

Enhancing productivity of rice-fallows of eastern India

through inclusion of pulses and oilseeds

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Rice is the principal crop grown during kharif/rainy season in the Eastern India, which occupies 26.8 million ha accounting for 63.3% of the total rice-growing areas of the country. However, this area is not fully utilized for crop production in subsequent rabi/post-rainy season and kept fallow due to a number of biotic, abiotic and socio-economic constraints. If this rabi fallow area can be effectively utilized with the growing of suitable short duration and high-yielding varieties of pulses and oilseeds like greengram, blackgram, safflower, sesamum and mustard, it will help in improving the economy of this region.

Key words: Eastern India, Oilseeds, Pulses, Rice fallows, Varieties

RICE fallows are mono-crop rice based production system of South Asia and mainly concentrated in India, Nepal, Pakistan and Bangladesh. India accounts for ~79% (11.65 million ha) of total rice fallows of South Asia (15 million ha) and mainly spread in Asom, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, West Bengal and Eastern Uttar Pradesh (Table 1). Rice fallows basically imply to the those lowland *kharif* sown rice areas, which remain uncropped during *rabi* due to lack of irrigation,

cultivation of long-duration high-yielding varieties of rice, early withdrawal of monsoon rain leading to the soil moisture stress at planting time of winter crops, waterlogging and excessive moisture in November/December, lack of appropriate varieties of suitable winter crop for late planting, and socio-economic problems like stray cattle, blue bulls etc.

In rice-based cropping system, productivity of subsequent *rabi* crops is considerably influenced by the crop establishment methods across the

country. The late harvesting of high-yielding transplanted rice varieties, particularly in eastern parts of the country leads to delays in sowing of the succeeding pulses and oilseed crops and resulted in lower crop yields. After harvest of *kharif* rice, climatic conditions of rice fallows in many areas are suitable of growing cool and warm pulses profitably.

The residual moisture left in the soil at the rice harvest is often sufficient to raise the short-season crops. Use of short-duration and high-yielding varieties of rice to allow vacating fields in October, then the traditional rice fallows can be converted into productive land. Introduction of cool and warm season pulses and oilseeds i.e. lentil, lathyrus, chickpea, linseed, safflower and mustard in rice fallows can increase productivity as well as sustainability of the rice. To meet the domestic demands of edible oil and pulses, a large quantity is imported, which leads to the huge drain of foreign exchange. Agro-climate of Eastern plains is characterized by the

Table 1. Area under the Rice fallow in Eastern India

States	Kharif-rice area (M ha)		Rice fallow (M ha)	Rice fallow as % of <i>kharif</i> rice area
	2001	2010-2011		
Asom	2.23	2.17	0.54	24.1
Bihar and Jharkhand	5.97	2.74+1.69	2.20	36.8
Chhattisgarh and Madya Pradesh	5.60	1.60+3.70	4.38	78.3
Odisha	3.88	3.93	1.22	31.4
Uttar Pradesh	6.26	5.66	0.35	5.6
West Bengal	4.62	3.57	1.72	37.2

Source: NAAS Policy Paper, 2013.



Typical rice fallows area



Lathyrus under utera at ICAR Research Complex for ER, Patna

hot dry sub-humid climate with hot summers and cool winters. The mean annual temperature ranges between 24 and 26°C. The area receives mean annual rainfall of 1,200 to 1,500 mm increasing towards Eastern sides of country. The growing period of this sub-region begins with onset of monsoon July and ends in December. The length of growing periods (LGP) ranges between 180 and 210 days in Eastern Uttar Pradesh, Bihar and Jharkhand, and exceeds 240 days in West Bengal.

Constrains in rice fallows

Despite the immense scope, extensive use of rice fallows for pulse cultivation is mostly restricted because of several biotic, abiotic and socio-economic constraints like early withdrawal of monsoon rain leading to soil moisture stress at planting time of winter crops, lack of appropriate varieties of suitable winter pulses for late planting, and socio-economic problems like stray cattle, blue bulls etc.

Lack of improved varieties and quality seeds: Crop varieties specially suited for rice fallows of different regions have not been developed, and therefore, among available varieties, which have comparative advantage should be recommended. There is an acute shortage of quality seeds of the recommended varieties, compelling the farmers to grow low-yielding local varieties. Apart from these, lack of suitable varieties of pulses for rice fallows is another major constraint in the region. Long duration varieties are poor performer in rice fallows and suffer from terminal drought. Based

on a feasibility study in central India, elicited that >90% farmers viewed lack of suitable variety is the prime reasons for a large area that remain fallow in *rabi*.

Poor plant stand: Under relay/*utera* cropping, plant population is often low due to the poor seedling emergence on account of compact soil, poor contact of seed with soil and low soil moisture in surface layer. In some areas, seed rotting due to the excessive moisture is to be observed a prominent reason.

Delayed sowing of succeeding crops: In rice fallows, even if crop is sown timely and established well, pulses experience high incidence of the pests and diseases. In chickpea, pod-borer is serious problem in Jharkhand and Chhattisgarh. In lentil and chickpea, the major problems were associated *Fusarium* wilt in initial stages of crop growth in part of Bihar, Jharkhand, West Bengal and Eastern Uttar Pradesh. Extent of plant mortality due to these diseases in lentil and chickpea were 30-40% and yield declines drastically in the regions up

to 50%.

