STUDY ON YIELD ADVANTAGE UNDER LINE SOWING V/S BROADCASTING IN DIRECT SEEDED RICE IN CHHATTISGARH DURING 2014-15

Abstract:

Paddy is one of the most important cereal crops in the country. Chhattisgarh occupies a prominent place in paddy cultivation. The state's share to national paddy area and production is 8.61% and 6.30% respectively. Chhattisgarh is the paddy dominated mono-cropped state with more than 80 per cent kharif cultivable area under paddy. Direct seeded rice (DSR)- Line sowing & Broadcasting, transplanting, system of rice intensification (SRI) etc. are the main methods of sowing of paddy. About 70 per cent farmers go for direct seeding of paddy by broadcasting method in Chhattisgarh. The yield levels of the state are very low at 1766 kg/ha compared to national average of 2416 kg/ha, and much below the potential yield of 2910 kg/ha.

The two Centrally Schemes of National Food Security Mission (NFSM) and Bringing Green Revolution in Eastern India (BGREI) with critical development interventions are under implementation since 2007-08 and 2010-11 respectively in Chhattisgarh state. Both the schemes, through various development interventions, have the objectives to enhance the production and productivity of paddy in the state. The improved technologies also include the method of sowing of paddy. Line sowing/transplanting is being promoted under NFSM and BGREI which gives higher yield compared to broadcasting.

In this context, a study was undertaken to evaluate the yield and other advantages of line sowing over broadcasting method of planting. The study was undertaken in two districts of Chhattisgarh i.e. Raipur covered under NFSM and Balod where BGREI is operational. One block of each district was identified for the study. A total of 64 farmers were covered from both the districts, covering 32 farmers (16 beneficiary & 16 non-beneficiary) from each district. These respondents were from all socio-economic categories viz. General, OBC, SC & ST and further classified into marginal, small, medium and large farmers based on land holdings.

The study revealed that the average increase in paddy yield was about 20 % under the line sowing method over the broadcast method of paddy planting. The per hectare net return was more under line sowing as compared to the broadcasted method of sowing. The cost of production per quintal was less in line sowing method of paddy cultivation i.e, Rs 545.33/ qtl. & Rs.517.36/qtl over the broadcast method of paddy cultivation i.e. Rs. 619.30/qtl & 550.81 Rs/qtl in Raipur and Balod district respectively. Thus, the findings reveal higher Cost Benefit ratio under line sowing method i.e.1:2.71 &1:2.87 in comparison to broadcast method i.e. 1:1.24 &1:2.71 in Raipur and Balod district respectively.

The farmers opined that the yield advantage of about 5-10 quintals/ha and saving in seed at 20-45% under line sowing method over the broadcasted paddy is remarkable. Most of the farmers also opined the other advantages of the line sowing DSR method such as good germination of seeds, easy pest management, nutrient management, application of plant protection chemicals, inter-culture practices like weeding, hoeing etc. and a comparatively less infestation of pests and diseases in the crop due to proper crop geometry and management.

However, the broadcasting method of sowing of paddy under DSR is still prevalent and being adapted in Chhattisgarh owing to limited window of sowing time, large number of operational holdings with the SMF to afford seed drills; poor access to custom-hiring of seed drills, and deep traditional wisdom of farmers to grow paddy with "Biyasi" operations.

Study on yield advantages under line sowing v/s broadcasting in Direct Seeded Rice

1. Background

Paddy is one of the most important food grain crops in the country. The total area under paddy cultivation has been 44.14 million hectares in the country during 2013-14 which is 64 per cent of kharif food grain area. The total production of paddy is 106.64 million tonnes which constituted 83 per cent of total kharif food grain production (128.69 MT) in the country during 2013-14. The national productivity of paddy is 2416 kg/ha**.** In Chhattisgarh, the area under paddy cultivation has been 3.80 million during 2013-14 with the production at 6.72 million tonnes realised at levels 1766 kg/ha. The per cent share of the state in all India area and production of paddy has been 8.61% and 6.30%.

Scope of the study

Chhattisgarh is the paddy dominated mono cropped state where more than 80 per cent area is covered under paddy during kharif season. The area under irrigated paddy is only about 26 per cent. During the year under study an area of 37.56 lakh ha was under paddy cultivation. Of this, 26.88 lakh hectares was planted by the direct seeding method i.e. DSR which is about 72% and remaining 28% area was under transplanted paddy. Further under DSR methods, about 80% is sown by broadcasting of DSR whereas about 20% under line sowing. The yield level is low compared to the average yield of FLD and national average yield of paddy. Poor seed germination, weed infestation, infestation of pests and diseases and imbalance application of fertilizers etc. are the inhibiting factors. Looking to these facts, the present study aimed at to compare the advantages of line sowing with that of the traditional broadcasting method. National Food Security Mission (NFSM) and Bringing Green Revolution in Eastern India (BGREI) are under implemented since 2007-08 and 2010-11 in Chhattisgarh state. Under both the schemes rice is covered with main objective to enhance the production and productivity by use of improved technologies. The broadcasting method of sowing paddy is still prevalent and being adapted in Chhattisgarh. The line sowing/transplanting is being promoted under NFSM and BGREI which gives higher yield compared to broadcasting. In this context, a study was undertaken to evaluate the yield and other advantages of line sowing over broadcasting.

2. Objectives

Followings were the objectives of the study:

i. Yield advantage of line sowing v/s Broadcasting in direct seeded rice,
ii. Weed management under line sown and broadcast direct seeded rice,
iii. Fertilizer management under line seeded and broadcasted rice and
iv. Varietal preferences under line seeded rice.

