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# Revitalising traditional rice varieties (landraces) through natural farming: story of Manne Srinivasa Rao (India)

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This paper is based on a farmer, Manne Srinivasa Rao's experiences and observations over a period of 4 years from 2021. Affected by the incidence of higher cancer rates in the villages and his own father's loss, he chose to grow food on his own farm using indigenous paddy. Communities firmly believe that the poor health resulting from poor-quality food consumption contributes to the increase in non-communicable diseases. Drawing knowledge from his ancestors and elders, combined with training and exposure at civil society organisations, he chose natural farming, a regenerative agroecological practice, to raise paddy using 8 varieties of indigenous seeds. The transition from chemical-based farming to Natural Farming on the study farm began in 2021 and has been practised continuously for 4 cropping seasons. The study documents the cultivation of selected traditional rice landraces, including Bahuroopi, Kumkumshali (Rakthashali), Kalabat, Kullakar, and Navara. Rice type – all varieties belong to *Oryza sativa*, predominantly indica-type rice. Seed material is sourced from Basudha farm, founded by Dr Depal Deb, which has preserved 1,500 landrace varieties in West Bengal. In the first year, he collected 5 kg of seed of each variety from the SAVE organisation. In the second year, he also collected 4 kg of seed from Basudha farm, Munugodu, Odisha. In subsequent years, he multiplied the seeds, saving seeds from the harvest. Further research is needed to validate observations on soil health, stress resilience, yields, and nutrition, highlighting the importance of preserving traditional seeds through community involvement. The writer is a video producer, and a film has been made, an oral history archived by the Food and Agriculture Organization of the United Nations (FAO) in the knowledge digest.

**KEYWORDS**

biostimulants, climate resilience, genetic diversity, landraces, natural farming, nutritional density, pre-monsoon dry sowing, soil microbiome

## Introduction

The case study of M. Srinivasa Rao from India explores the nutritional and ecological implications of the Green Revolution. It presents a compelling case for reviving traditional rice landraces through agroecological farming. In the present case study area, traditional varieties such as Bahuroopi, Kumkumshali (Rakthashali), Kalabat, Odisha Basmati, Saffron,

Kullakar, Govindbhog, Mysore Mallige, and Navara were known for their resilience, nutritional value, and suitability to low-input farming systems. Today, over 100,000 rice accessions are conserved at the National Bureau of Plant Genetic Resources (NBPGR), a reflection of India's rich but endangered agrobiodiversity (ICAR-NBPGR, 2024). The widespread adoption of hybrid varieties led to severe genetic erosion, including the loss of nearly 110,000 indigenous seed varieties in India (Deb, 2019), along with a significant decline (19–45%) in essential nutrients such as calcium, iron, and zinc in staple grains (Debnath et al., 2023). This genetic erosion has also contributed to declining nutritional diversity and hidden hunger among communities dependent on staple cereals. Recent studies show that traditional rice varieties are rich in B-complex vitamins, micronutrients, and antioxidants, yet are now cultivated only by a few marginal farmers. Their nutritional potential remains largely under-researched due to institutional neglect (Debnath et al., 2023; Roy et al., 2023).

The case of Mr Manne Srinivasa Rao, a farmer from Andhra Pradesh, illustrates a successful transition from chemical-based to Natural Farming. He implemented agroecological practices, including Pre-Monsoon Dry Sowing (PMDS), a technique promoted under the Andhra Pradesh Community-Managed Natural Farming (APCNF) programme in India. It involves sowing multiple seeds in dry soil before the monsoon, eliminating synthetic inputs, and restoring biodiversity to his fields.

## Case study limitations

The study highlights crucial questions about the link between traditional seeds, soil health, crop resilience, and nutritional density. While this is a single farmer's experience, further investigation is required to validate the claims made. However, in India, approximately 1 million farmers actively engage in conserving traditional seeds and maintain a documented repository of over 2,074 traditional crop varieties through 230 community seed banks. (Navdanya, 2021; Centre for Science and Environment (CSE), 2025; DIVERSIFARM-India, 2025).

Srinivasa Rao's case study calls for further research, policy backing, and increased seed access to revive indigenous paddy varieties and secure food and nutritional security. The field-level observations documented are corroborated by sufficient evidence published in the available literature. The insights aim to guide practitioners and policymakers on how to mainstream agroecological practices and landrace-based cultivation systems on a larger scale.

## Study approach and method of collection

This manuscript is based on a descriptive case study documenting the transition of a smallholder farmer in Guntur district, Andhra Pradesh, from conventional rice cultivation to Natural Farming, with a focus on the revival of traditional rice landraces. Information presented in the study was collected over

multiple cropping seasons through direct field observations, farmer-maintained records, and continuous engagement with the farmer during the implementation of Natural Farming practices.

The case study draws primarily on farmer-reported observations related to crop growth, pest incidence, soil conditions, and climatic resilience, complemented by programme-level evaluations and documentation generated under the Andhra Pradesh Community-Managed Natural Farming (APCNF) initiative and independent assessments by the Institute for Development Studies Andhra Pradesh (IDSAP).

