

Intensification of pulses and oilseeds in rice fallows

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Rice fallows are basically rainfed shallow lowland areas which remain uncropped during rabi (winter) after harvesting of kharif rice due to various reasons such as lack of irrigation, cultivation of long duration varieties of rice, early withdrawal of monsoon rains leading to soil moisture stress at planting time of winter crops, water logging and excessive moisture in November/December, lack of appropriate varieties of winter crops for late planting, and socio-economic problems like stray cattle, blue bulls etc. In India, 11.65 million ha is left fallow after harvesting kharif rice at the end of the monsoon during November found, nearly 82% of it lies in Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha and West Bengal, which is equivalent to the net sown area of Punjab, Haryana, and western Uttar Pradesh—the sheet of green revolution in the country.

Key words: Oilseed, Pulses, Rice fallows

RICE fallows offer good scope for area expansion of pulses and oilseed crops through crop intensification to utilise the moisture still retained in the soil. Development and popularization of improved varieties of pulses and oilseeds suiting to rice fallows coupled with improved agro-technology will boost production, and thus improve income and livelihood security of farming community. Moreover, introduction of legumes can provide a sustainable production base to the continued rice mono-cropping system leading to decline in total factor productivity and also provide much needed nutritional security. With the inception of Bringing Green Revolution in Eastern India (BGREI) programme and National Food Security Mission (NFSM), area under paddy has also gone up during *boro* season and area under oilseeds and pulses in rice fallows has also gone up considerably. While enhancing production and productivity of food grains in the region, equal importance should be

given to sustainable use of natural resources and suitable intensification of short duration crops like lentil, rape seed, linseed, field pea etc. in rice fallows.

Scope for cultivation of pulses and oilseed crops in rice fallows

The residual moisture left in the soil at the time of rice harvest is often sufficient to raise short-duration pulses and oilseed crops, and rice fallows can be converted into productive lands. This also provides an opportunity to increase cropping intensity through taking extra crop of lentil, green gram, black gram, lathyrus, field pea, rapeseed, linseed, safflower and sesame during lean period after *kharif* rice. Introduction of pulses and oilseeds in rice fallows can augment the domestic availability of pulses and oilseeds, which are in short supply and also help in restoration of the soil health. The small seeded varieties of pulses and oilseeds may find prominence under *Utera* cultivation (relay cropping). In lowland areas with excessive soil

moisture, lentil is more suitable and assured than chickpea. Rice-lentil cropping system can be popularized in the lowlands areas during winter season. Rice fallows can also be profitably used for groundnut cultivation in *Char* area of Brahmaputra valley of Assam. Mustard and linseed cultivation could be promoted in almost all the districts of eastern region.

Pulses and oilseeds production system in rice fallows

Utera cultivation: In *utera* cropping system small seeded crops like linseed, lentil and rapeseed seeds are broadcast in the standing rice field when rice crop is between flowering and dough stage. This is the best practice for utilizing the residual moisture efficiently under rainfed agro-ecosystem in rice fallows where tillage is difficult. This system helps the farmers to utilize the available moisture in rainfed shallow lowlands and diversify their cropping system by incorporating oilseed and pulses. About 25% of the linseed is





Cultivation of lentil, linseed and rapeseed under minimum tillage in rice fallows

under *utera* cropping system in rice fallows. In shallow lowland areas with excessive moisture, lentil is more suitable and assured than chickpea. Consequently, the rice-lentil system can be made more popular in the lowlands of eastern Uttar Pradesh, Bihar, Jharkhand and West Bengal. Early harvest of rice compared with Orissa or West Bengal, fertile soil and retreating north-east monsoon are the advantages for *utera* cropping in lower Assam. In one of the studies at Regional Rainfed Lowland rice Research Station (ICAR-National Rice Research Institute), Gerua, Assam, lentil resulted the maximum net return and B:C followed by *Khesari* (*Lathyrus*) whereas, black gram resulted in lowest economics under *utera* cropping system (Table 1). However, the maximum seed yield was recorded with *Khesari* followed by field pea but low market price resulted in lower economics as compared to lentil.

