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Role of cluster frontline demonstration in enhancement of Lathyrus production var Ratan under relay cropping system with paddy rice under rainfed condition in Central Brahmaputra valley zone

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Abstract
Lathyrus is considered to be an eye-catching option for sustainable food production because of its hardy nature and health profiting properties including limited water requirement and drought tolerance. The cluster frontline demonstration (CFLDs) was conducted to study the performance of Lathyrus in Sali rice (*Oryza sativa* L.) relay cropping situations during Rabi seasons of the year 2016-17 to 2018-19 covering an area of 30 ha comprising 6 to 9 villages in Nagaon district of Assam under Central Brahmaputra valley zone. Existing farmers' practices were treated as control for comparison with recommended practices. The results revealed that use of high yielding variety Bio L-212 (Ratan) along with 50% of recommended fertilizer application and seed treatment with biofertilizer (Azotobacter and PSB) @ 50g per kg of seeds recorded average highest yield 7.95 q ha^{-1} followed by 5.89 q ha^{-1} in farmer's practices. The similar trend was found in case of gross and net monetary returns, which was Rs.33973 /- and Rs.17441 /- ha^{-1} and for control Rs. 23479/- and Rs. 8432/- ha^{-1}, respectively. Benefit cost ratio for demonstration and control was 2.05 and 1.55, respectively. This shows that pulses production through adoption of recommended technologies which were followed in the CFLDs can be encouraging to our farmers.

Keywords: Lathyrus, biofertilizer, cluster frontline demomstration, lathyrus var ratan

Introduction
Lathyrus is one of the hardiest pulses suitable for relay cropping with paddy rice. It is often broad cast-seeded into standing rice crops one or two weeks before the rice harvest. This allows the crop to effectively exploit the residual moisture left after the rice harvest. It has potential among grain legumes for its tolerance to harsh conditions and its adaptability to unfavorable environments with little disease or insect problems. It requires no major input costs and is easy to cultivate under relay cropping system with paddy rice and also a cheap source of protein and fodder. In addition to nutritional benefits, lathyrus has an important role for improving soil fertility by adding around 67 kg ha^{-1} of nitrogen through biological nitrogen fixation in a single season, thereby conferring yield and protein benefits for the subsequent non-legume crop. Incorporation of leguminous forages in the soil has been reported to increase soil fertility in terms of OM and nitrogen.

It is a general practice for the farmers of this region particularly Central Brahmaputra Valley Zone to sow various winter pulse crops like lathyrus (*Lathyrus sativus* L.), chickpea (*Cicer arietinum* L.) and pea (*Pisum sativum*) in the standing rice crop field, just before the harvest to ensure germination using the residual moisture and to avoid tillage operations during pulse growing. Such a relay cropping operation (known by the terms utera or paira) is very popular for growing lathyrus. In recent past, a number of lathyrus varieties have been developed that are high yielder and contain very less ODAP ranging from 0.074 to 0.109 per cent. These varieties have once again opened the door of lathyrus cultivation in a big way, and it can contribute largely towards self sufficiency in pulse production. Almost 50 per cent of medium textured medium Sali rice (*Oryza sativa* L.) lands remain fallow during Rabi season in the state of Assam. These areas bear tremendous potential for lathyrus as a winter rice-relay crop under rainfed conditions. The growth and development of crop, its water use capability and yield under normal conditions are largely determined by weather during the growing season. Most pronounced effect of climate change is a drastic change in the rainfall pattern in the form of delayed monsoon, early withdrawal or inadequate precipitation with poor distribution leading to either drought or waterlogged conditions, particularly in rainfed ecosystem.

Therefore, timing of rice transplanting plays an important role in getting higher yield of rice and sowing of succeeding dry season crops mainly pulses. In Eastern India farmers cultivate rice during rainy season (June-Sept) and land leftover fallow after rice harvest in the post rainy season(Nov-May) due to lack of sufficient rainfall or irrigation amenities. However sufficient residue soil moisture are available in rice fallow areas in the post rainy season(Nov-March) which can be utilized for raising second crop. Implementation of suitable crop /varietal diversification is thus very much vital to achieve this objective. In this regard relay cropping also known as paira (utera) cropping with winter pulses in low land rice-fallows holds great promise, which would not only step up the pulse production but also help in protecting the environment from the risks of high input agriculture. As such the cluster frontline demonstration was undertaken on this unique system of growing Lathyrus var Ratan under residual moisture and fertility, paving the way towards increasing cropping intensity in mono-cropped areas.