3. Methodology:

3.1 Selection of Districts

District Raipur under NFSM and district Balod under BGREI scheme, were selected for the study in consultation with the state department of agriculture. The primary and secondary data related to socio-economic indicators like irrigation, infrastructure, implements, improved technologies including method of paddy sowing (viz. line sowing vis-a-vis broadcasting etc.) were collected to assess the yield advantage and other objectives of the study.

3.2 Selection of Blocks

Raipur district has four blocks namely Dharsiwa, Tilda, Abahnpur and Arang. On the basis of higher

5. Results and Discussion

Based on the collected data, discussions with farmers, staff and others, the main results summarised below:

5.1 Yield advantage of Line sowing v/s. Broadcasting

Raipur-The findings reveal that the improved technologies were adapted in the demonstrated plot as compared to the plots where farmers have used the traditional sowing method i.e. broadcasting. The increase in productivity of the crop may be attributed to the use of improved technology on demonstrated plots as compared to the check plots with the non-beneficiaries farmers. The details of adoption of technologies are given in **Annexure II**. Yield levels of paddy realised under both the methods of planting i.e. line sowing method demonstration vis-a-vis broadcasting method is given in **Table 5.** Method of sowing, application of quality seeds, weed management, recommended doses of integrated nutrients and its management and micro nutrients in the fields of demonstrations organized under the NFSM & BGREI crop development scheme, the average yield of paddy was 52.37 quintal/ha compared to the check plot where it is only 41.75 quintal/ha which is 20.27 per cent less than the yield of test plot (line sowing method). It establishes that the technology adapted at the demonstration plots is significantly better than the traditional method of paddy cultivation by non-beneficiaries group.

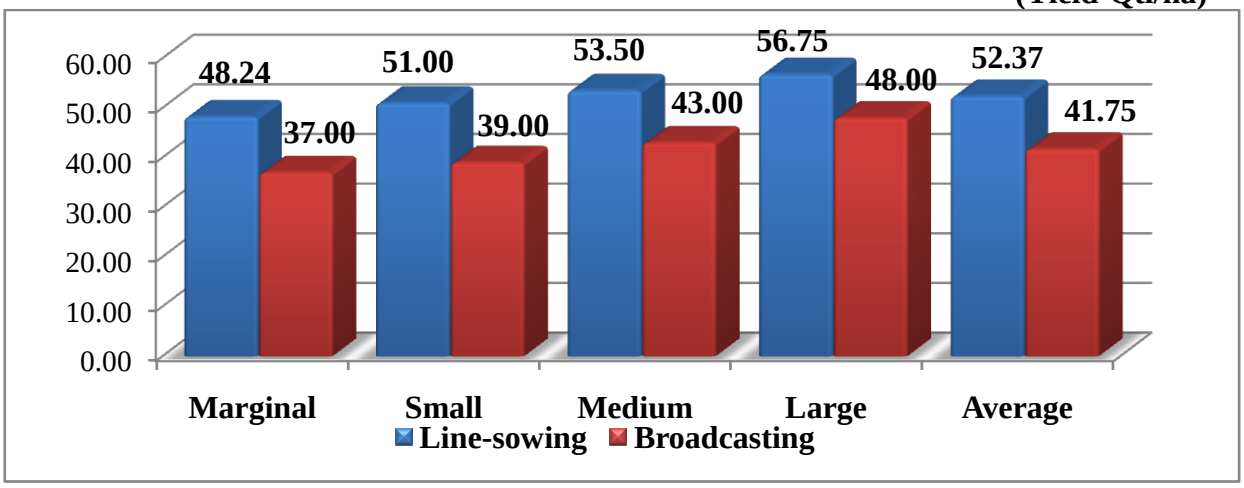
Table 5: Yield advantage of paddy at the farmer's field in Raipur district

(Yield-Qtl/ha)

S. No.	Particulars	Marginal	Small	Medium	Large	Average
1.	Line-sowing	48.24	51.00	53.50	56.75	**52.37**
2.	Broadcasting	37.00	39.00	43.00	48.00	**41.75**
Yield gap across the farms		11.24	12.00	10.50	08.75	**10.62**
Percent yield gap		**23.30**	**23.52**	**19.62**	**15.41**	**20.27**

Figure 1: Paddy Yield under line sowing and broadcasting method at sampled farms district Raipur

(Yield-Qtl/ha)



Balod- Yield of paddy under both the methods of sowing under DRS i.e. line sowing vis-a-vis broadcasting check plot is given in **Table 6**. Due to application of quality of seed, fertilizer and micro nutrients in the field of demonstration, the yield was 55 quintal/ha compared to using

traditional practices check plot (broadcasted method) with only 44 quintal/ha i.e. 20 per cent less than the improved method of line sowing plots. It shows that all the recommended interventions and technologies adopted at the demonstration plots and also these have paid dividends over the traditional method of paddy cultivation. The details of adoption of technologies are given in **Annexure V**. It may be suggested that farmers of the surrounding villages should visit the demonstration in order to increase the horizontal diffusion of such technology.

