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Review Paper

Rice-fallow Management in Eastern India: Challenges and Opportunities for Enhancing System Productivity and Profitability

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ABSTRACT

Vast fallows in the *rabi*/dry season are an issue of serious concern in the agricultural production system of Odisha and other parts of eastern India. With a rainfed rice-based mono-cropping system, resource-poor and small & marginal farmers of eastern India are forced to dwell in the vicious circle of poverty. Recently, the issue of rice-fallow is among the top agendas for the policymakers, and so public investment is happening. However, *ad hoc* investments in fallow intensification do not yield sustainable and satisfactory results as it is a very complex and multi-dimensional problem (biotic, abiotic, policy, and socio-economic) requiring attention at various levels of intervention. With this backdrop, based on secondary data and information and the review of literature, this paper discusses the key issues and challenges in rice-fallow development and recommends some strategic interventions needed for converting those fallow lands into croplands, particularly in *rabi* season. Also, the paper studies ongoing programs/schemes of central and state governments related to fallow management, keeping in view that research on fallow management must go in parallel with ongoing programs/schemes. Authors recommend that partners in a collaborative approach; should assess pathways of sequencing investment and intervention to catalyze the intensification of *rabi* fallows. If conceivable and low-to-medium risk pathways are identified, and associated convening and catalytic roles are defined for partners; policy dialogue and execution plan will not be an issue as all the local governments and agencies already understand the need for fallow management. This paper will be helpful for planners, policymakers, and development stakeholders while framing the policies, designing programs, setting implementation strategies, monitoring systems, critically analyzing potentially who can invest and where, etc., for a sustainable and environment-friendly agricultural system for poverty reduction, and food & nutritional security.

HIGHLIGHTS

- The vast rice-fallow in eastern India is a challenge in agriculture. However, this can be converted into an opportunity by appropriately introducing technologies and crops with tailored agronomy as per landscape suitability.
- This will help increase cropping intensity and hence the system productivity and profitability that will enhance farm income and ensure food and nutritional security for all.

Keywords: Rice-fallows, cropping system intensification, productivity & profitability, farm income, food & nutritional security

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Rice-fallow is the *kharif* (wet season) rice land that remains fallow during *rabi* (dry season). In contrast, *rabi* fallow is the entire land that remains fallow during *rabi* season irrespective of the previous season (*kharif*) crops. Rice is the principal crop during the *kharif* season in eastern India, which occupies 26.8 m ha accounting for 63.3 percent of the total rice-growing areas of the country.

However, this area is not fully utilized for crop production in the subsequent *rabi* (post-rainy) season and remains fallow due to several biotic, abiotic, and socio-economic constraints and challenges. Using remote sensing and GIS approach, it was estimated that about 12.54 m ha in *rabi* season is left fallow in eastern India (Sahoo *et al.* 2014). Some other studies also find that rice-fallow (~11.7 m ha) is a mono-crop rice-based production system in India and mostly (82%) is concentrated in the eastern states, i.e., Chhattisgarh, Jharkhand, Upper Assam, Bihar, eastern Uttar Pradesh, Odisha, and West Bengal (Pande *et al.* 2012; Kumar *et al.* 2018). In Odisha alone, rice-fallows spread over 1.6 m ha covering 21 percent of rice-fallow areas in eastern India (Gumma *et al.* 2016*a*). India accounts for 88.3 percent (19.7 m ha) of South Asia's total rice-fallows (22.3 m ha). Sourced from Subbarao *et al.* (2001) and later Gumma *et al.* (2016*b*), the paper of Singh *et al.* (2016) shows state-wise *Kharif* rice areas and *rabi* fallow areas.