Materials and methods

The study was conducted at farmer's field covering an area of 30 ha comprising a total of 6 to 9 villages in Nagaon district under central Brahmaputra zone (92.6838^0 E longitude and 26.3480^0 N latitude) during rabi 2016 to 2018 to find out the performance of lathyrus variety Ratan under relay methods of sowing on Lathyrus-Fallow-Sali rice pattern. Farmers were selected based on land situation for double cropping. The required inputs were provided to the farmers (Table 1), and regular visits to the demonstration fields by the KVK scientists ensured proper guidance to the farmers. Total 55 - 65 farmers were selected for the demonstration for each year. The farmers were trained to follow the full package of practices for Lathyrus cultivation as recommended by the Assam Agricultural University like Introduction of INM using chemical fertilizers and biofertilizers i.e 50% of RD of fertilizer application, seed treatment with biofertilizer (Azotobacter and PSB) @ 50 g kg^{-1} of seeds, etc. In case of local check, their traditional methods of sowing on Lathyrus-Fallow-Sali rice pattern were followed. In demonstrated plot Rice plant was harvested retaining straw height 15-20cm above the ground level for relay method of sowing. But in farmers's practice, rice plant was harvested at the ground level, local seed was used and without any seed treatment and fertilizer application. In the demonstrated plot Lathyrus variety Ratan with seed rate 60 kg ha^{-1} were broadcasted on Oct 18th to 11th of Nov in respective years in standing rice field 15 days after 50 per cent flowering of the rice crop when the soil was in moist condition. Urea was top dressed at 20 and 40 days after emergence of seedlings at the rate of 25 kg ha^{-1} in the demonstrated plots. Field days and group meetings were also organized to provide the opportunities for other farmers to witness the benefits of demonstrated technologies. The data output were collected from both demonstration plots as well as farmers practice plots and cost of cultivation, net income, and benefit cost ratio were also worked out (Samui *et al.,* 2000).

Table 1: Comparison between demonstration and existing practices

S. No	Operation	Farmer's practices	Demonstration
1	Use of seed	Local seed	Seed of improved varieties
2	Sowing time	5 to 7 days before harvesting of paddy	15 days after flowering of paddy crop
3	Seed Treatment	No seed treatment	Seed treatment with PSB and Rhizobium culture
4	Fertilizer application	Application of DAP	50% of recommended dose of fertilizers for each crop

Results and discussion

The experimental findings obtained from the present study have been discussed in following heads:

Plant height and no of branches plant per plant

The results revealed that there was significant difference between the traditional and relay method of sowing in relation to plant height. The average of 3 years data revealed that tallest plants (74.9 cm) were found in demonstration plot followed by 55.02 cm in farmers practice. The no of branches per plant was also higher 12 than the farmer's practice 7.3 nos. This may be occurred due to shading effect of rice on lathyrus plant as it was relayed in the standing rice crop before 15 days of harvest. But in traditional method there was less shading effect as it was sowed 5 to 7 days of harvest and the crop plant experienced less favourable environment for growth and hence, produced shorter plant. Again the Genetic variability, varietal difference may also attributed to the increse in plant height and no of branches plant per plant. Similar results were also reported by Lawrence and Gohain (2011) [2] in rice crops.

Length of pod and no of pods plant per plant

The average of 3 years data rice-lathyrus system, the demonstration plot were found to be more compared to farmers practices (Table 2). The highest length of pod 4.7cm and no of pods per plant 63.3 was found in demonstration plot followed by 3.6 cm and 38.3 no. of pods per plant in farmers practice. These may be due to use of high yielding varieties of lathyrus and adoption of improved packages and practices from sowing to harvesting.

No. of seeds per pod and test weight

Likewise the No. of seeds per pod and test weight (g) in demonstration plot was found to be more compared to farmers' practices. The maximum 5 no of seeds per pod and test weight (100 seed weight) 7.9 gm were recorded from the demonstration plot and lowest in the farmers field of 4 no of seeds per pod and test weight of 6.13 g. This reason may be owing to their genetic variability.