Table 6: Yield advantage of paddy at the farmer's field in Balod district

(Yield-Qtl/ha)

S. No.	Particulars	Marginal (Gen, OBC, SC, ST)	Small (Gen, OBC, SC, ST)	Medium (Gen, OBC, SC, ST)	Large (Gen, OBC, SC, ST)	Average (Gen, OBC, SC, ST)
1.	Line-sowing	50.61	53.75	56.00	58.00	**55.00**
2.	Broadcasting	39.00	41.00	46.00	49.00	**44.00**
Yield gap across the farms		11.61	12.75	10.00	09.00	**11.00**
% yield gap to line sowing		**22.94**	**23.72**	**17.85**	**15.51**	**20.00**

Figure 2: Paddy Yield under line sowing and broadcasting method at sampled farms district Balod

(Yield-Qtl/ha)

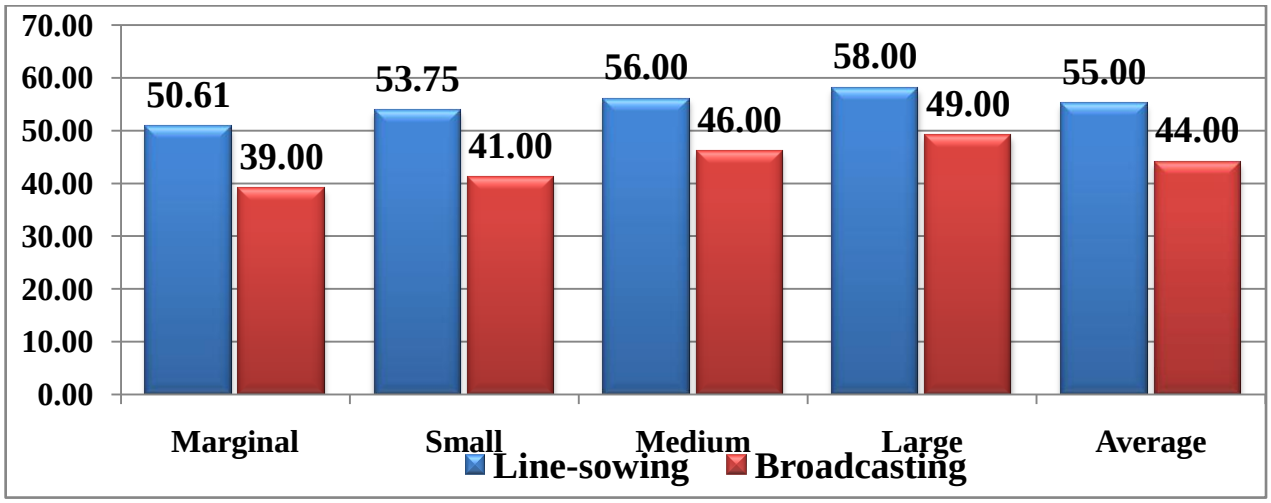


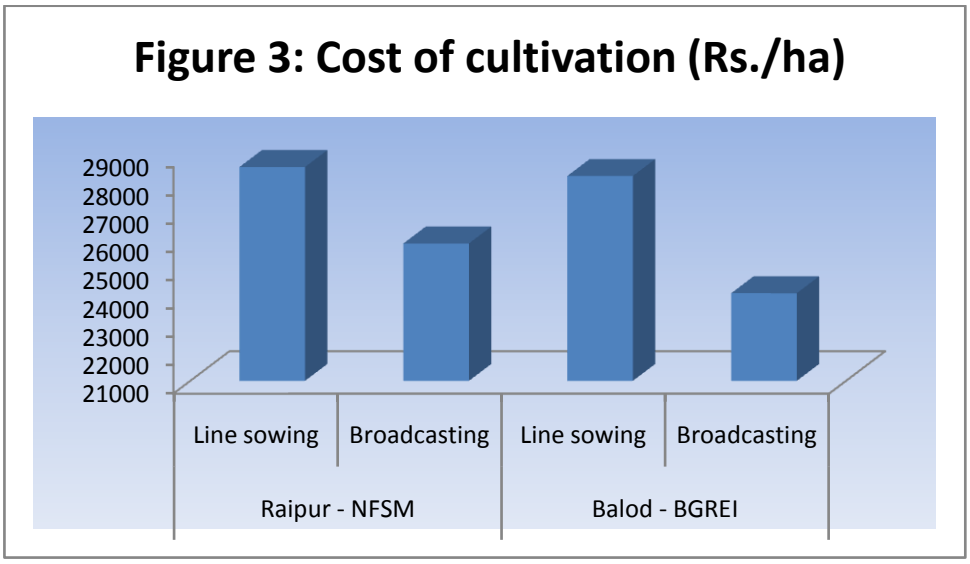
Table 7: Economics of production under line sowing and broadcasting method

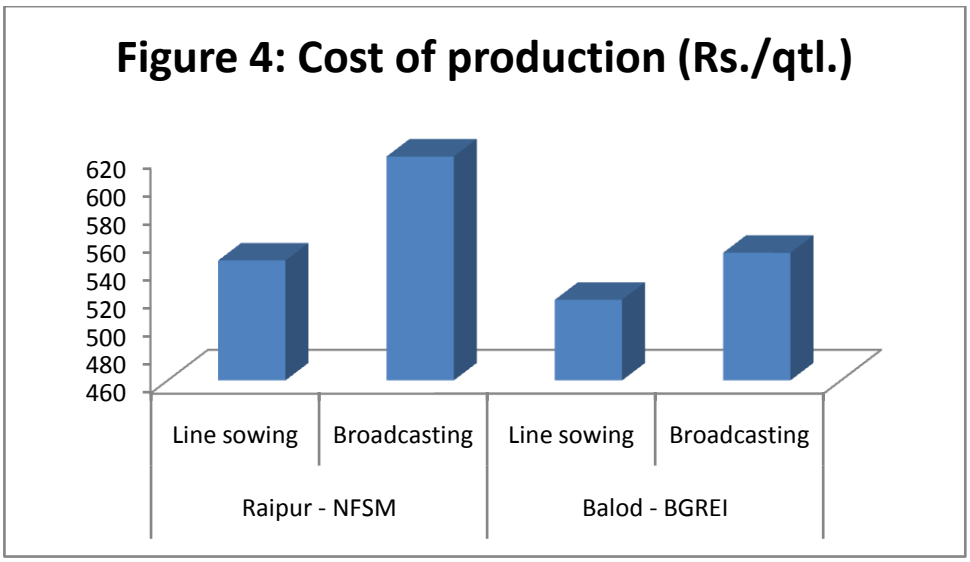
Particulars	Raipur		Balod	
	Line sowing	Broadcasting	Line sowing	Broadcasting
Cost of cultivation (Rs./ha)	28558.97	25856.17	28242.57	24097.86
Production (Qtl./ha)	52.37	41.75	55	44
Cost of production (Rs./qtl.)	545.33	619.30	517.36	550.81
Gross return (Rs./ha)	77427.20	62605.76	81097.96	65446.25
Net return (Rs./ha)	48868.23	36749.59	52855.39	41348.99
CB ratio	1:2.71	1:2.42	1:2.87	1:2.71

