

Rice-fallows: A hidden opportunity for enhancing farm income and food security in India

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Rice-fallows are croplands that remain uncultivated after the harvesting of rice. It represent one of the most underutilised agricultural production systems in India, mainly in eastern and central regions. These areas remain fallow due to a range of constraints, including lack of irrigation, early withdrawal of monsoon rains resulting in soil moisture stress at sowing, excess soil moisture and waterlogging in lowlands, delayed harvest of long-duration rice varieties, soil physico-chemical limitations, severe weed infestation, terminal drought during reproductive stages, biotic stresses, open grazing, and socio-economic factors. Practices like adoption of suitable rice establishment methods, conservation agriculture practices, crop diversification, rainwater harvesting and on-farm water storage and integration of short-duration pulses, oilseeds, vegetables, and allied enterprises can substantially enhance land productivity, soil health, farm income, and nutritional security. This article presents the major constraints responsible for the persistence of rice-fallows and practical strategies for their productive utilisation to enhance cropping intensity, farm income, food and nutritional security, and climate resilience.

Keywords: Conservation agriculture, Direct seeded rice, Integrated farming systems, Relay cropping, Stray cattle

RICE is the major cereal crop of India, occupying nearly 47 million hectares (mha) and forming the backbone of national food security and rural livelihoods. Despite this extensive area under rice cultivation, a substantial proportion of rice-growing land remains uncultivated during the *rabi* season, particularly in the rainfed upland, medium, and lowland ecosystems of eastern and central India, including Odisha, Jharkhand, Chhattisgarh, Bihar and West Bengal. These lands, commonly referred to as rice-fallows, represent one of the most underutilised agricultural resources in the country. India alone accounts for nearly 80% (11.65 mha) of the rice-fallow area in South Asia, highlighting both the scale of

the challenge and the opportunity for improving land use. Bringing rice-fallows under cultivation can increase cropping intensity and improve land-use efficiency. It also helps restore soil health, enhance farm income and dietary diversity, as well as contribute to domestic production of pulses and oilseeds. Improving water availability through decentralised rainwater harvesting can significantly reduce moisture-related risks associated with *rabi* cropping in rice-fallows. Such sustainable intensification of rice-fallows also supports national efforts towards achieving the Sustainable Development Goals by improving food and income security and promoting climate-resilient land-use practices.

Rice-fallows are often viewed as a technical challenge; however, for many small and marginal farmers, leaving land fallow during the *rabi* season is a rational risk-management decision. Uncertainties related to residual soil moisture, labour availability, market prices of pulses and oilseeds, and damage from open grazing strongly influences farmers' cropping choices.

Understanding the persistence of rice-fallows: Causes and constraints

Rice-fallows persist because of a combination of biophysical, agronomic, and socio-economic constraints that limit timely establishment and successful cultivation of *rabi* crops. The major biophysical and agronomic

constraints include:

- Rapid depletion of residual soil moisture in upland and medium lands after the harvest of *kharif* rice because of soil cracking and prolonged exposure of bare soil to high temperatures.
- Excess soil moisture and waterlogging in lowland areas, which delay sowing of *rabi* crops and expose them to heat stress during flowering and maturity.
- Delayed field availability resulted from cultivation of long-duration rice varieties and delayed sowing of *kharif* rice, thereby shortening the effective sowing window for *rabi* crops.
- Inadequate rainwater harvesting and on-farm water storage, leading to water scarcity during the *rabi* season despite adequate monsoon rainfall.
- Repeated puddling during transplanted rice cultivation may restrict root growth and establishment of succeeding crops. However, the extent of this effect varies with soil type and management practices and is generally more pronounced in fine-textured soils subjected to intensive puddling.
- Soil acidity, nutrient imbalances, micronutrient deficiencies, severe weed infestation, terminal drought during reproductive stages, and biotic stresses that adversely affect crop establishment and productivity.

In addition to above constraints, limited irrigation facilities, poor access to farm machinery, fragmented landholdings, seasonal migration, open grazing during the dry season, low farmer awareness, and market uncertainties collectively discourage farmers from cultivating a second crop. Consequently, *rabi* crops grown under residual soil moisture are exposed to high production risk and price volatility. Labour shortages after *kharif* harvest and crop damage from stray cattle further increase production risk, often discouraging farmers from adopting *rabi* crops despite the availability of suitable technologies.



Stray cattle intrusion in rice-fallow areas

Rice-fallows for sustainable agricultural growth

Effective management of rice-fallows is crucial for strengthening India's food and nutritional security. While the country has achieved self-sufficiency in food grain production, it continues to face deficits in pulses and a large shortfall in edible oil production. The rice-fallow area in eastern India alone is comparable to the combined net sown area of Punjab, Haryana, and western Uttar Pradesh. Field studies and published literature have demonstrated that bringing rice-fallows under cultivation with short-duration pulses, oilseeds, millets, and vegetables can substantially increase cropping intensity from 100 to 200 per cent or more. It will enhance domestic pulse and oilseed production, improve dietary diversity and nutrition, improve soil fertility through biological nitrogen fixation, generate rural employment, and reduce seasonal migration. Availability of supplemental irrigation from harvested rainwater can stabilise *rabi* crop yields during terminal drought and heat stress periods, thereby increasing farmers' confidence to adopt rice-fallow cropping. Productive utilisation of rice-fallows can therefore contribute to sustainable agricultural growth and improved livelihoods in rainfed regions.