In Madhya Pradesh + Chhattisgarh, Bihar + Jharkhand, West Bengal, and Odisha, the *rabi* fallow areas are approx. 4.38 m ha (71.21%), 2.20 m ha (36.85%), 1.72 m ha (37.23%) and 1.22 m ha (31.44%) against the kharif rice of 5.60 m ha, 5.97 m ha, 4.62 m ha, and 3.88 m ha, respectively. The DPD Annual Report 2016–17 shows the rice-fallow area in West Bengal, Jharkhand, Odisha, Bihar, Assam, and Uttar Pradesh is 1.72, 1.46, 1.22, 0.74, 0.54, and 0.50 m ha, respectively (Kumar *et al.* 2019*b*). Cropping intensity in the Eastern states ranges from 115% in Chhattisgarh to 177% in West Bengal (Kumar *et al.* 2019*b*). Besides, 116 million people in the region live below the poverty line (BPL 28.61%) and are dominated by small and marginal farmers of about 85.5 percent (small 18.5% and marginal 67%). With a rice-based mono-cropping system resulting in low farm income, it's difficult to sustain a farming household. This is probably one of the reasons why rural youth are detracting from agriculture and hence the aging in agriculture (Veettil *et al.* 2020). Also, this is resulting in hunger in all states of India. The first-ever Indian Hunger Index, released along with the Global Hunger Index, found that not a single state in India fell in the 'low hunger' or 'moderate hunger' categories (Grebmer *et al.* 2008). To be out of the poverty trap and to increase farmers' income, Mohapatra (2018) suggests that there is a need for farmers to obtain generous economic incentives to optimize their production from their existing arable land, and increase their purchasing power. This existing rice-fallow area in eastern India is equivalent to the combined net sown area of Punjab, Haryana, and western Uttar Pradesh –the green revolution belt in India, and if brought under cultivation, it may escort another green revolution in India, benefiting millions of farmers. Promotion of pulse and oilseed crops in the existing fallow area would also improve the sustainability of the rice production system besides enhancing production, nutritional security, and augmenting income. It calls for identifying abiotic, biotic, and socio-economic constraints to *rabi* cropping that can be addressed through technological and policy intervention (Kumari and Badal, 2020).

Moreover, sustainability in agriculture can be achieved broadly through efficient management of the natural resource base and integrated approaches to crop management (Mohapatra *et al.* 2022). Hence, it's high time to bring fallow lands into cultivation through all-around interventions (research, agricultural policy, infrastructure development, incentives, farming community mobilisation, convergence, etc.). Keeping all these in mind, the central government, state governments, and other private stakeholders have started investing in the research and development of rice-fallows in the region through different schemes/ programs/ projects. For example, the Government of India has introduced a special program to address rice-fallow, namely "Targeting Rice Fallow Areas in Eastern India for Pulses and Oilseeds" under Rashtriya Krishi Vikas Yojana (RKVY) (GoI, 2016). Recently, the Commission for Agricultural Costs and Prices (CACP) called for the conversion of rice-fallow lands for the production of pulses to facilitate better income for farmers (Spectrum, 2020). However, ad hoc investments in fallow intensification do not yield sustainable and satisfactory results as it is a complex and multi-dimensional problem requiring attention at various levels of intervention. The return to investors will be visible and positive if there is a comprehensive understanding of the precise assessment of *rabi* fallow area, natural resources of this region, identification of the constraints (biophysical and socio-economic) to crop production, and then providing a scientific sound, economically viable, environmentally sustainable, and socially acceptable landscape specific crop plan for the *rabi* season for this region. This could play a vital role in enhancing farm income, alleviating poverty, and ensuring food security for all. With this backdrop, the present paper discusses the challenges and strategies for developing rice-fallow in eastern India for manifold agricultural and socio-economic impacts at scale.

The data and information used for this review paper are from secondary sources like articles, books, reports, conference proceedings, websites, and documents from websites/electronic sources. The observations, feedback, and learnings from a couple of ongoing projects helped the authors during discussion and validation.

