<p>Deputy director, Department of Agriculture</p>	<p>District-level subordinate of nodal officer (e.g., Deputy Director, ATC, Project Director, ATMA).</p>

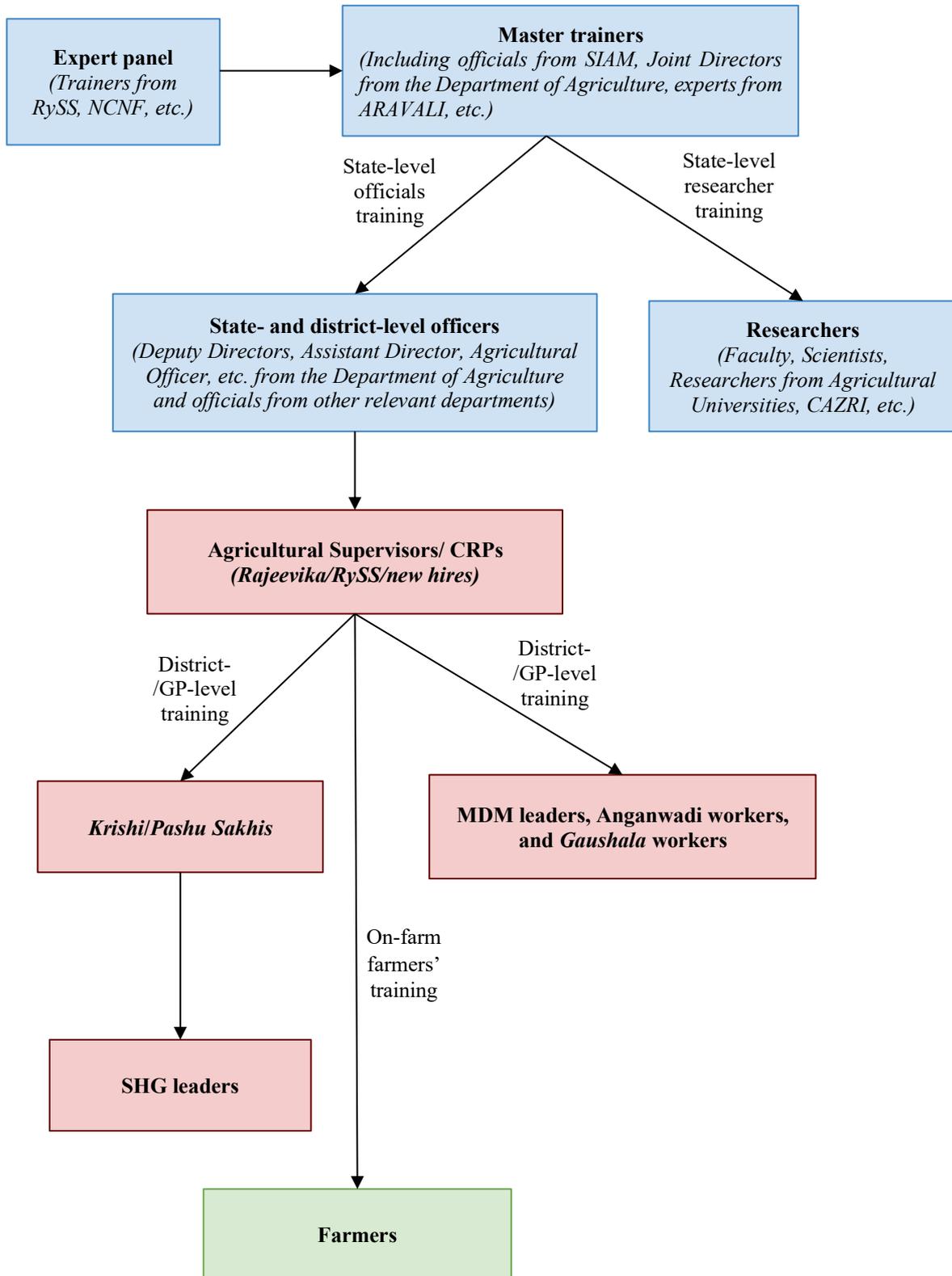
		<p>task forces set up for technical inputs and advisory (e.g., developing the base PoP for launching the programme).</p> <ol style="list-style-type: none"> 4. Responsible for spending the allocated funds under various planned implementation activities, including payments to external individuals and organisations engaged in programme implementation. 5. Drive innovation activities, such as high-end model development, customising NF practices, and so on (bottom-up innovation). 		
	District team lead (district-level CSO partner)	<ol style="list-style-type: none"> 1. Identify and engage suitable CSO functionaries for cluster-level implementation. 2. Support in the overall programme implementation and management. 3. Support the implementation of innovation activities (bottom-up). 		District programme lead (to be co-located with the DPMU lead) from the district level; CSO partner to be identified and engaged by the regional CSO engagement partner.
Cluster level				
Cluster-level programme management unit	Cluster (4–5 GPs) level agricultural officers	<ol style="list-style-type: none"> 1. Meeting at least twice a month in the first year as the programme shapes up; the frequency may be 	Block-level agricultural officer	Cluster-level officer from the line department of the DPMU lead.