It is concluded that the average increase in paddy yield was about 20 % under the line sowing method over the broadcast method of paddy planting in both the district. The per hectare gross return and net return has also been realised more under line sowing as compared to the broadcasted method of sowing in both the districts. The per quintal cost of production has also been recorded less in line

sowing method of paddy cultivation i.e, Rs 545.33/ qtl. & Rs.517.36/qtl. over the traditionally broadcast method of paddy cultivation which was Rs. 619.30/qtl & Rs.550.81 /qtl in Raipur and Balod district respectively.

Thus, the finding reveal higher cost benefit ratio under line sowing method i.e.1:2.71 &1:2.87 in comparison to broadcast method i.e. 1:1.24 &1:2.71 in Raipur and Balod district respectively.





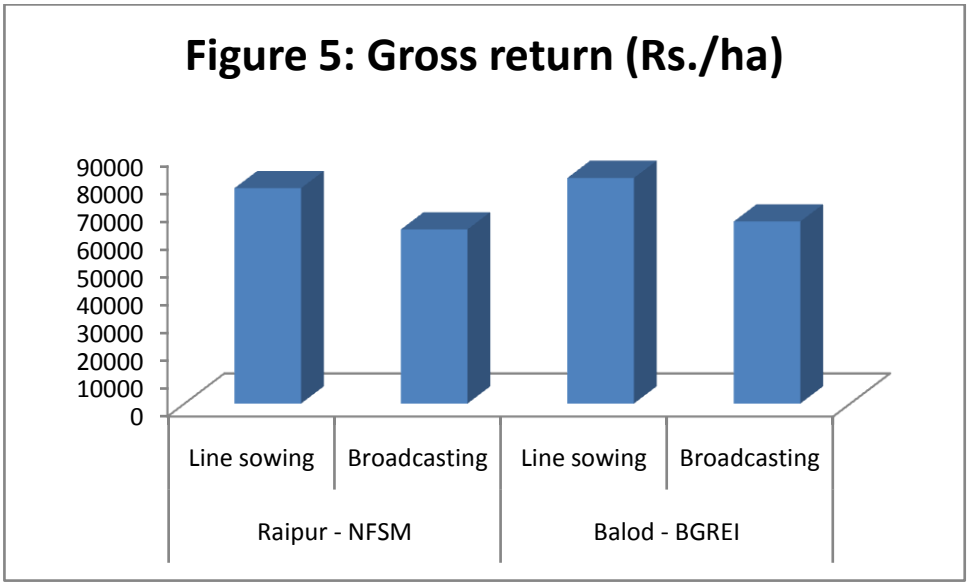


Figure 5: Gross return (Rs./ha)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Line sowing
Broadcasting
Line sowing
Broadcasting
Raipur - NFSM
Balod - BGREI

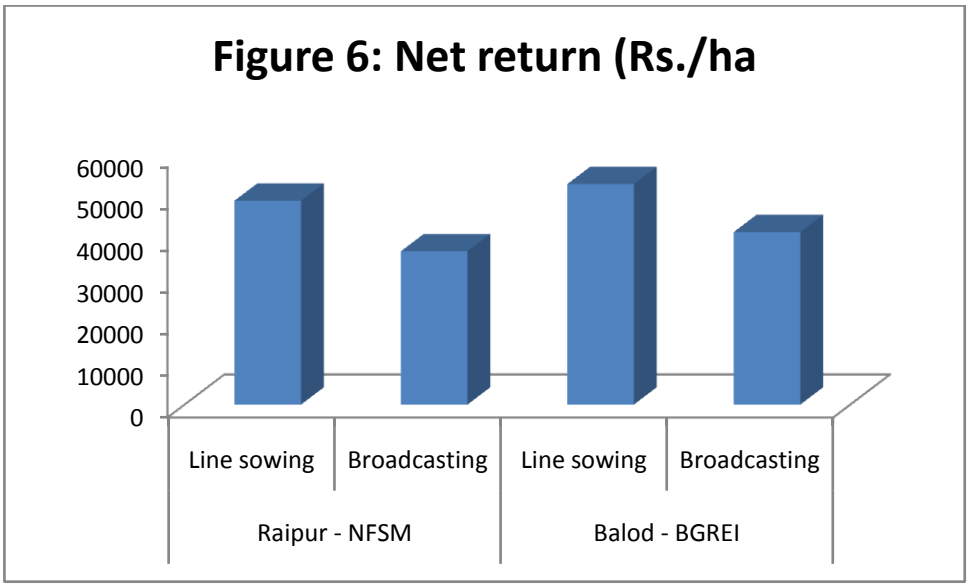


Figure 6: Net return (Rs./ha
60000
50000
40000
30000
20000
10000
0
Line sowing
Broadcasting
Line sowing
Broadcasting
Raipur - NFSM
Balod - BGREI