Field-level data collection involved 4 repeated field visits conducted during 2023, 2024, and 2025, which included transect walks, participatory field observations, and visual documentation through photographs and video recordings to capture changes in cropping practices, field conditions, and crop performance over time.

Additional contextual and scientific information, particularly on soil health, nutritional properties of rice landraces, microbial inheritance, and agroecological outcomes, was derived from peer-reviewed literature and secondary reports. The study does not involve controlled experimental trials or laboratory-based measurements; rather, it aims to present practice-based insights from a real-world farming context. All observations and outcomes are therefore interpreted as context-specific to the study farm and are presented to illustrate potential agroecological pathways rather than to make generalised claims applicable across regions.

Information on the nutritional and medicinal attributes of traditional rice landraces was compiled from published scientific literature and documented traditional knowledge sources. Nutritional values reported in this manuscript are based on secondary studies conducted on these landraces in different regions and contexts and do not represent laboratory analyses of grain harvested from the case study farm.

The methodological approach emphasised contextual depth over statistical generalisation, with findings interpreted as case-specific observations situated within the broader agroecological and environmental conditions of the study area. Where broader claims are discussed, these are explicitly supported by peer-reviewed literature or programme-level assessments. This approach aligns with established case-study methodologies commonly used in agroecology and sustainability research, particularly where farmer-led innovations and experiential knowledge form a central component of analysis.

## Soil degradation and nutritional decline

Paddy is one of the major crops in Guntur district, along with cotton, chillies, tobacco, and turmeric. Historically, Guntur ranks as one of the highest pesticide-consuming districts in India. During the 2001–2003 cropping season, for example, Andhra Pradesh accounted for about 22.5% of India's total pesticide use, with Guntur ranking first within the state (Gurava Reddy, 2001). Recent national-scale reviews show that India's pesticide contamination has measurable ecological and human-health impacts, particularly in high-use regions such as Guntur, where residues persist in soil, air, and water (Kashyap et al., 2024).

Continuous cultivation of these crops, coupled with excessive use of chemical fertilisers and pesticides, has led to severe soil degradation through surface drying and wind erosion. The prolonged dependence on synthetic inputs contributed to soil contamination, airborne pesticide drift, and groundwater pollution from runoff and leaching (Kashyap et al., 2024).

Research and academic studies indicate that the average Soil Organic Carbon (SOC) content in Guntur is less than 0.5%, reflecting poor microbial presence and disrupted nutrient cycling (Subbaiah et al., 2022). While Guntur is mostly canal irrigated, some areas remain rainfed, with farmers depending on tube wells. Srinivasa Rao's farm is among those that rely on tube well irrigation.

Returning from his work as an electrician in Malaysia to attend to his ailing father, Srinivasa Rao observed the connection between food quality and human health, a link later reflected in APCNF's community-level nutrition assessments and national research on nutrient decline. He firmly believed that conventional farming compromised both nutritional density and soil health in his village (MontgomeryBiklé, 2021). This personal awakening connected the region's soil degradation directly to the community's declining health. A recent study conducted by Bidhan Chandra Krishi Viswavidyalaya, an affiliate of the Indian Council of Medical Research, has revealed a decline in nutritional density (Debnath et al., 2023). National food composition data indicate that traditional rice varieties contain appreciable levels of protein, dietary fibre, and essential micronutrients such as iron and zinc (National Institute of Nutrition (ICMR), 2017).

Srinivasa felt that the belief that external inputs would yield more was a myth that had become a nemesis of farming. Srinivasa also mentioned arsenic pollution in the groundwater level, which he attributed to the increased health risks faced by the villagers. Deep tube well drilling can mobilise arsenic into groundwater, which then enters the food chain through irrigation and crop uptake, especially in rice. Rice plants absorb arsenic through root transport systems meant for other nutrients (Srivastava et al., 2016; Awasthi et al., 2017; Mlangeni, 2023). Rice plants absorb arsenic through root transport systems meant for other nutrients (Srivastava et al., 2016; Awasthi et al., 2017; Mlangeni, 2023).

He referred to studies from Guntur district documenting elevated arsenic concentrations in groundwater and paddy soils (Aradhi et al., 2023), aligning with ICAR–NIN evidence on geogenic sources and agrochemical leaching pathways. Long-term consumption of arsenic-contaminated water can lead to serious health issues such as skin, lung, kidney, and bladder cancers, as well as cardiovascular disease, respiratory disorders, and dermal arsenicosis (Hassan et al., 2017). To address this growing crisis, Srinivasa decided to adopt Natural Farming practices and cultivate traditional landraces, aiming to restore soil vitality and produce safe, nutrient-rich food.

## Transition from conventional to natural farming

### Pre-monsoon dry sowing

In 2021, Srinivasa Rao was given land that was nearly compacted and lifeless for cultivation by a tenant farmer. He

realised that the land was infertile, with no biological activity. He recalled how his grandfather brought life to the land through a practice called Navadhanya, borrowed from farmer practices in the dryland regions of the Rayalaseema region.