REVIEW AND DISCUSSION

Challenges

In Eastern India, farmers cultivate rice mainly during the rainy season (June–September), and land is leftover fallow after the rice harvest in the post-rainy season (November–May) due to a lack of sufficient rainfall or irrigation amenities. Rice follows may be the reason for the constant productivity of rice, which imply to that lowland *kharif* sowed rice areas that remain uncropped during *rabi* due to various reasons such as early withdrawal of monsoon rains leading to soil moisture stress at planting time of winter crops, water-logging, lack of appropriate varieties of winter crops for late planting, and socio-economic problems like stray cattle, blue bulls, etc. (Lal *et al.* 2017). As per Ali and Kumar (2009), the main reasons for leaving the lands fallow during the winter season are lack of irrigation, late harvesting of long–duration wide yielding rice varieties, moistures stress at sowing during the *rabi* season due to early withdrawal of monsoon, water-logging and excessive moistures in November/December, and nuisances like stray cattle and blue bulls. Still, further in-depth research needs to be done on fallow challenges (biophysical and socio-economic), including farmers' behavior along with potential and feasible solutions and the responsibility of stakeholders. Kumari and Badal (2020) indicated that various reasons lead to remain land fallow after rice cultivation. Some of them are lack of irrigation, highly variable and inadequate monsoon rains, very low probability of winter rains, low soil moisture in the surface layer after harvest of rice, water stagnation / excessive moisture in November/December, soil compaction, and cracks in Vertisols, cultivation of long duration rice varieties, lack of appropriate varieties of winter crops for late planting, lack of public awareness, research and development efforts and policy support and of course the stray cattle.

Singh *et al.* (2017) opines that the quick drop in soil moisture leads to mid-season/ terminal drought overlapping with flowering and pod-filling stages. It is the main drawback in cultivating pulses and oilseeds in rice-fallows. Among the abiotic factors, low soil moisture content and rapid soil–moisture depletion frequently led to drought situations at flowering and harvesting (Pande *et al.* 2012). Even if the crop is managed well with residual soil moisture, short of winter rains at the grain-filling stage often lead to complete crop failures (Kumar *et al.* 2016). Lack of irrigation facilities and poor soil moisture thus constitute the main limiting factors for the production of pulses/ oilseed in rice–fallows. Site-specific nutrient deficiency (P, Zn, S, B, Mo), soil acidity, and low soil organic carbon (SOC) directly affect pulses/oilseeds production in rice–fallows (Pande *et al.* 2012). Many puddling in rice creates slurried soil by the physical destruction of macro-pores and aggregates, resulting in a decrease in the bulk density of the puddled soil (Cassman *et al.* 1995). These soils frequently dry out and build up cracks at the end of post-*kharif,* leading to the unavailability of soil moisture to support the winter crops. Ploughing of these soils after rice harvest also creates clods with higher breaking strength and thus decreasing yields of the subsequent crop, perhaps due to the restricted root growth (Kar and Kumar, 2009). Panda *et al.* (2018) reported that socioeconomic problems and the absence of appropriate technologies to convert fallow areas into cropped areas are the main apprehensions for the sustainability of the rice ecosystem. Though these rice-fallow areas have enough potential for cultivating a crop profitably under available advanced agro-techniques and scientific crop husbandry using residual moisture (Huke, 1982), these areas haven't invited proper attention during the past few decades. Consequently, a substantial food and fodder production has been lost over the years. So far as Odisha state is concerned, the Odisha University of Agriculture and Technology (OUAT) team, in their report "OUAT strategies for pulse production in rice-fallows of Odisha" has pointed out some constraints under different categories. Physical constraints include (1) nearly 94% of pulse area is rainfed (33% in *kharif* as rainfed and 61% in *rabi* under residual soil moisture), (2) suffer from moisture stress during *rabi* season due to low winter rainfall, (3) plant growth is affected due to waterlogging in coastal tracts, (4) about 70% of cultivated area in the state is acidic, which reduces the yield, (5) a sizeable area in coastal districts is salinity affected, (6) canal irrigated lands are gradually becoming unsuitable for pulse cultivation, (7) rain at maturity for *kharif*, the cold Climate during winter sowing and heat stress at reproductive stage of summer crops cause low productivity, (8) stray cattle menace restricts the horizontal expansion. The technological constraints include (1) lack of varieties resistant to various biotic and abiotic stresses in general such as YMV and cold, (2) non-availability of suitable varieties with better yield advantage and desirable characteristics suitable for varied agro-climatic conditions and multiple adversities, (3) lack of varieties responsive to high impacts, e.g., irrigation, fertilizers, etc., (4) most of the improved varieties are lacking preferred consumption quality as compared to the local varieties, (5) lack of commercial exploitation of hybrid vigor, (6) non-adoption of improved production technology because of more instability and poor crop performance under adverse condition. The service-related constraints are (1) a wide gap between the requirement of certified/ quality seeds and their distribution and low SRR, (2) no or very less use of *Rhizobium* inoculants because of no visible yield advantage, (3) poor storability and lack of storage facility leading to post-harvest losses to the extent of 23-30% (OUAT, 2016). Kumar *et al.* (2019*b*) in their review paper, also indicated that the major constraints are soil moisture stress and lack of irrigation, shortage of superior cultivars and quality seeds, long-duration rice varieties, severe weed menaces, soil acidity, terminal drought, poor crop management, and socio-economic constraints.