Promotion of rice-fallow intensification can be further accelerated through convergence with Government of India programmes such as

- National Food Security Mission (NFSM) for pulses and oilseeds,
- Per Drop More Crop component of the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY),
- Sub-Mission on Agricultural



Fencing of rice-fallow fields to protect *rabi* crops from stray cattle

Mechanisation (SMAM),

- Programmes supporting conservation agriculture, rainwater harvesting, and efficient water management.

Strengthening value chains through Farmer Producer Organisations (FPOs), aggregation of produce, processing, and assured market linkages for pulses and oilseeds can further improve the economic viability and profitability of rice-fallow diversification. A notable example is the Comprehensive Rice Fallow Management (CRFM) Programme implemented in Odisha, where farmers successfully adopted short-duration pulses such as chickpea, green gram, and black gram after *kharif* rice using residual soil moisture. The programme has demonstrated that rice-fallow intensification can increase cropping intensity, generate additional farm income, and improve household pulse availability, highlighting the practical potential of productive utilisation of rice-fallow lands. By converting fallow lands into productive systems, pressure on natural resources can be reduced, land degradation minimised, and sustainable agricultural production promoted.

Strategies for productive utilisation of rice-fallows

Productivity of rice-fallows often remains low as *rabi* crops are treated as secondary or bonus crops and receive limited management attention from farmers as well as other constraints. However, productivity of rice-fallows can be significantly improved through better crop husbandry, appropriate crop and variety selection, and efficient water and

nutrient management. Adoption of conservation agriculture practices in rice-fallows promotes *in-situ* retention and utilisation of rice residues, reducing open-field straw burning and improving air quality and on-farm sustainability.

Crop and variety selection: Crop and variety selection plays a key role in successful utilisation of rice-fallows.

- Adoption of short-duration rice varieties of 100–120 days allows early availability of fields during September–October, creating a wider window for timely *rabi* crop establishment.
- Crops such as black gram, green gram, chickpea, lentil, field pea, grass pea, and *rabi* pigeonpea have shown good performance across regions, while lentil and lathyrus are more suitable for lowland areas.
- Short-duration oilseeds such as toria, mustard, niger, linseed, safflower, and sesame also fit well in rice-fallow systems, along with millets and *rabi* sorghum.
- Intercropping pulses with linseed or sesame can further enhance land-use efficiency and farm income.

Establishment of good plant stand: Poor crop establishment remains a common constraint in rice-fallows due to compact soil conditions, uneven moisture distribution, and poor seed-soil contact. Conservation tillage and reduced tillage after rice harvest help improve soil physical conditions and facilitate better crop establishment. Proper field levelling, timely sowing, seed priming or seed treatment, and adoption of a 20–25% higher seed rate under relay cropping and rice-fallow conditions to compensate for poor germination and inadequate plant establishment can help achieve an adequate plant stand. Early sowing of *rabi* crops through relay cropping (sowing the succeeding crop before harvesting the standing rice crop) or zero-tillage seeding immediately after rice harvest enables better utilisation of residual soil moisture, resulting in improved crop growth and yield.

However, relay cropping can result in low plant population because of poor germination or seed rotting under excess moisture.

Nutrient management: Nutrient management in rice-fallows requires special attention because basal fertiliser application is often not feasible under no-tillage or relay cropping systems. Poor soil physical conditions reduce nutrient mobilisation and microbial activity, limiting nutrient availability to crops. A practical nutrient management strategy involves

- Soil testing before sowing.
- Seed treatment with recommended biofertilisers such as *Rhizobium*, phosphate-solubilising bacteria (PSB), and mycorrhizae, liming of acidic soils wherever required.
- Correction of phosphorus, zinc, boron, and sulphur deficiencies based on soil-test recommendations.
- Need-based foliar nutrient application during critical growth stages to alleviate nutrient stress and improve yield.
- Crop residue retention further improves nutrient recycling, soil organic matter, and moisture conservation under rice-fallow conditions.

Weed management: Integrated weed management involving residue retention, conservation tillage, and need-based application

of recommended post-emergence herbicides helps suppress weeds, thereby improving crop establishment and *rabi* crop productivity.

Water management: Since *rabi* crops in rice-fallows largely depend on residual soil moisture, appropriate water management is essential for successful crop establishment and stable yields.

Integrated pest management: Integrated pest management helps keep pest and pathogen populations below economic threshold levels and minimises crop losses in rice-fallow crops. Seed treatment with fungicides and biological agents, use of pheromone and light traps for pest monitoring, and need-based application of plant protection measures effectively manage insect pests and diseases under rice-fallow conditions.