Navadhanya involves sowing a mix of nine diverse crops to build soil fertility, fix nitrogen, and promote biodiversity (Chinnadurai and Balasubramanian, 2019). This age-old method, passed down through his ancestors, had been sidelined due to the dominance of modern agriculture. As natural manures like cow dung, poultry waste, and sheep manure become increasingly difficult to obtain, Navadhanya cultivation—an accessible and time-tested alternative—is re-emerging as a viable option for farmers.

Building on this ancestral practice, the APCNF programme through Rythu Sadhikara Samstha (RySS) refined and institutionalised it as PMDS—a farmer-led Natural Farming innovation designed to sustain 365-day green cover and restore soil biology. This method has proved beneficial for thousands of farmers aiming to rejuvenate soils. Pre-Monsoon Dry Sowing involves sowing diverse, multi-species seeds into the soil 45–60 days before the onset of the monsoon (Institute for Development Studies Andhra Pradesh (IDSAP), 2023b).

Traditionally, sowing is done after the rains start, especially in rural agricultural systems. However, this approach allows seeds to germinate quickly once the rains begin, resulting in faster crop growth, stronger early vigour of the main crop, and stronger early-stage plants.

PMDS crops thrive for 25–40 days, adding over 30 metric tonnes of biomass per field, which improves soil quality, reduces surface heat, and increases moisture retention for subsequent Kharif crops (Institute for Development Studies Andhra Pradesh (IDSAP), 2023b). Independent evaluations by IDSAP in collaboration with IIM Ahmedabad reported that PMDS plots showed greater biomass addition, higher root vigour, and improved soil organic carbon compared to conventional fields (Institute for Development Studies Andhra Pradesh (IDSAP), 2023b, Institute for Development Studies Andhra Pradesh (IDSAP), 2023a).

### PMDS seeds

Srinivasa Rao used 12 kg of various seed varieties for PMDS, including 50 kg of daincha (*Sesbania bispinosa*) per acre. These varieties included grasses (maize, sorghum), pulses (black gram, green gram), oilseeds (groundnut, castor, marigold), spices (mustard, coriander), leafy vegetables (*Amaranthus*, spinach, sorrel leaves), and creeping vegetables (ridge gourd, cucumber, pumpkin).

He sowed the PMDS seeds 55 days before the paddy crop. One of the key factors contributing to the success of PMDS was the seed pelletization method adopted by the farmer. While single clay coating has long been a common traditional practice, RySS developed a multi-layer pelletization method using Beejamrutham, Ghanajivamrutham, fine clay, and wood ash. This RySS innovation enhances seed viability, improves uniform germination, and strengthens early seedling vigour under variable rainfall. He applied Beejamrutham to coat the seeds for improved

germination and early establishment (Sreenivasa et al., 2009; Mukherjee et al., 2022).

## Seed pelletization

Srinivasa Rao treated seeds with Beejamrutham, a bio-inoculant known for effectively activating the seed microbiome (Sreenivasa et al., 2009). It is composed of cow dung, cow urine, and lime, and is slightly alkaline due to these components.

In the pelletization process, seeds were first treated with Beejamrutham, prepared using 5 kg of fresh desi cow dung, 5 L of desi cow urine, 25 g of lime, and 100 L of water. The treated seeds were then successively coated with fine bank soil, followed by powdered Ghanajivamrutham, and finally wood ash, with water added as required, until seed pellets of approximately three to five times the original seed size were formed. The pelletised seeds were shade-dried before sowing. These pellets effectively retain moisture, remain viable in the soil for up to 3 months, and germinate with minimal rainfall or occasional summer showers.

Pelletised seeds remain viable even under the hot weather conditions prevailing during summer. Minimal early rainfall is sufficient to trigger germination and sustain the crop during the initial growth period (Institute for Development Studies Andhra Pradesh (IDSAP), 2023b).

These formulations offer a rich source of nutrients, growth hormones, sugars, and organic acids, thereby supporting microbial growth and diversity. They improve germination rates, protect germinating seeds and seedlings against soil- and seed-borne pathogens, and enhance nodulation in legume crops. Early germination and uniform crop growth can be expected (Sreenivasa et al., 2009; Muhammad et al., 2022).

## Bund cultivation and horticultural crops

On the bunds, vegetables were cultivated over 4.5 acres of land. A total of six types of vegetables were grown, including bottle gourd, ridge gourd, bitter gourd, snake gourd, cluster bean, cucumber, okra, and coconut.

In addition, the farm included six types of horticultural crops, comprising 10 varieties of mango, 5 varieties of sapota (chikoo), custard apple, milk fruit (star apple), jamun, and water apple.

## PMDS outcomes: soil enhancement

PMDS crops thrive for 25–40 days, adding over 30 metric tonnes of total biomass, both above-ground and root biomass, which improves soil structure, enhances organic carbon, reduces surface heat, and increases moisture retention for the subsequent Kharif crop.

Based on 4 years of field practice, Rao reported improved crop cover and reduced risk of crop failure, corroborated by independent evaluations conducted by IDSAP in collaboration with IIM Ahmedabad under the APCNF programme. Mulching, animal grazing, and using biomass as fodder while leaving roots in the soil are all integral benefits of this method. The decomposition of below-ground biomass has enhanced soil structure, increased soil organic carbon, and improved microbial activity through root

respiration (Institute for Development Studies Andhra Pradesh (IDSAP), 2023b, Institute for Development Studies Andhra Pradesh (IDSAP), 2023a). Even conventional chemical farmers in India are using PMDS to improve soil health, thereby reducing synthetic inputs.