Table 2: Performance of Lathyrus crop at demonstration plot and farmer's field from 2016 to 2018

S. No	Parameter	Demonstration				Farmers Practice			
		2016	2017	2018	Average	2016	2017	2018	Average
1.	Plant height (at harvest) cm	84.1	66.3	74.4	74.9	54.1	52.32	58.7	55.02
2.	No of branches per plant	12.4	9.7	13.9	12.0	8.4	7.4	6.3	7.3
3	Length of pod (cm)	4.5	4.8	4.7	4.7	3.6	3.3	3.8	3.6
2.	No of pods/plant	67.5	54.8	67.5	63.3	38.2	36.6	40.2	38.3

3.	No of seeds/pod	4.6	5.6	5.3	5.1	4.5	3.8	3.4	4.0
4.	100 seed weight(g)	8.4	7.4	8.2	7.9	6.5	5.7	6.2	6.1

Grain Yield

Likewise the data revealed that under demonstration plots the performance of lathyrus yield was found to be higher than that under farmer's practices during the study period (2016 to 2018). The yield of lathyrus under demonstration was recorded as 7.95 q ha^{-1} as well as biological yield 34.19 q ha^{-1} followed by 5.89 q ha^{-1} and 24.16 q ha^{-1} biological yield under farmer's practices. Similarly the harvesting index percentage under demonstration recorded 23.25% followed by 24.43% under farmer's practice.The yield enhancement due to technological intervention was to the tune of 36.56 % over the farmer's practice. This improvement in yield might be due to the fact of high yielding variety, application of 50% RDF, seed treatment with Azotobacter and PSB provided significantly higher seed yield than partial application of fertilizer & no seed treatment in the existing farmers practice. Early sowing of lathyrus var Ratan at 15-20 days before harvesting of rice may result in effective utilization of more residual moisture from the rice field which gave a better performance in respect of yield. Duary *et al*. (14) were of the same opinion.

Economics and B.C ratio

The inputs and outputs prices of commodities prevailed during the year of demonstration were taken for calculating cost of cultivation, net returns and benefit cost ratio. The economic analyses were estimated and the results have been presented in (Table- 3). Economic analysis of the yield performance revealed that cluster front line demonstrations recorded higher gross returns (Rs. 33973/- ha^{-1}) and net return (Rs. 17441/- ha^{-1}) compared to existing farmer's practice of (Rs 23479/-) and (Rs 8422/-) respectively. Benefit cost ratio for demonstration and farmer's practice was 2.05 and 1.55 respectively suggesting the higher profitability and economic viability of the demonstration.

Table 3: Details of yield and Economics of the demonstration and Farmers Practices

Year	Grain Yield (q ha^{-1})		% increase	Biological Yield (q ha^{-1})		Harvest Index (%)	
	Farmer's practice	Demo		Farmer's practice	Demo	Farmer's practice	Demo
2016	6.31	7.74	22.66	25.87	33.28	24.39	23.26
2017	5.12	8.16	59.37	20.99	35.09	22.02	23.25
2018	6.25	7.96	27.36	25.63	34.23	26.88	23.25
Average	5.89	7.95	36.56	24.16	34.19	24.43	23.25

Year	Gross return (Rs ha^{-1})		Cost of cultivation (Rs ha^{-1})		Net Return (Rs ha^{-1})		B: C ratio (Rs ha^{-1})	
	Demonstration	Farmers practices	Demonstration	Farmers practices	Demonstration	Farmers practices	Demonstration	Farmers practices
2016	30573	22085	15600	14725	14973	7360	1.96	1.49
2017	36720	23040	17636	14480	19084	8560	2.08	1.59
2018	34626	25312	16359	15935	18267	9377	2.12	1.58
Average	33973	23479	16531	15046	17441	8432	2.05	1.55

Fig 1: Flowering and Pod formation stage

Conclusion

Thus, it may be concluded that the yield and returns in lathyrus crop increased substantially with the improved production technologies. The results the demonstrations convincingly brought out that the yield of lathyrus could be increased by 22.66 per cent to 59.37 per cent with the adoption of appropriate recommended production technologies, management practices, relay (*paira/utera*) cropping of lathyrus in rice-fallows may be able to increase overall pulse production in Central Brahmaputra Valley Zone. Lathyrus being a leguminous crop can also sustain productivity of the rice-based cropping systems which otherwise remain fallow therby the cropping intensity may be increased. So, there is need to disseminate the improved technologies among the farmers with effective extension methods like training and field demonstrations. The farmers should be encouraged to adopt the recommended production technologies for getting maximum returns from the considerable areas. This would sustainably increase the income as well as the livelihood of the farmers of this CBVZ.

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