Cultivation with minimum tillage

In this system, field is ploughed to place seeds at proper soil depth. Minimum tillage practices have the advantages of cost effectiveness and time saving in field preparation. This system is advantageous in heavy clay

and clay loam soils where it is often difficult to create optimum condition in the seed zone. Three crops of pulses and oilseeds (lentil, linseed and rapeseed) were tested in two consecutive years during season of 2014-15 and 2015-16 at Research Farm of Regional Rainfed Lowland Rice Research Station (ICAR-NRRI), Gerua, Assam to assess the productivity and profitability of pulses and oilseeds in rice fallows under minimum tillage situations. Rice followed by linseed cropping sequence resulted in the maximum seed yield, rice equivalent yield (REY) and net return whereas, maximum sustainability yield index (SYI) and B:C was obtained from rice-rapeseed cropping sequence. However, the lowest values of REY, net return, SYI and B:C were recorded with sole rice crop. Pulses and oilseeds reported the benefit towards the net return of cropping systems. The study further revealed that rice productivity could be enhanced by 18.1% and 20.3% through inclusion of pulses and oilseeds, respectively, than that of its sole crop (Table 2).

Production constraints of pulses and oilseeds in rice fallows

Although, the Government of

India is putting much emphasis on enhancing the production and productivity of pulses and oilseeds by harnessing the best in frontier technologies there exists a host of limitations for enhanced crop production. A feasibility study on growing chickpea in the rainfed rice fallow land identified the major constraints such as biotic and abiotic stresses, poor crop management practices, lack of awareness about modern methods of cultivation including quality seed of high yielding varieties and integrated pest management, poor linkage to market and government support price policies (Table 3). Addressing these major constraints through appropriate interventions will pave way in increasing pulses and oilseeds production and improving the well-being of resource-poor farmers in the country.

Lack of improved varieties and quality seeds: Crop varieties especially suited for rice fallows of different regions have not been developed, and therefore, among the available varieties which have comparative advantage should be recommended. There is an acute shortage of quality seeds of recommended varieties, compelling farmers to grow low-yielding local varieties.

Table 1. Productivity and economics of pulses and oilseeds under *utera* cropping system

Utera crops	Seed yield rabi crops (kg/ha)	Net return (INR/ha)	B:C
Linseed	666.3	6347	1.47
Lentil	963.3	14308	1.84
Khesari	1712.5	11673	1.71
Field pea	1516.5	11080	1.58
Black gram	397.0	2870	1.23

Table 2. Increment in productivity, sustainability index and profitability of rice fallows through inclusion of pulses and oilseeds (Two year pooled data)

Treatment	Yield of pulses and oilseeds (kg/ha)	Rice equivalent yield (kg/ha)	Sustainability yield index	Net return (INR/ha)	B:C
Sole rice	-	5081	0.80	30420	1.64
Rice-lentil	500.3	5999	0.82	41961	1.86
Rice-linseed	514.2	6107	0.84	43742	1.90
Rice-rape seed	488.4	5809	0.86	41754	1.91



Poor plant stand: Under relay (*utera*) cropping, plant population is often low due to 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 excessive moisture is also observed.

Weed menace: Weeds are a serious problem under *utera* cropping as there is no land preparation. Hand weeding is a difficult proposition due to fast drying of soil surface. In many areas, *cuscuta* infestation is also associated with urdbean and mungbean. Use of pre-emergence or pre-plant herbicides is not feasible under these conditions.

No use of fertilizers: In rice fallows, generally no manure or fertilizer is applied due to no-tillage practice under relay planting, and consequently the crops suffer due to nutrient stress. Further, the physical condition of soil is poor due to transplanted puddled rice and consequently nutrient mobilization is reduced. Owing to puddling for transplanting of rice and anaerobic conditions, rhizobial populations are considerably reduced which limit biological N₂ fixation. In addition, the mono cropped rice cultivation also creates nutrient imbalance in soil.