PMDS has improved key soil health indicators such as porosity, water percolation, and nutrient availability (Institute for Development Studies Andhra Pradesh (IDSAP), 2023b). According to Srinivasa Rao, over 3 years, he also observed better soil structure, richer microbial life, reduced clay compaction, and increased rainwater percolation.

The farm also witnessed the return of birds and a visible increase in earthworms. Earthworms play a vital role in soil health by enhancing mineral weathering, increasing nutrient availability through cation exchange, and promoting organic matter decomposition, though their effects on carbon sequestration remain complex and time-dependent.

A study conducted by APCNF revealed that naturally farmed crops have an average of 46.83 earthworms per square metre, whereas chemically farmed crops have an average of 5.71 earthworms per square metre (Institute for Development Studies Andhra Pradesh (IDSAP), 2023b).

## Landraces – crop performance

India's traditional rice varieties have been the backbone of food security and cultural heritage for centuries. While new hybrid varieties promise high yields, they come with a cost: increased dependence on chemical fertilisers, water-intensive farming, vulnerability to climate shocks, and altered food quality and nutrient content (Gurava Reddy, 2001; Deb, 2019; MontgomeryBiklé, 2021).

Rao observed visible soil deterioration under hybrid and high-yielding varieties, a trend also documented in APCNF and ICAR assessments comparing conventional and natural farming plots (Indian Council of Agricultural Research (ICAR), 2024). High-yielding varieties displaced nearly 85% of traditional landraces after 1960 (Eliazar Nelson et al., 2019).

Srinivasa Rao decided to raise paddy using traditional varieties after learning about their resilience and nutritional benefits. He opted for eight traditional landraces. The characteristics and performance of traditional rice varieties cultivated by the case-study farmer are summarised in Table 1.

There were strong personal reasons behind his selection of these landraces, as he felt that chemically grown paddy was a reason for his father's cancer. His association with Dr Depal Deb, founder of Basudha Farm, who has conserved over 1,500 landraces in West Bengal and provided scientific insights into their nutritional and ecological value, further strengthened his conviction (Deb, 2019).

Under Natural Farming conditions, the selected landraces exhibited clear differences in phenology and morphology. Most varieties were medium- to long-duration, with strong early establishment and steady vegetative growth. Plants showed robust tillering, deeper root systems, and sturdy culms, contributing to better lodging resistance under variable rainfall conditions. Grain characteristics varied across landraces, including aromatic grains, pigmented husks, and coloured kernels, reflecting their distinct

genetic traits. Although yield levels were moderate compared to high-yielding varieties, the landraces demonstrated yield stability under low external input conditions, along with improved resilience to climatic stress and reduced pest incidence, aligning with farmer observations and prior reports on traditional rice varieties (Deb, 2019; Eliazar Nelson et al., 2019).

## Landraces – plant microbial inheritance

Landraces carry original microbial taxa that helped plants survive harsh environmental conditions and adapt to terrestrial ecosystems. They also contributed to dispersal across landscapes and provided plant embryos with protection and nourishment (Nelson, 2018; Vannier et al., 2018; Abdelfattah et al., 2023).

Plant microbial inheritance encompasses three stages: plant to seed, seed dormancy, and seed to seedling. Each process governs and influences the next (Vannier et al., 2018; Abdelfattah et al., 2023). Landraces are locally adapted, open-pollinated varieties with high genetic diversity. Seeds play a unique role in this inheritance process by linking plant generations and representing a bottleneck in the continuity of the plant microbiome.

Seeds harbour more than just a plant's genetic future; they are living capsules that transmit not only genetic material but also entire communities of microorganisms from one plant generation to the next—a phenomenon known as microbial inheritance (Nelson, 2018; Vannier et al., 2018; Abdelfattah et al., 2023). Landrace seed varieties carry these native microbial populations. When seeds germinate, surviving microbes colonise the developing seedling with remarkable precision. Different species migrate to specific plant tissues—some to the leaves, others to the roots—suggesting a highly organised process. These inherited microbes compete and collaborate with soil organisms to establish the seedling's microbiome, setting the foundation for the plant's future health (Nelson, 2018; Vannier et al., 2018).

The parent plant initiates this process by sending microbes to developing seeds through two distinct pathways. The primary route involves transfer through the plant's vascular system, while the secondary, less understood pathway occurs during fertilisation via reproductive cells (Vannier et al., 2018; Abdelfattah et al., 2023).

During seed dormancy, these microbial communities face extreme environmental stress. Their populations drastically decline as seeds dehydrate, creating a natural bottleneck that selects for organisms capable of surviving such conditions. Some microbes enter dormant states, while others maintain minimal metabolic activity. This period shapes the microbial community that will emerge with the next generation (Vannier et al., 2018).