Weed menace: It is another serious problem under relay cropping, as there is no land preparation. Meanwhile the hand-weeding is difficult due to the fast drying of the soil surface. In many areas, *Cuscuta* infestation is associated with mungbean. Use of pre-emergence herbicides is not feasible under this condition.

Soil acidity: It is a vital constraint responsible for low productivity of pulses in eastern region (ER). More than 50% of total area of ER and ~80% of cultivated soils is acidic in nature. Basically, pulses are sensitive to acidity that directly impact on biological nitrogen-fixation (BNF), microbial diversity, plant-nutrient accessibility and toxic effect to crop root. Strongly acidic soil is observed in rice fallows of Chhattisgarh Asom and Jharkhand. Similarly, rice-fallow soil of the lower and middle indo-Gangetic plain, salinity and alkalinity problem are predominant.

Terminal drought: Since *rabi* crops are grown on residual soil moisture

Table 2. Potential crops varieties of pulses for rice fallows in eastern states of India

Crops	Varieties	States
Lentil	HUL 57, KLS 218, Narendra Masoor, Arun, DPL 62, Vaibhav	Asom, West Bengal, Bihar, Odisha, Eastern Uttar Pradesh, Chhattisgarh and Jharkhand
Lathyrus	Ratna, Prateek, and Maitri	Tal area Bihar, Chhattisgarh and West Bengal
Pea	Arkel, and Azad pea	Jharkhand, Chhattisgarh, Eastern Uttar Pradesh
Chickpea	GCP 105, Pusa 372, JG 11, JG 14, JG 11, Pant G 186, Rajas, Pusa 547, Pusa 256, and Vaibhav	Chhattisgarh, West Bengal, Bihar and Jharkhand
Mungbean	SML 668, Pusa Vishal, and Samrat	Odisha, Chhattisgarh, Jharkhand, Bihar
Urdbean	Utera, Navin, T 9, and ADT 3	Odisha



Chickpea under *utera* at ICAR Research Complex for ER, Patna



Lentil under *utera* at ICAR Research Complex for ER, Patna

under the rainfed condition, terminal drought severely affect the crop yield. Terminal drought and heat stress result in forced maturity and may reduce seed yield by 50% in tropics.

Poor crop management: *Rabi* crops in rice fallows are considered as bonus crop. In view of the risk involved in successful cultivation of second crop due to limiting the soil moisture and likely drought situation beside socio-economic problems, farmers do not pay much attention to crop management i.e. choice of appropriate varieties, seeding rate, pest management, *rhizobium* inoculation and foliar nutrition of 2% urea and di-ammonium phosphate (DAP). In Eastern Region, lathyrus and lentil are comparatively hardy crops, can withstand the pest attack better than chickpea.

Socio-economic constraints: Most important, awareness and knowledge about winter cultivation in rice fallows among the farmers are lacking. Further, poor economic condition and purchasing capability induce farmers to left the field idle after rice harvesting. Besides, fragmented land holding, shortage of labour, non-availability of input, limited access to institutional credit, lack of market, lack of knowledge among farmers on water-conservation techniques, poor extension service directly/indirectly discourage farmers for taking a second crop. Other important problems, animal grazing or free grazing is another potential threat to the pulses in rice-fallows. Wild animals, such as *Neelgai* (blue bull) and monkeys cause severe damages in

Bihar. There is no policy support and other incentives, which can motivate the farmers to grow pulses.

Strategic crop management in rice fallows

Water harvesting structures: Construction of farm pond/ community water reservoirs to harvest excess rain-water during-rainy season is a feasible strategy to provide the life saving irrigation to the successive pulses in rice fallows. Excess run-off available to the extent of 300 to 400 mm, which can be harvested in silpaulin-lined ponds to provide come-up/life-saving irrigation.

Soil-moisture conservation: In rice fallows, effective moisture-conservation practice can mitigate moisture-related stress and terminal drought. Resource conservation technologies (RCTs) prevent rapid soil moisture loss, improves soil organic carbon and soil bio-physical properties could be a strategic approach in rice fallows. To better utilize the residual soil moisture efficiently, pulses need to be sown immediately after rice harvest. The zero tillage system prevents moisture loss and advances planting by one week. In rice fallows of eastern India, reduced tillage can increase pulses (lathyrus, urdbean, chickpea, field pea and mungbean) yields by 33 to 44% over conventional tillage and moisture-conservation potential of reduced tillage is better than that with no-till.

Selection of varieties: Extensive trapping of rice fallows needs the growing of short-duration and hardy

pulses varieties that can effectively avoid terminal drought. Pulse genotypes with fast growing and wide canopy coverage could minimize evaporation losses from soil surface. In rice-pulse relay cropping, small-seeded varieties perform better than large-seeded once owing to better contact with soil, less rotting and thus better plant stand. Besides this, growing early to medium duration rice variety enable farmers to advance sowing of pulses for utilizing the residual moisture more efficiently.