	Cluster-level CSO functionaries and key CRPs (e.g., champion farmers, <i>Rajeevika</i> CRPs)	<p>reduced to at least once a month as the programme stabilises in that cluster.</p> <p>2. Implementation at the cluster and panchayat levels.</p>	(e.g., assistant agriculture officer)	Cluster-level CRPs from <i>Rajeevika</i> and/or CSOs, champion farmers, and so on engaged via a CSO engagement partner.
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Source: Authors' recommendations

Note: targeted regions includes the Western zone, the Southern zone and the irrigated zone*

Annexure 8: Proposed capacity-building flow chart



Source: Authors' recommendations

Proposed implementation plan

CEEW carried out an eight-month-long study to evaluate the feasibility of NF in Rajasthan. The study was carried out under the initiative of the CMRETAC. The detailed report titled ‘Scaling up Natural Farming in Rajasthan’ explores the suitability of NF in Rajasthan and proposes a strategic road map for successful scale-up. Table A provides the calendar for year 1 of the programme. The calendar highlights the monthly milestones for scaling up NF.

Table A. Proposed milestones for year 1 of the NF scale-up programme

No.	Particulars	Year 1											
		M0–M1: March– April	M2: May	M3: June	M4: July	M5: August	M6: September	M7: October	M8: November	M9: Decemb er	M10: Janu ary	M11: Februa ry	M12: March
0	Setting up the programme and the operational guidelines in consultation with members suggested for the state-level monitoring and implementatio												

<p>n committee (please refer to Annexure 7 for suggested members)</p> <p>Continuing the consultation with the members suggested for the state-level monitoring and implementation committee (refer to Annexure 7), map out the list of activities to develop a detailed work plan for driving the NF programme in line with this calendar</p> <p>1</p> <p>2</p> <p>Developme nt of the module for</p>	
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	capacity building by the technical and research committee										
3	Establishment of the steering committee, and programme implementation and monitoring committees at the state and district levels										
4	Establishment of the state and district PMUs (refer to the chapter above)										
5	Training of the master trainers										
6	State-level training of the government										

<p><i>Anganwadi</i> workers, and school/MDM leaders</p>	
<p>12 Policy research studies to develop road maps for high-potential opportunities (e.g., NF certifications, payment for ecosystem services)</p>	
<p>13 Innovation, research, technology demonstration, and extension (top-down as well as bottom-up)</p>	