Opportunities

Policymakers, experts, scientists, and farmers have been trying to manage fallows by addressing various issues associated with it for a logical increase in system productivity and income. On 19 August 2019, the Commission for Agricultural Costs and Prices (CACP) called for the conversion of rice-fallow lands for the production of pulses to facilitate better income for farmers. As per the commission, about 8.5 m ha of rice-fallow in the country can be utilized for the cultivation of pulses. Assam and West Bengal have 1 m ha each of such lands, whereas Odisha and Chhattisgarh have about 3 m ha each. The commission indicated to improve the productivity of pulse and reducing fluctuation in rice yield by introducing better technologies and varieties. The commission also recommended that the government should include pulses in the public distribution system and other welfare schemes. The commission has suggested that the export of water-intensive crops, such as rice and sugarcane, should not be promoted; instead, the production of pulses needs to be promoted by better quality seed distribution to farmers and appropriate price support. As pulses have high volatility as they are grown in rain-fed areas, there is a need to make available drought-tolerant varieties and technologies (Spectrum, 2020). If the location-specific constraints to produce the crop are alleviated, the unutilized lands might be converted into productive lands with crop-appropriate planning (Kumar *et al.* 2019*a*).

In lowland areas, sufficient residual soil moistures are available in rice-fallows in the post-rainy season (November–March), which can be utilized for raising second crops in the region. Implementation of proper crop/varietal diversification is thus very much vital to achieving this objective (Lal *et al.* 2017). To exploit these rice-fallow areas, there is a need to develop and promote location-specific cultivation technology for remunerative and sustainable pulse production (Huke, 1982). Efficient utilization of these fallow lands may improve the productivity and sustainability of the regions. Based on soil properties of the region, short-duration pulses, i.e., chickpea (*Cicer aerietinum*), lentil (*Lens culinaris*), lathyrus (*Lathyrus sativa*) and oilseeds, viz. safflower (*Carthamus tinctorius*), linseed (*Linum usitatissiumum*) and mustard (*Brassica campestris*) can also be successfully grown in rice-fallows with life-saving supplemental irrigation (Kumar *et al.* 2019*a*).