Terminal drought: Since *rabi* crops are grown on residual soil moisture under rainfed conditions, terminal drought severely affects crop productivity. Drought onset accelerates leaf senescence, and decreases net photosynthesis and translocation from leaf to developing grains. Further, the accumulation of poor biomass often does not support the grain filling at reproductive stages. Terminal drought and heat stress result in forced maturity and may reduce seed yield by 50% in the tropics.

Prevalence of diseases: Powdery mildew is a serious disease of *rabi* planted urdbean and mungbean in coastal peninsula. Similarly, rust and *Fusarium* wilt are common in lentil.

Delayed planting: In rice fallows, planting is dependent upon duration of rice varieties, withdrawal of monsoonal rains and soil moisture status which are highly variable. Non- adoption of proper cropping

pattern is one of the major problems of pulses and oilseeds cultivation. Planting is often delayed which reduces crop yield.

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 soil moisture and likely drought situation besides socio-economic problems, farmers do not pay much attention to crop management such as choice of appropriate varieties, seed rate, pest management, rhizobial inoculation, foliar nutrition, mechanization etc.

Problem of iron toxicity: The soil of Assam in general is acidic with poor base saturation and low exchange capacity which restrict productivity potential of soil. Also the iron content of soil and groundwater sources is very high and continuous use of such water may lead to complex iron toxicity problem in the soil which may cause nutritional imbalance and may affect the production of crops and environment. The problem was also witnessed in waterlogging areas and chronically flood affected areas and was identified as one of the factors retarding the productivity of rice as well as pulses and oilseeds.

Lack of soil testing facilities: Soil testing is considered to be an important step to determine the requirement of soil nutrients for different crops for better production. The basic objectives of soil testing are

to guide the farmers for efficient and economic use of soil nutrients and other required inputs in crop cultivation. In fact soil testing services leads to better use of fertilizer and soil management practices. Although the state has 12 soil testing centres, most of the farmers are not aware about the benefit of soil testing and failed to reap better harvest from their cultivation practices.

Socio-economic constraints: Rice fallows are generally invaded by stray cattle and wild animals like blue bulls, boars etc. There is no policy support and other incentives which can motivate farmers to grow pulses in these areas.

Strategies for enhancing production and productivity of pulses and oilseeds

The key interventions like demonstration of improved production technologies with cluster approach, augmenting the availability of quality seed, seed priming and treatment with *Rhizobium*/fungicide, application of micro nutrient, insect-pests management and protective irrigation will be useful to enhance productivity of pulses and oilseeds (Table 4).

In rice fallows, yields of *rabi* crops are generally low as explained above, and thus a large area still remains uncropped. Limited R&D efforts in the past have led to development of improved production technologies which need to be refined and

Table 3. Major technological interventions for improving productivity of pulses and oilseeds in rice fallows

Issues	Interventions
Lack of suitable cultivars	Development of high-yielding varieties with appropriate maturity duration
Poor crop stand and establishment	Tillage machines, sowing methods, seed priming, higher seed rate, timely planting, seed treatment with fungicides
Diseases and pests	Development of IPM modules
Weed menace	Post-emergence herbicides like Quizalofop ethyl and Imazethapyr
Nutrient management	Foliar spray of urea/DAP to supplement N and P
Micronutrient deficiencies	Mo, B, Zn as seed pallets
Terminal moisture/heat stress	Residue mulching
Non-availability of quality seeds	Informal and formal seed production and supply systems
Lack of mechanization	Tillage machines, zero-till planter and harvester
Poor transfer of technology	Innovative farmer's participatory approach



validated for different eco-regions. The suggested interventions to improve the productivity of rice fallows are given in Table 3. Some efforts have been made in the past for increasing productivity of pulses and oilseeds in rice fallow areas in respect of identification of suitable varieties, planting methods, foliar nutrition and plant protection. The rice fallow initiative builds on past successes, refining and packaging improved technologies to address different problems.