Inherited microbes act as specialised symbionts that assist plants in growth, disease resistance, and stress adaptation. Early evidence that seeds harbour beneficial microorganisms was described in studies on the symbiosis between endophytic fungi of the family Clavicipitaceae and tall fescue *Festuca arundinacea* (Tsai et al., 1994; Schardl et al., 2004).

For many crops, “landraces” or farmers' traditional and local varieties are the main sources of seed for smallholder farmers. Srinivasa Rao's farm demonstrated that the indigenous paddy

varieties he adopted withstood both biotic and abiotic stress due to inherited genetic traits.

Studies on traditional crop varieties have shown that seed-associated microbial communities are functionally diverse and include plant growth-promoting rhizobacteria (such as *Bacillus*, *Pseudomonas*, and *Azospirillum* spp.), nitrogen-fixing and phosphate-solubilising bacteria, actinomycetes, and endophytic fungi. These microbial groups contribute to multiple plant functions, including improved nutrient acquisition, hormone regulation, disease suppression, and tolerance to abiotic stress such as drought and heat. The functional diversity of these inherited microbial populations is considered a key factor underlying the resilience and adaptive capacity of traditional landraces under low-input and stress-prone environments (Syamsia et al., 2015; Lubna et al., 2018; Nelson, 2018; Vannier et al., 2018; Verma and White, 2018; Simonin et al., 2022; Abdelfattah et al., 2023).

## Agronomy practices – nursery and transplantation

Seed paddy transplantation involves preparing the field, cultivating seedlings in a nursery, and then transplanting them to the main field. Seedlings, usually around 3 weeks (21–25 days) old, are carefully pulled from the nursery, transported to a puddled and levelled field, and planted at a shallow depth with uniform spacing (International Rice Research Institute (IRRI), 2017).

Transplanting was performed 10 days after puddling using 25-day-old seedlings at the 3–4 leaf stage to ensure healthy growth. Before transplanting, the nursery beds were well watered to make uprooting easier and avoid root damage. The leaf tips were slightly trimmed to reduce water loss (International Rice Research Institute (IRRI), 2017).

For pest control, Neemastram was sprayed every 15 days, while Agniastram was applied every 30 days to prevent stem borer infestation. Neemastram, an organic bio-pesticide, is widely used in Zero Budget Natural Farming (ZBNF) and APCNF systems. Neemastram was prepared using 5 kg of neem leaves, 5 kg of fresh cow dung, 5 L of cow urine, and 100 L of water, and allowed to ferment for 24 h before application (Nativus Farms, 2023). Neemastram primarily controls pests such as aphids, leafhoppers, mealybugs, and other soft-bodied insects, providing a natural alternative to chemical pesticides. Its active compound, azadirachtin, is responsible for its pesticidal properties. Unlike chemical pesticides, Neemastram is safe for beneficial insects, including pollinators and natural predators, and enhances soil health by supporting beneficial microbial activity.

Agniastram is a traditional botanical formulation used to manage pests such as stem borers, fruit borers, and other chewing and sucking insects. A stem borer is an insect larva that bores into plant stems to feed on internal tissues, causing damage by disrupting sap flow and leading to wilting, yellowing, and potentially plant death (Times of Agriculture, 2023; Kris Food Forest, 2025).

Agniastram was prepared using 5 kg of neem leaves, 500 g of tobacco, 500 g of green chillies, 250 g of garlic, and 10 L of cow urine. The ingredients were crushed, boiled, fermented, and filtered to obtain a bio-pesticidal solution. It acts as an antifeedant, repels pests, disrupts growth and reproduction cycles, and exhibits mild toxicity to soft-bodied pests (Times of Agriculture, 2023; Kris Food Forest, 2025).

Being biodegradable, both Neemastram and Agniastram leave no harmful chemical residues on crops or in the environment and are safe for beneficial organisms such as pollinators and natural predators. In addition, they are cost-effective and easy to prepare using locally available materials, making them sustainable and eco-friendly alternatives to synthetic pesticides.

During the early tillering stage, Panchagavya was applied to promote plant growth. Panchagavya is an organic mixture made from five cow-derived products: 3 L of cow milk, 2 L of cow curd, 1 kg of cow ghee, 5 kg of fresh cow dung, and 5 L of cow urine. Each component is referred to as *gavya* in Sanskrit, and together they are known as Panchagavya (Rawal et al., 2024). In some formulations, a few additional ingredients are added.

Panchagavya improves plant growth and disease resistance, making it a valuable input in organic agriculture (Raghavendra et al., 2014). It offers multiple benefits, including serving as a natural manure and biopesticide. Derived from cow urine and manure, it enhances soil nutrients, increases fertility, and ensures chemical-free food. Cow-based by-products used in its preparation are also environmentally benign and can be used for generating biogas and energy (Dhama et al., 2005; Rawal et al., 2024).

Saptadhanya Kashayam was used twice during the later growth stages to boost crop strength and improve yield quality.

## Irrigation

Tube well water was used as the primary irrigation source throughout the crop period to maintain soil moisture. According to Srinivasa Rao, water consumption was reduced by approximately 50% compared to chemically grown paddy. Conventionally grown paddy typically requires continuous irrigation across the crop cycle, whereas naturally farmed fields rely on limited rainfall and supplemental tube well irrigation (Institute for Development Studies Andhra Pradesh (IDSAP), 2023a).