References

- Abhilash, P. C. and N. Singh. 2009. "Pesticide Use and Application: An Indian Scenario." *Journal of Hazardous Materials* 165 (1–3): 1–12. doi:10.1016/j.jhazmat.2008.10.061.
- Aggarwal, Prateek, Anjali Viswamohanan, Danwant Narayanaswamy, and Shruti Sharma. 2020. "Unpacking India's Electricity Subsidies: Reporting, transparency, and efficacy." *Winnipeg: International Institute for Sustainable Development*.
- Agricultural and Processed Food Products Export Development Authority (APEDA). 2021-2022. "Consolidated Organic Agricultural Statistics for the Year 2020–21." https://apeda.gov.in/apedawebsite/organic/data.htm#certification_process_6_2021.
- Battu, R. S., B. Singh, B. K. Singh, and B. S. Joia. 2005. "Risk Assessment through Dietary Intake of Total Diet Contaminated with Pesticide Residues in Punjab, India 1999–
- Department of Agriculture and Farmers Welfare. 2015. "Participatory Guarantee System for India." https://pgsindia-ncof.gov.in/pgs_india.aspx.
- Department of Animal Husbandry, Dairying & Fisheries. 2019. "20th Livestock Census." <https://www.dahd.nic.in/sites/default/files/Key%20Results%2BAnnexure%2018.10.2019.pdf>.
- Deb, D. 2021. "Productive Efficiency of Traditional Multiple Cropping Systems Compared to Monocultures of Seven Crop Species: A Benchmark Study." *Experimental Results* 2:E18. doi:10.1017/exp.2021.7.
- Department of Economics and Statistics. 2019. "Gross State Domestic Product." [https://plan.rajasthan.gov.in/content/dam/planning-portal/Directorate of Economics and Statistics/Publication/Regular Publications/state domestic product rajasthan/State Domestic Product 2019-20.pdf](https://plan.rajasthan.gov.in/content/dam/planning-portal/Directorate%20of%20Economics%20and%20Statistics/Publication/Regular%20Publications/state%20domestic%20product%20rajasthan/State%20Domestic%20Product%202019-20.pdf).
- Department of Economic Affairs. 2023. "Economic Survey 2022-23." <https://www.indiabudget.gov.in/economicsurvey/>
- Devi, P. I. 2007. "Pesticide Use in the Rice Bowl of Kerala: Health Costs and Policy Options." Working Paper No. 20–07, South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu.
- Gill, Harsimran and Harsh Garg. 2014. "Pesticides: Environmental Impacts and

- Management Strategies.” In *Pesticides: Toxic Aspects*, edited by Marcelo Larramendy and Sonia Soloneski. London: IntechOpen. doi:10.5772/57399.
- Government of Rajasthan. 2017. “Rajasthan Organic Farming Policy 2017.” https://cuts-cart.org/pdf/Rajasthan_Organic_farming_Policy-2017.pdf.
- Gupta, N., S. Tripathi, and H. Dholakia. 2020. Can Zero Budget Natural Farming Save Input Costs and Fertiliser Subsidies? Evidence from Andhra Pradesh. <https://www.ceew.in/sites/default/files/can-zero-budget-natural-farming-save-input-costs-and-fertilizer-subsidies.pdf>
- Gupta, N., S. Pradhan, A. Jain, and N. Patel. 2021. “Sustainable Agriculture in India 2021: What We Know and How to Scale Up.” <https://www.ceew.in/sites/default/files/CEEW-Sustainable-Agriculture-in-India-2021-May21.pdf>
- H. Pathak, A. Bhatia. 2017. “24 - Reactive Nitrogen and Its Impacts on Climate Change: An Indian Synthesis, 383 – 401.” Editor(s): Yash P. Abrol, Tapan K. Adhya, Viney P. Aneja, Nandula Raghuram, Himanshu Pathak, Umesh Kulshrestha, Chhemendra Sharma, Bijay Singh, The Indian Nitrogen Assessment. <https://doi.org/10.1016/B978-0-12-811836-8.00024-0>.
- Kalra, R. L., B. Singh, and R. S. Battu. 1994. “Organochlorine Pesticide Residues in Human Milk in Punjab, India.” *Environmental Pollution* 85:147–51.
- Kaphalia, B. S. and T. D. Seth. 1983. “Chlorinated Pesticide Residues in Blood Plasma and Adipose Tissue of Normal and Exposed Human Population.” *Indian Journal of Medical Research* 77:245–47.
- Khurana, A., M. A. Halim, and A. D. Singh. 2022. *Evidence (2004-20) on Holistic Benefits of Organic and Natural Farming in India*. New Delhi: Centre for Science and Environment.
- Kumar, R., S. Kumar, B. S. Yashavanth, P. C. Meena, A. K. Indoria, S. Kundu, and M. Manjunath. 2020. *Adoption of Natural Farming and Its Effect on Crop Yield and Farmers’ Livelihood in India*. Hyderabad, India: ICAR–National Academy of Agricultural Research Management.
- Misra, S. 2017. “Water Use and Reallocation for Economic Growth: A Case Study of Rajasthan, World Bank.” <https://openknowledge.worldbank.org/bitstream/handle/10986/28579/120421-WP-v2-PUBLIC-WB-Rajasthan-Cross-sectoral-Water-Issues-and-Strategies-Main-Report-06-10-17.pdf?sequence=1&isAllowed=y>