The rice-fallow areas are suitable for short-season, low water-requiring (thriving best on residual moisture with adequate conservation measures) legumes such as chickpea, *urd* bean, mung bean, and lentil. Conventionally, lentils and lathyrus are sown after rice as a relay crop in lowland areas of Bihar, Chhattisgarh, Eastern UP, Jharkhand, and West Bengal; and now more advanced crop management could enable the cultivation of a pulse (Praharaj *et al.* 2017) as a rotational crop after rice, profitably. Inclusion of short-duration low water requiring legumes (grain/green manure purpose) offered an excellent opportunity to utilize carry-over residual soil moisture in rice-fallows (Kar *et al.* 2004). Based upon multi-located adaptive trials and demonstrations conducted under IRRI-GoO-DSR-Odisha and CSISA projects during *rabi* season of 2021-22 in Odisha, it was realized that mechanically sown pulses (green gram and back gram), and oilseeds (groundnut) in well-prepared fields with residual soil moisture (after rice harvest) and layered with improved varieties, basal application of phosphatic fertilizer and other improved agronomic practices could result into a significant improvement in the productivity and profitability of the crops besides addressing the issue of rice-fallows, soil health, and nutritional demand. Moreover, the same multi-crop planter used for DSR in *kharif* season may be engaged for establishing the following crops. Intensification of rice-fallow was found to enhance productivity and farmers' income in rice-based systems. Nevertheless, the yield differences were significant only in 2009 during which rice-potato-green gram recorded maximum rice grain yield being at par with the grain yield in rice- potato + wheat (1:1) - green gram (Prasad *et al.* 2013). Effect of the cropping system on the harvest index of the rice crop was also significantly higher at 300% intensification in rice- potato + wheat (1:1)-green gram and rice-potato-green gram over others (Prasad *et al.* 2013). That's why an effective site-specific strategy plays a decisive role in comprehending productive potential from particular rice-fallow areas coming under each agro-climatic zones/subzone and landscape.

In eastern Indian states, approximately 70% of the cultivated area during *kharif* is covered by rice. Most of this area remains fallow during the *rabi* season, leading to lower cropping intensity, as the irrigation potentials created so far are too few cropped areas. The utilization of vast areas under rice-fallow is possible to a great extent by shifting over to Direct Seeded Rice (DSR) with shorter/medium duration rice varieties in place of the traditional practice of rice cultivation along with extended duration varieties during *kharif* season.

For example, in states like Odisha, Jharkhand, and Chhattisgarh, there is around 1.6 m ha, 1.0 m ha, and 4.1 m ha of rice-fallow area, which needs diversification and intensification mainly through pulse production every year to increase the cropping intensity to more than 150% in the rained area (Deogharia, 2018). Hence, in this way cropping system intensification comprising two crops could further increase farmers' income, human health (diversified food choice), and soil health (nitrogen-fixing), along with addressing food insecurity of growing populations without having to expand croplands (Gumma *et al.* 2016). So, the focused target should be towards possible intensification in these rice-fallow areas with short-duration pulses and oilseeds. Panda *et al.* (2018) suggest several short-duration and moisture-stress-tolerant crops/varieties which can be cultivated in these fallow lands.

However, knowledge and technical gaps in best management practices (BMPs) of pulses and oilseeds under different soil conditions create difficulty in their proper application. Adoption of early and mid-early short and medium duration rice varieties/hybrids in the *kharif* will have a larger window for cultivating low-temperature tolerant crops like pulses and oilseeds in the *rabi*. Other crops should also be targeted in matching landscapes where pulses and oilseeds are not feasible crops. Cultivation of zero tillage vegetable pea after the rice harvest recorded higher green pod yield at 5.89 t ha^{-1} besides 44 percent lesser energy consumption compared to conventional tillage (Singh *et al.* 2015). Moreover, Das *et al.* (2008) found a significantly higher net return in the rice-French bean system as compared to rice mono-cropping. Farmer's net income was increased by ₹ 29,000 ha^{-1} and ₹ 21,500 ha^{-1} over the rice-fallow system due to the inclusion of pea (vegetable) and lentil, respectively with a zero-tillage practice. Singh *et al.* (2014) suggested that the suitability and profitability of cropping systems vary not only with soil type but also with soil series. For example, rice–potato produced a higher yield in Lahangaon series, whereas rice–pea in Teok series of Upper Brahmaputra valley of Assam. In rice-fallows of eastern India, various pulses, viz. lathyrus, lentil, field pea, black gram, green gram, chickpea, faba bean, and oilseeds crop viz. linseed, mustard, toria, til, niger etc. can be grown as utera crops. The on-farm trials proved that the black gram crop was the most feasible crop in coastal Odisha. Crops like sunflower, groundnut, watermelon, and lady's finger can also be raised with limited irrigation. Medicinal crops like *Brahmi, Bhrungaraj, Bhukadamba, Panmadhuri, Juani,* and *Jalabrahmi* were found promising in rice-based cropping sequence for increasing the profitability of rice farmers. The sunflower was found promising in coastal Odisha after rice with limited irrigation (Panda *et al.* 2018).