During the 120-day crop cycle of the indigenous paddy, irrigation was applied only three to four times on average, resulting in a noticeable reduction in energy consumption compared to conventional fields. Surface irrigation was practised on a flat-bed land configuration.

Irrigation was provided only at critical stages of crop growth, namely:

- at sowing.
- during seedling establishment.
- at the tillering stage.
- at flowering.
- during grain filling.

Water was completely drained fifteen days before harvest to facilitate grain maturity and ease of harvesting.

## Crop yields

A rice plant usually produces between 5–20 tillers (Yuan et al., 2024), but the number depends on factors such as variety, nutrient levels, spacing, and planting method. Since panicles grow from tillers, more tillers generally mean more panicles. However, when plants are crowded, they tend to produce fewer tillers and panicles.

On Srinivasa Rao's farm, plants produced 60–65 tillers (Video testimonial), significantly higher than hybrid varieties raised through conventional methods. Additionally, 25 bags of 75 kg each were harvested, totalling 1.8 tonnes per acre. Retailers in the Guntur district sold the produce at an 80% higher price than conventional rice varieties.

## Nutritional value

Srinivasa Rao discussed the medicinal and nutritional value of these traditional rice varieties.

Traditional coloured rice varieties are particularly known for their high levels of dietary fibre, starch, flavonoids, phenols, and other beneficial compounds. These compounds are believed to contribute to reducing the incidence of non-communicable diseases such as cardiovascular disease, diabetes, cancer, and stroke (Bhattacharyya and Roy, 2018). The nutritional and bioactive properties of selected traditional rice varieties, compiled from published sources, are presented in Table 2.

## Landraces – resilience to biotic and abiotic stress

The Green Revolution in India led to a sharp decline in traditional landraces as government-backed hybrids were introduced through formal seed systems (Deb, 2019). Although hybrids offer higher yields, they depend heavily on chemical fertilisers and water, are more vulnerable to climate change, and often produce lower-quality, less nutritious food (Gurava Reddy, 2001; MontgomeryBiklé, 2021; Debnath et al., 2023).

Traditional varieties are being lost gradually, primarily due to their replacement by high-yielding, genetically uniform modern cultivars (Subbaiah et al., 2022; Debnath et al., 2023). This trend, driven by industrialised agriculture and monoculture practices, contributes to significant genetic erosion. The loss of landraces and wild relatives reduces the crop gene pool's ability to adapt to pests, diseases, and changing environmental conditions, posing a serious threat to food security (Deb, 2019; Eliazar Nelson et al., 2019; MontgomeryBiklé, 2021).

These traditional varieties showed compatibility with diverse soil types and exhibited natural resistance to pest and insect attacks. The crop remained healthy, featuring stronger stems, more panicles, and weed-free fields—outcomes attributed to Natural Farming practices (Institute for Development Studies Andhra Pradesh (IDSAP), 2023a).

A large-scale meta-analysis across 50 plant species identified *Cladosporium perangustum*, *Alternaria* spp., *Pantoea agglomerans*, *Pseudomonas viridiflava*, and *Pseudomonas fluorescens* as dominant seed-associated taxa (Simonin et al., 2022). From the perspective of plant fitness and survival, seed endophytes consistently displayed key

TABLE 1 Farm management practices and cropping details (2021–2024).

Year	Land details	Seed rate	Bund (ridge) size	Paddy varieties	Natural farming practices
2021	9 acres single field + 2 acres separate field	3 kg per acre	1 foot height × 1.5 feet width	8 varieties	PMDS (18 varieties), Seed Pelletization, Vermicompost, Farmyard manure (cow dung), Neem cake, 50 kg neem cake + castor cake, soil puddling carried out, Jeevamrutham applied 10 days after transplanting and then every 15 days, Neem oil spray (50 ml neem oil + soapnut extract in 20 litres of water), Panchagavya spray at 45 days
2022	9 acres single field + 2 acres separate field	12 kg per acre	1 foot height × 1.5 feet width	8 varieties	PMDS (Sunn hemp), Seed Pelletization, Vermicompost, Farmyard manure (cow dung), Neem cake, 50 kg neem cake + castor cake, soil puddling carried out, Jeevamrutham applied 10 days after transplanting and then every 15 days, Neem oil spray (50 ml neem oil + soapnut extract in 20 litres of water)
2023	9 acres single field + 2 acres separate field	12 kg per acre	1 foot height × 1.5 feet width	8 varieties	PMDS (Sesbania (Dhaincha)) Seed Pelletization, Vermicompost, Farmyard manure (cow dung), Neem cake, 50 kg neem cake + castor cake, soil puddling carried out, Jeevamrutham applied 10 days after transplanting and then every 15 days, Neem oil spray (50 ml neem oil + soapnut extract in 20 litres of water), Solid Jeevamrutham – 300 kg per acre, reapplied after 1 month
2024	9 acres single field + 2 acres separate field	12 kg per acre	1 foot height × 1.5 feet width	8 varieties	PMDS (Sunn hemp + Green gram), Seed Pelletization, Vermicompost, Farmyard manure (cow dung), Neem cake, 50 kg neem cake + castor cake, soil puddling carried out, Jeevamrutham applied 10 days after transplanting and then every 15 days, Neem oil spray (50 ml neem oil + soapnut extract in 20 litres of water), Solid Jeevamrutham – 300 kg per acre, reapplied after 1 month

microbial functions, including phosphorus solubilisation, nitrogen fixation, antibiosis, acetoin secretion, 1-aminocyclopropane-1-carboxylate (ACC) deaminase activity, production of growth-promoting hormones such as indole acetic acid (IAA), siderophore-mediated iron transport, and suppression of plant pathogens (Syamsia et al., 2015; Lubna et al., 2018; Verma and White, 2018).