Seed-priming for better crop establishment: It is an important low cost beneficial technology to obtain better plant stand and high yield of pulses. Pre-sowing seed soaking with $\text{KH}_2\text{PO}_4/\text{Na}_2\text{HPO}_4$ or water was earlier reported to improve the seed germination, seedling vigour and root growth, resulting in better crop establishment, moderate the drought tolerance and more yields.

Foliar nutrition: Seed pelleting and foliar nutrient application should be practised as application of fertilizer under relay cropping is not only a viable approach in rice fallows system. A large number of front-line demonstrations under the AICRP on Pulses showed that significant improvement in yields of pulses like chickpea and lentil under rainfed conditions due to foliar application of 2% urea at flowering and pod formation stage. In general, higher response of pulses to phosphate is observed in rice fallows. Deficiency of micronutrient is very common and there is a decreasing trend of soil micronutrients. Hence, seed pelleting

with micronutrient (Zn) is recommended. Along these lines, supplementary application of micronutrient particularly Mo is necessary in acidic rice-fallow soils.

Improving plant-nutrient supply: Apart from the moisture stress, winter crop in rice fallows experience variable degrees of nutrient stresses. As a result of poor soil physical condition and low native *rhizobium* population in rice-fallows, nutrient mobilization is substantially reduced. Under relay cropping, foliar spray of KNO_3 and $\text{Ca}(\text{NO}_3)_2$ at 0.5% significantly improved grass pea yields in rice fallows of Eastern India. In acidic soil, liming and seed priming with Mo is effective, while in calcareous soil, pyrite and seed priming with water/ KNO_3 is an effective approach.

Planting strategy: In rice fallows system, planting is generally delayed. Under *utera*/relay planting, seeds should be broadcast 10 to 15 days before harvesting of rice. The zero tillage seed-cum-fertilizer drill should be used wherever feasible, when planting is done after harvest of rice. It is necessary to use short/medium maturing varieties of rice for timely planting of *rabi* crops.

Pest-management options: In rice fallows system, timely plant protection is very much important. Effective pre-emergence application of herbicides is not economical and intercultural operations are

additionally troublesome, as soil turns hard. In this way, hand-weeding is main choices that ought to be done at early stage. Integrated weed management strategies with mulching, application of pre-emergence herbicides and need-based hand weeding should be adopted. Insect, pests and diseases should be effectively managed through adoption of integrated pest management components like bird perches, spray of nuclear polyhedrosis viruses (NPV) and chemical pesticides at economic threshold levels (ETL) will be useful for controlling the pod borer in pulses. The cultural practices like use of small-seeded lentil varieties 'WBL 77', 'KLS 21' and 'DPL 15' having resistance to rust are performing well in the Eastern India. Newly developed *Lathyrus* varieties 'Ratna' and 'Parteek' with low ODAP are suitable for rice fallows. Varieties resistant to Yellow Mosaic Virus and powdery mildew in mungbean and urdbean need to be promoted. Seed treatment with *Trichoderma* + carboxin or alternately carbendazim+thiram for root rot, collar rots and wilt in chickpea, lentil, mungbean and urdbean is useful for pulse production. To prevent the spread of seed-borne diseases, pre-seed treatment with fungicide/bio-control is to be resorted to Bavistin 2 g/kg seed or *Trichoderma viride*. Similarly, application of quizalofop

can be used to check ratooning of rice stubbles, which cause substantial moisture loss in subsequent crops in rice fallows in Eastern India.

SUMMARY

Rice fallows thus offer a great opportunity to maximize the area of pulses with adoption of advance agro-techniques. Soil-moisture conservation and mitigation of abiotic stresses is two successful trapping of rice fallows. Location-specific, short duration, drought-resistant varieties of pulses are vital for rice fallows area. Further, extension system needs to be strengthened to sensitize the farming community. This way, pulses and oilseeds can be included as an integral part of rice-fallow production system. Among technical constraints, low residual soil moisture coupled with lack of irrigation, poor soil and crop management are important, whereas among socio-economic constraints, labour shortage, poor economic status of farmers, poor extension services, lack of availability of inputs and fragmented land size are important.

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Jai Kisan, Jai Vigyan

- A total of ₹ 788.33 crores have been sanctioned for opening six new agricultural colleges for eastern India under Central Agricultural University, Imphal, and a new Central Agricultural University in Meghalaya.
- For the establishment of two new agricultural research institutes in Asom and Jharkhand, a sum ₹ 100 crores is allocated.
- First academic session of the Rani Lakshmibai Central Agricultural University has been allocated for four new agricultural colleges in Datiya and Jhansi.
- An Memorandum of Understanding was signed for transforming the Rajendra Central Agricultural University, Pusa, Samstipur, Bihar. A proposal of ₹ 400 crores is submitted in EFC.
- Post-Graduate Institute of Horticulture is being established in Amritsar, Punjab.
- Foundation stone of the Indian Institute of Agricultural Biotechnology is laid at Ranchi for promoting agricultural biotechnology.