Reorienting the rice-based cropping system for better utilisation of rice-fallows

Rice-fallows cannot be effectively managed by focusing only on the *rabi* crop; the entire rice-based system must be reoriented. Although puddled transplanted rice provides higher yields, it delays maturity and may adversely affect soil physical conditions under repeated puddling, limiting opportunities for timely establishment of *rabi* crops. Direct-seeded rice (DSR), particularly dry DSR established without puddling

Table 1. Recommended water management practices for rice-fallow systems

Component	Recommended practice	Expected benefit
Soil moisture conservation	Adopt zero tillage together with rice residue retention.	Conserves soil moisture and improves crop establishment.
Drainage management	Provide timely drainage of excess water through suitable drainage systems.	Facilitates timely sowing and successful establishment of <i>rabi</i> crops.
Supplemental irrigation	Provide one lifesaving irrigation during flowering or pod formation stages, wherever feasible.	Substantially improves yield by reducing terminal drought stress.
Rainwater harvesting	Harvest surplus monsoon runoff through farm ponds, percolation tanks, field bunds, and small check structures for supplemental irrigation during the <i>rabi</i> season.	Provides supplemental irrigation and reduces production risk.
Residue management	Retain rice straw as surface mulch instead of burning.	Provides an environmentally friendly alternative to residue burning while conserving soil moisture and improving soil health.

or transplanting, matures earlier, requires less water and energy, maintains better soil structure, and provides a wider and favourable window for *rabi* crop establishment.

Crops such as pulses and oilseeds grown after dry DSR show improved productivity and system profitability. Shifting towards DSR along with residue-based land preparation reduces dependence on burning for field clearance and supports climate-friendly rice production systems. Despite DSR being most advantageous where effective weed management and suitable seedbed conditions can be ensured, in poorly drained lowland ecosystems or situations with persistent waterlogging, puddled transplanted rice may remain a more suitable option.

Integrated farming systems for productive utilisation of rice-fallows

Rice-fallow lands can be transformed into productive systems through integrated farming approaches involving crops, pulses, oilseeds, vegetables, and allied enterprises. Creation of farm ponds and other rainwater harvesting structures plays a critical role in harvesting excess monsoon runoff and providing lifesaving irrigation during the *rabi* season. In addition, these structures enhance groundwater recharge, reduce surface runoff and soil erosion, and improve overall water-use efficiency at the farm level. Excavated soil can be used to strengthen bunds for vegetable and fruit cultivation, generating additional income and year-round employment while reducing production risks. Integrated Farming System (IFS) models developed at ICAR-Central Rice Research Institute (CRRI), Cuttack, provide a practical approach for productive utilisation of rainfed lowland rice-fallow areas. Integration of rice with fish, horticultural crops, and livestock can improve resource-use efficiency, diversify farm income, and enhance the resilience of farming systems, particularly where irrigation opportunities are limited.



Integrated farming system model developed by ICAR-CRRI, Cuttack for rainfed lowland area

Table 2. Reported yield response under selected rice-fallow management practices

Management practice	Yield response	Key benefit
Short-duration rice varieties	36–40% higher <i>rabi</i> crop yield	Earlier field availability; better use of residual moisture
Zero-tillage direct-seeded rice (DSR)	25–40% higher system productivity	Earlier maturity; timely <i>rabi</i> establishment; lower water and energy use
Reduced tillage for succeeding <i>rabi</i> crops	33–44% higher <i>rabi</i> crop yield	Better soil moisture conservation and soil condition
Diversification with pulses and oilseeds	25–50% higher system productivity	Improved soil fertility through biological nitrogen fixation

SUMMARY

Rice-fallow areas represent one of India's largest untapped opportunities for enhancing agricultural productivity, farm income, and food and nutritional security. Their productive utilisation can substantially increase cropping intensity, strengthen climate resilience, and reduce the country's dependence on imported pulses and edible oils. It also promotes sustainable use of land and water resources while reducing straw burning and associated environmental pollution. However, realising the full potential of rice-fallows requires coordinated efforts involving farmers, researchers, extension agencies, policymakers, and local communities to overcome both technical and socio-economic constraints. Community-based approaches such as collective fencing, regulated grazing, and village-level coordination can reduce production risks and facilitate wider adoption of rice-fallow technologies, particularly in areas affected by stray cattle.

Harvesting surplus monsoon runoff through farm ponds and field-level water harvesting structures provides critical supplemental irrigation during the *rabi* season, thereby reducing production risk in rice-fallow systems. Rice-fallows thus offer a viable pathway for increasing cropping intensity, reducing pulse and edible oil deficits, strengthening climate resilience, and improving livelihoods of small and marginal farmers. A system-based approach integrating soil, water, crops, and socio-economic factors is essential for unlocking the full potential of rice-fallow areas in India. A holistic, system-based approach integrating technological innovations, institutional support, and improved access to credit, insurance, extension services, and markets will be essential for achieving sustainable rice-fallow intensification and improving the livelihoods of small and marginal farmers.

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