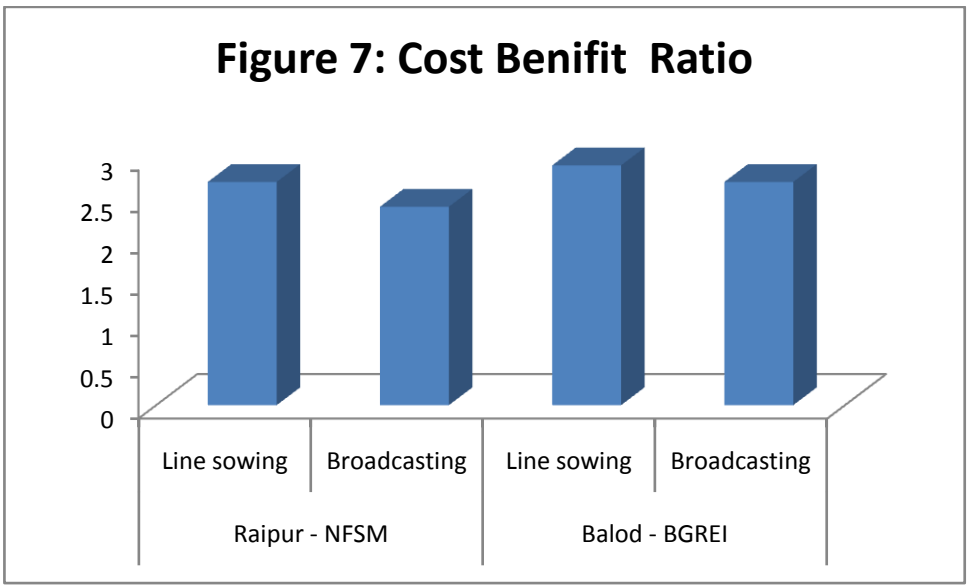


Figure 7: Cost Benifit Ratio
3
2.5
2
1.5
1
0.5
0
Line sowing
Broadcasting
Line sowing
Broadcasting
Raipur - NFSM
Balod - BGREI

5.2 Weed management under line sowing v/s broadcasting method

Raipur (NFSM) - The occurrence of major weeds at the farmer's field is given in **Annexure III**. Weeds are major crop competitor to suppress the growth of main crop. Annuals, perennials, broad leaves and grasses were observed in the paddy field. Sanwa, motha and dub grass are the common and major weeds reported by almost all the farmers. The average number of weeds intensity is observed as 6 which varies from 5 at medium farms to 6.50 at small farms under line sown paddy. Similarly, the average weed intensity was 6.13 numbers which varies from 4.60 at small farms to 5.20 at marginal farms in the broadcasted paddy fields. The farmers opined easy inter-culture practices like weeding, hoeing etc. in the line sowing DSR method.

The cost of weed management is found less under line sowing about 6% over broadcasting method. It is also observed that the less labour requirement about 15% in line sowing over the traditional broadcasting method. The details are given in **Table 8.**

Table 8: Economics of weed management in paddy cultivation in Raipur district

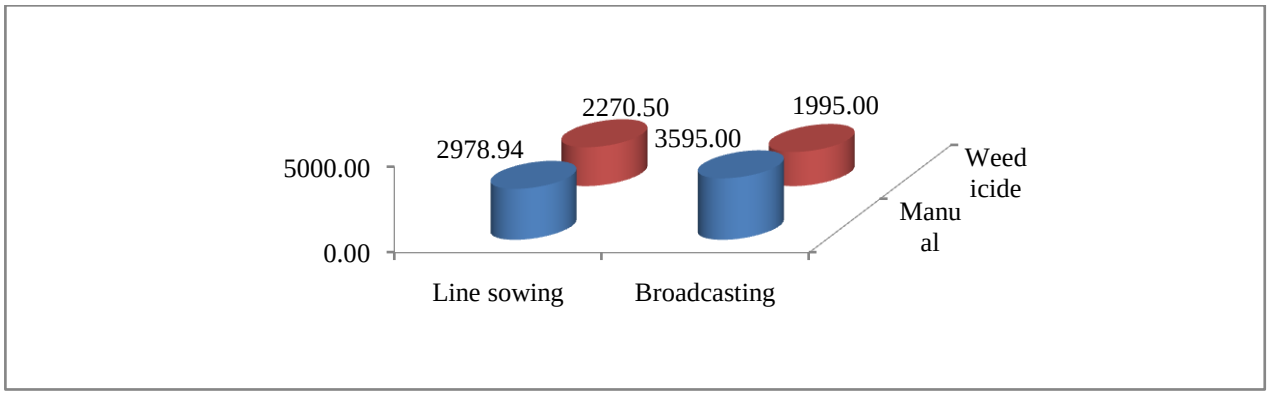
(Cost Rs/ha)

SN	Particulars	Line sowing					Broadcasting				
		Marginal	Small	Medium	Large	Average	Marginal	Small	Medium	Large	Average
1	Manual Weeding	2425.74	2910.00	3405.00	3175.00	**2978.94 (56.75)**	3525.00	3917.50	3812.50	3125.00	**3595.00 (64.31)**
2	Weedicide	1408.00	2308.00	2708.00	2658.00	**2270.50 (43.25)**	1375.00	1985.00	2010.00	2610.00	**1995.00 (35.69)**
Total/Average		**3833.74**	**5218.00**	**6113.00**	**5833.00**	**5249.44**	**4900.00**	**5902.50**	**5822.50**	**5735.00**	**5590.00**

Note: Figures in the parenthesis indicate percentages to the total

Figure 8: Economics of weed management in paddy cultivation in Raipur district

(Cost Rs/ha)



Balod (BGREI)- The major weeds occurrence at the farmer's field of Balod district is given in **Annexure VI.** The weeds of various nature i.e. annuals, perennials, broad leaves and grasses were observed in the paddy field. Sanwa, motha, dub grass and gajar ghas were the common and major competition to both the paddy fields. The average weeds intensity was observed at 4.31 numbers which varied from 3.25 at medium farms to 5 at small and marginal farms in the paddy line sowing field. Similarly, the same figure was observed as 4.94 numbers which varies from 4.25 at small farms to 5.75 at marginal farms in the broadcasting paddy field in Balod district.