- Mohanty, A. and S. Wadhawan. 2021. “Mapping India’s Climate Vulnerability: A District Level Assessment.” <https://www.ceew.in/publications/mapping-climate-change-vulnerability-index-of-india-a-district-level-assessment>
- MOSPI. 2019. “Situation Assessment of Agricultural Households and Land and Holdings of Households in Rural India, (2019), NSS 77th Round.” <https://im4change.org/docs/Situation%20Assessment%20of%20Agricultural%20Households%20and%20Land%20and%20Livestock%20Holdings%20of%20Households%20in%20Rural%20India%202019.pdf>.
- NABCONS. (2017). “State Agriculture Plan (SAP) and State Agriculture Infrastructure Development Plan (SAIDP) under RKVY-RAFTAAR 14th Financial Commission Rajasthan State Government of Rajasthan. [https://www.rkvy.nic.in/static/SAP/RA/For this Period\(2017-18 to 2019-20\)/Final Report- SAP and SADIP Rajasthan State.pdf](https://www.rkvy.nic.in/static/SAP/RA/For%20this%20Period(2017-18%20to%202019-20)/Final%20Report-SAP%20and%20SAIDP%20Rajasthan%20State.pdf).
- National Coalition on Natural Farming. 2021. Organisation Mapping Report. Page 60.
- National Coalition on Natural Farming (website). n.d. <http://nfcoalition.in/>.
- NITI Aayog (website). n.d. <https://naturalfarming.niti.gov.in/>.
- NRMC. 2018. “Doubling Farmers’ Income: Issues and Strategies for Rajasthan Final Report.” <https://www.nabard.org/auth/writereaddata/tender/2802192439Doubling%20of%20Farmers%20Income%20Issues%20&%20Strategies%20in%20Rajasthan.pdf>
- Rose, S., Halstead J., and Griffin T. (2021). “Zero Budget Natural Farming in Andhra Pradesh: A Review of Evidence, Gaps, and Future Considerations.” CREATE Solutions for a Changing World, no. 2. Medford, Mass.: Tufts University.
- Rythu Sadhikara Samstha* (RySS). n.d. “Andhra Pradesh Community Managed Natural Farming.” <https://apcnf.in/>.
- Singh, P. P. and R. P. Chawla. 1988. “Insecticide Residue in Total Diet Samples in Punjab, India.” *Science of the Total Environment* 76:139–46.
- Subhash Palekar Natural Farming. N.d. Directorate of Agriculture. Himachal Pradesh. <https://spnfhp.nic.in/SPNF/en-IN/index.aspx>
- Smith, J., Yeluripati, J., Smith, P., & Nayak, D. R. (2020). Potential yield challenges to scale-up of zero budget natural farming. *Nature Sustainability* 2020 3:3, 3(3), 247–252. <https://doi.org/10.1038/s41893-019-0469-x>
- Suresh, N. S., S. Ravuri, A. Bose, H. Haritha, A. Shanker, and P. Anantha Lakshmi. 2019.

“Life Cycle Assessment of ZBNF and Non-ZBNF: A Study in Andhra Pradesh.”
<https://apcnf.in/wp-content/uploads/2020/05/LIFE-CYCLE-ASSESSMENT-OF-ZBNF-AND-NON-ZBNF-A-STUDY-IN-ANDHRA-PRADESH.pdf>

Varghese, Jean V., Elveena M. Sebastian, Thamanna Iqbal, and Antriya A. Tom. 2021.
“Pesticide Applicators and Cancer: A Systematic Review.” *Reviews on*

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