The major districts having higher rice-fallow areas under different eastern Indian states are given below for particular targeting. (1) Odisha- Koraput, Kalahandi, Sambalpur, Sundergarh, Bhadrak, Cuttack, Puri, Dhenkanal, and Mayurbhanj, (2) West Bengal- Purulia, Bankura, Birbhum, Bardhaman, Medinipur, Murshidabad, South 24-Parganas, Maldah, West Dinajpur, Jalpaiguri and Coochbehar, (3) Bihar- Kishanganj, Gaya, Aurangabad, Katihar, Mokama, Bhagalpur and Nalanda, (4) Chhattisgarh- Surguja, Jashpur, Raipur, Raigarh, Durg, Bastar and Bilaspur, and (5) Jharkhand- Ranchi, Hazaribagh, Bokaro, Deogarh, Sahibganj, Gumla, Palamau, Dumka, Dhanbad, Purbi Singbhum, and Pashchim Singbhum (NAAS, 2013). The potential crops with areas for specific landscapes/states in existing rice-fallow areas may be targeted as estimated by ICAR-IIPR and mentioned here. (1) Chickpea (0.40 m ha)- Eastern U.P., Bihar, Jharkhand, Odisha, Chhattisgarh, West Bengal; (2) Urd bean/mung bean (0.50 m ha)- Andhra Pradesh, Tamil Nadu, Odisha, Karnataka; (3) Lentil (0.30 m ha)- Eastern U.P., Bihar, West Bengal, Assam, Jharkhand; and (4) Lentil/field pea (0.10 m ha)- North-east states (IIPR, 2015).

Coming to Odisha specifically, the pulses area (1.34 m ha) and oilseed area (0.32 m ha) cover around 56% and 13.26% of the gross *rabi*-cropped area, respectively (DAFP, 2018). This area can further be increased, and also higher productivity target can be achieved as the productivity of *rabi* pulses (0.57 t ha^{-1}) and oilseeds (0.82 t ha^{-1}) in the state is about half of the national productivity. Green gram, black gram, and horse gram are the three major pulse crops grown during *rabi* season in the state, contributing 87% of the total *rabi* pulses area and 83% of *rabi* pulse production. Besides, gram, field pea, lentils, cowpea, and other minor pulses are also grown sporadically during *rabi* season in the state (OUAT, 2016). Displacing *rabi* season rice may also help save irrigation water to bring more area under pulses and oilseeds in the state.

Over and above all the constraints, pulses/oilseeds are considered as the main crop for strengthening of these fallow areas (Table 1) (Kumar *et al.* 2019*b*).

Our recent experience during *rabi* season of 2021-22 under IRRI-GoO-DSR-Odisha project also indicated that improved varieties of green gram line MH 421 and HUM 16 could be a game changers to enhance productivity and farm income in Odisha. However, more research work is required to confirm these findings in different parts of Odisha.