The cost of weed management is found less under line sowing about 3% over broadcasting method. It is also observed that the less labour requirement about 43% in line sowing over the traditional broadcasting method. The details are given in **Table no 9.**

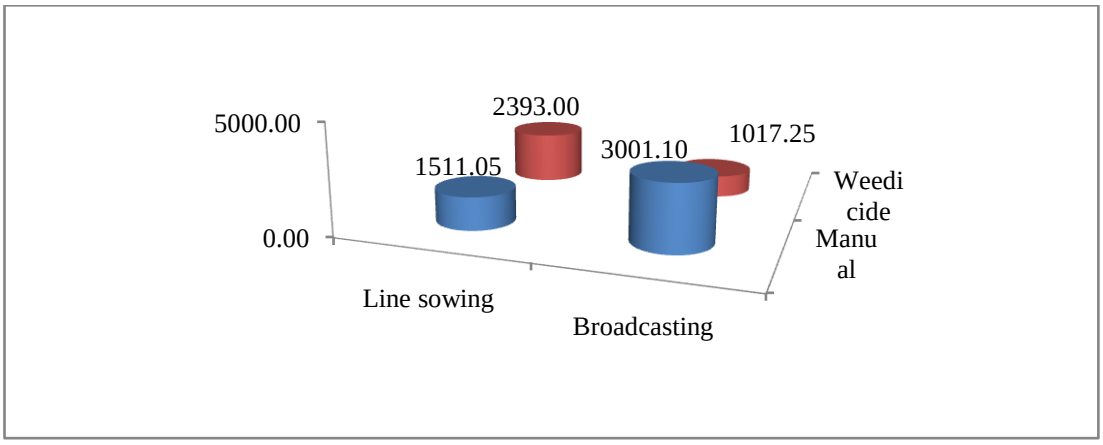
Table 9: Economics of weed management in paddy cultivation in Balod district

(Cost Rs/ha)

S. No.	Particulars	Line sowing					Broadcasting				
		Marginal	Small	Medium	Large	Average	Marginal	Small	Medium	Large	Average
1.	**Manual Weeding**	2189.19	1755.00	2250.00	250.00	**1511.05 (38.70)**	2926.93	3187.50	3590.00	2300.00	**3001.10 (74.68)**
2.	**Chemical control**	1768.00	2368.00	2343.00	3093.00	**2393.00 (61.30)**	1450.00	868.00	800.00	950.00	**1017.25 (25.32)**
Total/Average		**3957.19**	**4323.00**	**4793.00**	**3343.00**	**3904.05**	**4376.93**	**4055.50**	**4390.00**	**3050.00**	**4018.35**

Figure 9: Economics of weed management in paddy cultivation in Balod district

(Cost Rs/ha)



It is concluded that the hectare less cost towards weed management and labour requirement has exhibited the superiority and advantage of line sowing method of paddy cultivation over the traditional and prevalent broadcast method in both the districts viz Raipur (NFSM) and Balod (BGREI). The farmers of both the districts were of the considered opinion that the inter-culture operations like weeding, hoeing and use of weedecide etc. can easily and effectively be performed under the improved method of line sowing of the Direct Seeded Rice (DSR).

5.3 Fertilizer management under line sowing v/s broadcasting method.

Raipur (NFSM)-The comparative fertilizer consumption pattern under line sowing and broadcasting method at sampled farms is presented in **Table 10.** The table reveals that the DAP, Urea, SSP and MOP are four major fertilizers which were applied by the farmers as 128.96 kg, 196.43 kg, 19.48 kg and 48.05 kg per hectare respectively in the demonstrated paddy cultivation in line sowing which is equivalent to 113.44 kg N, 62.11 kg P and 28.83 kg K. Similarly, the application of these fertilizers in the field of broadcasting method of paddy is observed as 137.76 kg D.A.P. 190.82 kg Urea, 27.21 kg SSP and 53.74 kg MoP per hectare to the paddy crop which is equivalent to 112.57 kg N, 67.72 kg P and 32.24 kg K.

Table 10: Fertilizer application in paddy cultivation at the farmer's field in district Raipur

S. N.	Name of fertilizer	Line sowing				Broadcasting			
		Fertilizer (in kg) Per ha	Nutrients (in kg)			Fertilizer (in kg) Per ha	Nutrients (in kg)		
			N_2	P_2O_5	K_2O		N_2	P_2O_5	K_2O
1.	DAP	128.25	23.08	58.99	-	137.76	24.80	63.57	-
2.	UREA	196.43	90.36	-	-	190.82	87.78	-	-
3.	SSP	19.48	-	3.12	-	27.21	-	4.35	-
4.	MOP	48.05	-	-	28.83	53.74	-	-	32.24
5.	Zinc	25.00	-	-	-	-	-	-	-
Total			**113.44**	**62.11**	**28.83**		**112.57**	**67.72**	**32.24**

Balod (BGREI)- The comparative fertilizer consumption pattern in line sowing and broadcasting method at sampled farms is presented in **Table 11**. The DAP, Urea, SSP and MOP have been used by the farmers as 131.44 kg, 194.81 kg, 35.71 kg and 42.86 kg per hectare respectively, which is equivalent to 113.28 kg N, 66.20 kg P and 25.71 kg K. under line sowing. Similarly, the application of these fertilizers under broadcasting method of paddy was observed at 129.21 kg DAP, 195.13 kg Urea, 28.09 kg SSP and 38.95 kg MoP per hectare respectively, which is equivalent to 113.02 kg N, 63.93 kg P and 23.37 kg K.