Moreover, the genetic diversity preserved in traditional varieties and their wild relatives remains vital for climate resilience. All the rice varieties cultivated by Srinivasa Rao withstood the impact of Cyclone Michaung (December 2023), unlike conventionally grown paddy, highlighting the adaptive strength of landraces (Institute for Development Studies Andhra Pradesh (IDSAP), 2023a).

### Seed sovereignty – need for landrace cultivation and localized distribution

For centuries, farmers have been selecting, saving, and sharing seeds, enriching agricultural biodiversity and strengthening local resilience. Their knowledge and traditional practices have sustained local seed production and storage systems. In most Global South countries, farmers continue to dominate seed production by volume and crop diversity compared to the formal seed sector. On-farm seed production and storage ensure seed availability at planting time and reduce dependence on expensive certified seed (Westengen et al., 2023).

TABLE 2 Nutritional characteristics of selected traditional rice landraces.

Rice landrace	Duration type	Source	Major nutritional characteristics*	Reference
Bahuroopi	Medium	Basudha Farm (Dr Depal Deb)	Moderate protein, dietary fibre, carbohydrates; high antioxidant activity	(Kumari et al., 2025)
Kumkumshali (Rakthashali)	Long	Basudha Farm (Dr Depal Deb)	Protein (~11%), dietary fibre (~6.6%); rich in iron and zinc	(BioBasics, 2017)
Kalabat (Black rice)	Medium	Basudha Farm (Dr Depal Deb)	Dietary fibre (~4.8%), iron (~8.2 mg/100 g), zinc (~2.8 mg/100 g); strong antioxidant activity	(Pattanaik and Jena, 2025)
Kullakar (Red rice)	Short–Medium	Basudha Farm (Dr Depal Deb)	High dietary fibre and antioxidant activity; low glycaemic response	(Sharon et al., 2025)
Gobindobhog	Short	Basudha Farm (Dr Depal Deb)	Moderate protein and lipid content; antioxidant potential	(Bhattacharyya and Roy, 2018)
Navara (Njavara)	Short	Basudha Farm (Dr Depal Deb)	Glycaemic control benefits; antioxidant activity	(R and N, 2018)
Mysore Mallige	Medium	Basudha Farm (Dr Depal Deb)	High phenolic content; antioxidant activity	(Muttagi and Ravindra, 2020)
Odisha Basmati/Saffron	Medium–Long	Basudha Farm (Dr Depal Deb)	Aromatic rice with moderate protein and mineral content	(Bhattacharyya and Roy, 2018)

\*Major nutrients only; values compiled from published studies conducted in different regions and contexts, not from laboratory analysis of grain harvested from the study farm.

However, the current structure of the food system makes it increasingly difficult for traditional seeds to survive. Consumer choices in India also contribute to this, largely due to limited awareness of the nutritional and ecological value of traditional foods.

Srinivasa Rao sells traditional rice varieties to organic stores and individual customers, earning a 25% premium for residue-free, pesticide-free produce. Yet, market access remains limited, as these products are largely absent from supermarkets and public food programmes.

Rao's advocacy for local seed exchange mirrors APCNF's broader framework promoting community seed banks and decentralised conservation of traditional germplasm within self-help group federations ([Institute for Development Studies Andhra Pradesh \(IDSAP\), 2023b](#)).

Public funding for such banks is essential to prevent genetic loss and ensure farmers' access to traditional seeds. Srinivasa Rao recommends that each village cluster identify one farmer, under the Department of Agriculture, to cultivate traditional varieties for local distribution. Establishing regional conservation centres would further help preserve genetic heritage. He also emphasises the need for collaborative programmes where farmers and scientists work together to share knowledge and improve traditional seed performance.

## Conclusion

India's seed laws, including the Seed Act, 1966 and the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, rely on rigid Distinctness, Uniformity, and Stability (DUS) standards that are costly and unsuitable for genetically diverse traditional varieties. Existing legal frameworks offer limited support to farmer-led seed systems, restrict community seed exchange, and impose complex certification requirements on informal seed networks. Traditional varieties also lack adequate recognition through Geographical Indication (GI) tags and national seed frameworks, limiting market access and opportunities for premium pricing ([Government of India, 1966](#), [Government of India, 2001](#)).