Leaving the arable lands fallow could be costlier to farmers and agricultural development. New crops must be brought in fallow lands with strategic planning and management of existing technologies, *kharif* crop management and synchronization of agri-activities, optimal utilization of available resources etc. (Mohapatra, 2021). As per the Committee on World Food Security (CFS), High-level Panel of Experts (HLPE), the COVID-19 pandemic is already affecting food systems directly through impacts on food supply and demand and indirectly - but just as significantly - through decreases in purchasing power, the capacity to produce and distribute food, and the intensification of care of tasks, all of which will have differentiated impacts and will more strongly affect the poor and vulnerable (CFS-HLPE, 2020). So, for strengthening and diversifying the food supply chain, cropping intensification has to be increased by addressing rice-fallow issues. The twin objectives of poverty reduction and enhancing food security require systematic intervention in the domains of sustainable agriculture, and this can be ensured through innovative farming models, farm

Table 1: Suitable crops and varieties for rice–fallow areas of eastern India

Crop	Variety	State
Lentil	HUL 57, KLS 218, Narendra Masoor, Arun, DPL 15, DPL 62, Vaibhav, Pusa Masoor, IPL 316, IPL 01, IPL 406, Ranjan, K 75	Assam, West Bengal, Bihar, Odisha, eastern Uttar Pradesh, Chhattisgarh, and Jharkhand
Lathyrus	Ratna, Prateek, Mahateora	Tal area Bihar, Chhattisgarh, and West Bengal
Pea	Arkel, Azad pea, Rachna	Jharkhand, Chhattisgarh, and eastern Uttar Pradesh
Chickpea	GCP 105, Pusa 372, JG 11, JG 14, JG 16, Pant G 186, Rajas, Pusa 547, Pusa 256, Vaibhav, GCP 105, GNG 1581	Chhattisgarh, West Bengal, Bihar, and Jharkhand
Mungbean	SML 668, Pusa Vishal, Samrat	Odisha, Chhattisgarh, Jharkhand, and Bihar
Urdbean	Navin, T 9, ADT 3, ADT 4	Odisha and Jharkhand
Mustard	Pusa Bold, Kesri Gold	Bihar, Eastern Uttar Pradesh, and Jharkhand
Groundnut	JL 24, ICGS 1, TAG 24	Bihar, Assam and Odisha
Safflower	PBNS 12, Manjira, Bhima	Bihar, Eastern Uttar Pradesh, and Jharkhand
Linseed	Sweta, Uma, Shekhar, Indu, RLC 133, RLC 138, RLC 143, SLS 79, JLS 95, BAU 06-03, BAU 2012-1, BAUP 101	Eastern Uttar Pradesh, Bihar, Jharkhand, Assam
Toria	TS 36, TS 38, TS 61, M 27	Assam, Bihar, and Jharkhand

Source: *Modified from Ghosh et al. (2016).*

mechanization, stress-tolerant, and high-yielding crop seeds, best agronomy practices, and resilient mechanisms, etc. (Mohapatra, 2020). Without bringing at least a second crop in rice-fallow land into the cultivation system, profitability and the farmers' income can't be enhanced. For this, the adoption of innovative farming/business models is indispensable for the creation of an enabling situation for the next crops. One such model is Small Farmers, Large Field (SFLF), through which synchronized agricultural operations in the *kharif* season and liquidity (higher income) in hand will generate scope for establishing the next crop in the *rabi* season (Mohapatra, 2021).

CONCLUSION

While many technological, institutional, and market-based solutions have been identified, there is limited utilization of the existing evidence base in the design and implementation of fallow intensification pathways. Despite its importance, rice-fallows intensification in risk-prone geographies does not have an active, well-defined coalition of supporters, a community of practice, or a policy network at the country, state/division, or local level through which to influence policy reforms.

Research on fallow management must go parallel with ongoing programs/schemes. In a collaborative approach, partners should assess pathways for investment and intervention sequencing to catalyze the intensification of *rabi* fallows. If plausible and low-to-medium risk pathways are identified and associated, convening and catalytic roles can be defined for partners; policy dialogue and execution plan will not be an issue as all the local governments and agencies already understand the need for fallow management.

As various stakeholders' involvement is required for fallow management, departmental coordination and convergence of their schemes/programs are indispensable. Say, for the arrangement of irrigation water, various departments (agriculture, water resources, electricity, revenue, public works, etc.) will have to play active roles in making it successful.

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