Table 11: Fertilizer consumption in paddy cultivation at the farmer's field in district Balod

S N	Fertilizer	Line sowing				Broadcasting			
		Fertilizer (in Kg.) Per ha.	Nutrients (in Kg.)			Fertilizer (in Kg.) Per ha.	Nutrients (in Kg.)		
			N_2	P_2O_5	K_2O		N_2	P_2O_5	K_2O
1.	DAP	131.44	23.67	60.49	-	129.21	23.26	59.44	-
2.	UREA	194.81	89.61	-	-	195.13	89.76	-	-
3.	SSP	35.71	-	5.71	-	28.09	-	4.49	-
4.	MOP	42.86	-	-	25.71	38.95	-	-	23.37
5.	Zinc	25.00	-	-	-	-	-	-	-
Total			**113.28**	**66.20**	**25.71**		**113.02**	**63.93**	**23.37**

It is concluded that no remarkable difference in application of fertilizer and their doses but higher yield obtained from line sowing method which is attributed to method of planting and use of micronutrients i.e. zinc sulphate.

5.4 Varietal preferences under line sowing direct seeded rice

The detailed varietal preferences from the beneficiary farmers from both the districts under NFSM (Raipur) and BGREI (Balod) were obtained by discussion. Farmers desired that the varieties should be according to specific area of the districts. According to the opinion expressed by farmers during consultation, the varietal preferences are as under:

i. Variety provided should be of short duration so that next crop can easily be sown in time.
ii. Variety should respond to the particular soil condition of the locality of the area.
iii. Variety should respond to the nutrient availability/deficiency of the area.
iv. Variety should be tolerant to insect pest & diseases.
v. Variety should be tolerant to water stress conditions, and
vi. Variety should be tolerant to the lodging.

6. Farmers Perception about the technology/interventions under NFSM & BGREI

Raipur (NFSM)-The perception of beneficiaries for line sowing technology/intervention of paddy cultivation under NFSM project is given at **Annexure IV**. About 62.50 per cent farmers expressed growing of direct seeded rice in rows for last 1-2 years while remaining 37.50 per cent were already using this technique of sowing for the last 2-4 years. About 75 per cent farmers informed that under line sowing method 40-45 per cent less seed is required while 25 per cent farmers informed a seed saving of 20-40 per cent over the traditional broadcast method. About the yield advantage in line sowing method, farmers recorded over yield advantage of about 5-10 quintals/ha. About 62 to 87 per cent farmers informed other advantages of the line sowing method such as good germination, easy and effective application of plant protection chemicals in the crop and less infestation of pests and diseases. All beneficiary respondents acknowledged that line sowing technology was most favourable with regards to weed control in future. About 90 per cent of non-beneficiary farmers who practiced traditional broadcasting method of sowing, however, satisfied with the seed germination and recorded up to 90% germination ability.

Balod (BGREI)- The perception of beneficiaries about the line sowing technology/intervention of paddy cultivation under BGREI project is presented in **Annexure VII**. This analysis is on the basis of sixteen beneficiary farmers who are benefited under the project. About 50 per cent farmers informed of planting paddy in rows from last 1-2 years, the remaining 50 per cent were using seed drills/ line sowing for the last 2-4 years. 100 per cent farmers were of the view that 40-45 per cent less seed is required under line sowing over that of traditional method of sowing. The farmers also harvested about 5-10 quintal more yield. Other benefit of this improved planting technique are good germination of seeds, easy application of plant protection chemicals in the crop and less infestation of pests and diseases.

6.1: Perception of non-beneficiaries about the performance of paddy germination under broadcasting method

Raipur-Performance of seeds germination under broadcasting method in NFSM district Raipur is given in **Table 10**. It is evident that 90 per cent farmers are satisfied with the germination ability aspect. More than 80 per cent farmers perceived the germination in the range of 75 - 90 per cent. The germination percentage in the range of 60-75% is perceived by the 18 per cent farmers in this method. Due to scattered sowing of seed may be the reason behind lack of very good germination (<90%) which clearly indicate for low yield comparatively to the line sowing method at farmers field.

Table 10: Performance of paddy seeds germination in broadcasting method in Raipur district

S. No.	Particulars	Marginal	Small	Medium	Large	Total
A.	**Seed germination performance (N=16)**					
1.	Very good	-	-	-	-	-
2.	Good	03	04	04	04	**15 (93.75)**
3.	Poor	01	-	-	-	**01 (06.25)**
	Total	**04**	**04**	**04**	**04**	**16 (100.0)**
B.	**Seed germination percentages (N=16)**					
1.	<50%	-	-	-	-	-
2.	50-60%	-	-	-	-	-
3.	60-75%	02	01	-	-	**03 (18.75)**
4.	75-90%	02	03	04	04	**13 (81.25)**
5.	>90%	-	-	-	-	-
	Total	**04**	**04**	**04**	**04**	**16 (100.0)**

Note: Figures in the parenthesis indicate percentages to the total.

Balod- Performance of paddy seeds germination under broadcasting method is given in the **Table 11**. It indicates that 81 per cent farmers were satisfied with the performance of seed germination, while poor seed germination was perceived by 18 per cent farmers. About percentages germination of 75 per cent farmers perceived the seed germination under the range of 75 - 90 per cent. The germination percentage in the range of 60-75% is perceived by 25.00 per cent farmers.