Choice of appropriate crops and varieties: Depending upon winter temperature, soil texture and moisture, selection of crops and varieties should be made. The varieties suggested in Table 4 are suitable for rice fallows.

Seed priming and optimum seed rate: Overnight soaking of seeds, referred as seed priming, hastens seed germination and establishment under relay cropping. Since all broadcast seeds do not establish good contact with soil, the seed germination is low. Therefore, adoption of 20-25% higher seed rate over the recommended rate ensures desired plant stand.

Foliar nutrition: Since application of fertilizers under relay cropping is not feasible, seed pelleting and foliar application of nutrients should be practiced. The foliar application of 2% urea at flowering and pod formation significantly improved yields of chickpea under rainfed conditions by increasing leaf N content and making them photosynthetically more active. Seed pelleting with micronutrients like Zn and Mo is also recommended as a part of nutrient management strategy in rice fallows.

Planting strategy: In rice fallows, planting is generally delayed. Under relay planting, seeds should be broadcast 2-5 days before harvest of rice. Zero-till seed-cum-fertilizer drill should be used wherever feasible when planting is done after harvest of rice. It is necessary to use short to medium maturing varieties of rice for timely planting of *rabi* crops.

Plant protection: Since post-

Table 4. Suitable pulses and oilseeds varieties for rice fallows

Group	Crop	Varieties
Pulses	Lentil	L-9-12, Pant L-406, VL-126, WBL-77, PL-8, DPL-15
	Field pea	Azad P-1, T-163, Aparna, Rachna
	Kidney bean	Uday, PDR-14
	Greengram	K-851, Pratap-1
	Blackgram	T-27, T-9, KU-309, PU-31
	Lathyrus	Ratan, Mahateora and Prateek
Oilseeds	Rape seed/mustard	TS-36, TS-38, TS-29, TS-67, M-27
	Linseed	T-397 and locals
	Sesame	Madhavi, Gouri, Vinayak, Punjab Tall No.1, RT-1, Pratap Til

emergence herbicides are not commercially available specially for crops like chickpea and lentil and inter-cultivation is difficult due to hard soil, hand pulling of weeds is the only option which should be done at an early stage. A post-emergence herbicide (imazethapyr @ 50 g/ha) is quite effective against seasonal grassy weeds in crops like groundnut, urdbean and mungbean. It should be applied at 3-4 leaf stage. Similarly, quizalofop can be used to check ratooning of rice stubbles, which cause substantial moisture loss. Insect-pests and diseases should be promptly controlled. Seed dressing with fungicides like carbendazim should be done. Efforts should be made to choose disease-resistant varieties.

Soil testing services: Soil testing services should be made available to all farmers. Therefore, the numbers of soil testing laboratories should be increased to cater the needs of the farmers so that each farmer can get tested soil for better harvest.

Improvement of marketing system: The State Government must operate in an effective way in regulating the marketing of agricultural produce in general and oilseeds and pulses in particular. Through regulated market and through procurement drive, the farmers may get remunerative prices for their producers.

Improvement of post-harvest technology: The State government should take initiatives for development of rural godowns, storage facilities at market places, establishment of quality processing

mills and creating infrastructural facilities at strategic points.

Strengthening of agricultural extension and farmer linkage support services: An agricultural extension services has to be strengthened to educate the farmers. For that, frequent training and visit programmes of extension officials particularly the subject matter specialist can help the farmers in increasing production and income thereby improving their economic condition.

SUMMARY

Pulses and oilseeds have enormous potential in rice fallows despite a number of constraints being faced by the farmers. Rice followed by rapeseed, linseed and lentil gave higher seed yield and economic returns in the rice fallows of shallow lowland of North eastern region. Oilseeds and pulses can be grown successfully in rice fallows of shallow lowlands either through *utera*/zero tillage or with minimum tillage. The major thrust should be given on development of suitable varieties, dissemination of new technology, assured input supply and strong marketing support. The effort should be made location specific and need based to enhance production productivity of pulses and oilseeds.

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