Key government schemes such as PM PRANAM and the National Food and Nutrition Mission have yet to integrate alternative seed systems within agroecological practices. There is no mechanism to recognize or compensate farmers for the ecosystem services they provide by conserving agrobiodiversity through traditional seeds. Additionally, certification systems disproportionately burden organic and traditional farming, while chemical-intensive farming faces fewer regulatory hurdles.

The case study merits attention from policymakers and research institutions. This is important from two angles. Firstly, the landraces have withstood biotic and abiotic stresses, making them relevant for further research that could help scale production and make seeds locally available. Secondly, the landraces from existing research studies and farmers' own experience demonstrated higher nutritional density. However, there are policy gaps that need attention when it comes to promoting landraces.

There are challenges in scaling indigenous varieties in India. These include a lack of knowledge and mechanisms to support community seed banks in many regions. Local seed varieties should be integrated into formal seed systems and policies. This includes steps such as building capacity among farmers in seed selection, multiplication, and storage at the farm level. This calls for including popular landraces in the government seed delivery system and providing appropriate mechanisms for market access. Mr Srinivasa Rao also advocates identifying one farmer from each village to support seed production. At the state level, establishing biodiversity blocks is necessary to map and characterise the existing crop diversity, involving farmer participation and including intraspecific diversity. These steps require developing the institutional and financial capacities of state biodiversity boards to maintain the people's biodiversity registers ([Kochupillai et al., 2019](#); [ACT Alliance EU, 2020](#); [Kuruganti and Ramachandrudu, 2022](#); [WASSAN, 2023](#)).

## Key policy recommendations for landrace promotion

### Recognize and protect farmers' knowledge and rights

Policies must formally acknowledge farmers as custodians of landraces, supporting their role in conserving, improving, and exchanging traditional seeds.

### Strengthen community seed systems

Invest in well-funded, accessible community seed banks and regional conservation centres to safeguard traditional varieties that depend on local exchange rather than commercial seed markets.

### Digital catalogue

To scale and replicate landrace promotion, it is necessary to set up a National Digital Platform to identify, catalogue, and map traditional varieties, along with their geographical locations and availability.

### Support participatory plant breeding

Increase public funding for participatory breeding programmes where farmers and scientists jointly improve traditional varieties for local conditions and climate resilience.

### Align subsidies, procurement, and incentives

Reform subsidies and procurement systems to include landraces and traditional crops, expanding Minimum Support Prices (MSP) and government buying for indigenous rice and its distribution.

### Create markets for traditional crops

Develop processing, marketing, and value-chain support so farmers can sell landrace-based produce, including integration into school meals, hospitals, and public distribution systems.

## Promote nutrition- and climate-smart food systems

Use policy levers to highlight the nutritional, environmental, and climate benefits of traditional varieties, by promoting consumer awareness and demand creation. This requires coordinated national action to conserve genetic diversity and restore balance in India's food system.

These policy points collectively argue that saving landraces is not only a conservation issue, but a systemic reform of agriculture, markets, research, and consumer behaviour.

Most importantly, no exclusive rights should be granted to private entities or individuals; rather, these varieties should remain in the public domain. The right of farmers to engage in these practices is recognized and protected under Article 19 of the Declaration on the Rights of Peasants and Other People Working in Rural Areas, endorsed by the United Nations Human Rights Commission in 2018 (United Nations, 2018). This knowledge plays a critical role in supporting agroecological systems that prioritise the empowerment of producers (Ashraf et al., 2024).

## Promotion of natural farming

### Natural Farming as a systemic solution

Natural Farming (NF) must be positioned as a comprehensive response to multiple crises: soil degradation, high input costs, climate vulnerability, low farm incomes, and nutritional deficiencies, without compromising yields. This narrative is important for adoption among small farmers across India.

### Community-led extension model

Farmer-to-farmer learning through Community Resource Persons (CRPs), champion farmers, and young farmers are central, recognising that behavioural change and full transition take time.

### Knowledge generation

The focus should be on designing and customising principles of Natural Farming practices to diverse agrodiversity zones for paddy cultivation. Engaging and involving youth at the Panchayat level is crucial for full participation in Natural Farming.

### Seven-pillar framework for universalization

The policy rests on seven pillars: behavioural change, communication and advocacy, science and research, farm models, champions, women-led institutions, and extension value-chain market support.

### Science and institutional backing

Mainstream research on traditional landraces into national agricultural research institutions to support local initiatives.

## Health and nutrition integration

NF is closely linked with public health goals, promoting chemical-free, nutritious food for children, pregnant and lactating women, people with non-communicable diseases, and senior citizens through schools, anganwadis, and health systems.

## Eco-credits and ecosystem services

The policy must recognize NF's role in reducing chemical use, saving energy and water, enhancing carbon sequestration, and delivering ecosystem services, with plans to share benefits and credits with farmers.

## Whole-of-government convergence

Coordinated action across agriculture, rural development, health, education, civil supplies, social welfare, tourism, and other departments is central to mainstreaming NF.

India faces various challenges, including soil depletion and unhealthy food consumption, making it impractical to rely solely on conventionally grown food crops. It should never be a choice between food security and sustainability. In the current situation, investing in traditional paddy varieties is crucial. This will help create a sustainable food system that is resilient, nutritious, and aligned with India's agricultural heritage.

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