Table 11: Performance of paddy seeds germination in broadcasting method

S. No.	Particulars	Marginal	Small	Medium	Large	Total
A. Seed germination performance						
1.	Very good	-	-	-	-	-
2	Good	03	02	04	04	**13 (81.25)**
3	Poor	01	02	-	-	**03 (18.75)**
Total		**04**	**04**	**04**	**04**	**16 (100.0)**
B. Seed germination percentages						
1	<50%	-	-	-	-	-
2.	50-60%	-	-	-	-	-
3.	60-75%	01	02	01	-	**04 (25.00)**
4.	75-90%	03	02	03	04	**12 (75.00)**
5.	>90%	-	-	-	-	-
Total		**04**	**04**	**04**	**04**	**16 (100.0)**

Note: Figures in the parenthesis indicate percentages to the total number of farmers.

7. Conclusion and Recommendations

Based on findings, feedback and suggestions received from the paddy growers of the study districts of Chhattisgarh regarding technological interventions of method of sowings viz DSR-Line sowing v/s DSR-Broadcasting under the on-going Centrally Sponsored Crop Development Schemes of NFSM-Rice and BGREI and adoption of technology at farmers' field, the major conclusion and recommendations are summarized below:

7.1 Conclusion

- The survey and discussions have revealed that the paddy growers in Chhattisgarh are traditionally accustomed to DSR-broadcasted method of paddy sowings to opt "Biyasi" (ploughing paddy crop field after 30-45 DAS sowing in standing water). Traditionally the state's farmers find the broadcast as the quickest and cheapest method of sowings where no skilled labourers are required. The farmer perceives that the paddy sowings by this method can be followed in moist condition also and the "Biyasi" is useful for better secondary and tertiary root-system development, to realise higher yields.
- Further, disadvantages to the traditional system of sowing were concluded as high per hectare seed requirement, staggered and un-uniform heavy crop competition within crop plant and amongst weeds owing to non-maintenance of plant to plant and row to row spacing fallowed by labour intensive weed management.
- Only the farmers with large operational holdings and endowed with rich- resources like machineries, labours, irrigation facilities etc, practice the transplanting method of paddy cultivation in a limited area.

- The line sowing method has been found economical over that of broadcasting owing to less per hectare seed requirement and cost of weed management.
- Weed has been found as a major yield limiting factor in the paddy. The weed management can be done properly under line sowing as compared to broadcasting method. Integrated Weed Management (IWM), i.e. combination of mechanical, chemical & manual weeding operation could be possible.
- The cost of weed management under line sowing was also found less at 3- 6% with the reduced labour requirement 15-45% over the traditional broadcast method.
- The increase in productivity could be attributed to increased Nutrient use Efficiency (NuE) under Line sowing method owing to proper placement of seeds and fertilizers and reduced competition amongst weeds and rice plants.
- The study also revealed the limiting factors in adoption of the improved method of line sowing method as:

  narrow sowing window, unavailability of sowing implements, non availability of seed drills, absence of custom-hiring centres, > 80% operational holdings with SMF categories to afford mechanization, farmers traditional preference and deep-rooted faith of paddy cultivation through broadcast involving "Biyasi".

7.2 Recommendations

- Awareness campaign for popularisation of Line sowing need to be aggressively pursued. To make the farmers believe in the improved method of line sowing, the cluster demonstrations should be organised widely following all the recommended quality parameters. A good number of nearby farmers/villages should be assembled for field days.
- The sowing implements like seed-cum-fertilizer drill, both tractor and bullock drawn may be made available to SMF at affordable prices under the Resource Conservations Tools (RCT) interventions as also through Custom Hiring Centres.
- The season long training need to be mandatorily organised and frequency of training programs in each season should be increased in order to improve the learning about the aspects like soil health, INM, IPM and weed management.
- Invariably, the Control Demonstration plot should also be maintained for comparison and building the farmers' confidence.
- Improved and labour saving implements should be made available at affordable price in order to solve the scarcity of labour, reduce the cost of cultivation and time taken in the operations.
- It is suggested that the yield obtained and technology used at demonstration plots may extended widely to the non-beneficiary farmers so that more number of farmers switch from broadcasted cultivation to improved line sowing technology.
- The small bullock drawn/manual implements at affordable price should be promoted to complete the time bound operations like sowing, weeding and harvesting by small farmers. It will not only reduce the time and cost but will also improve the productivity of crop.

REFERENCES

Anonymus, (2008). Direct Seeding of Rice and Weed Management in the Irrigated Rice-Wheat Cropping System of the Indo-Gangetic Plains, book published by International Rice Research Institute, Los Baños, Philippines.

Anonymus, (2011). Feeding the World, Part-3, Food & Agriculture Organisation Statistics Division.

Anonymus 2 (2013) Directorate of Economics and Statistics, Department of Agriculture and Cooperation, New Delhi (2013).

Anonymus 3 (2013-14) Directorate of Agriculture, Government of Chhattisgarh, Raipur, Chhattisgarh (2013-14)

Karam Singh (2014). Challenges of Food Security in India: Role of Food Policy and Technology, Indian Journal of Agri. Economics Vol.69 (1) Jan.-March (2014).

Mulesh Uikey (2011) Economic analysis of paddy production in irrigated vis-à-vis rainfed area of Chhattisgarh, thesis submitted in Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh.

Annexure I

LAND USE STATISTICS OF THE STATE AND SELECTED DISTRICTS

S. N.	Items	Raipur	Balod	Chhattisgarh
i) **Land use statistics**				
1.	Geographical Area (Lakh ha)	2.89	3.52	137.70
2.	Net Sown Area (Lakh ha)	1.68	1.83	47.74
3.	Net Sown Area (Kharif) (Lakh ha)	1.62	1.80	47.68
4.	Total Rainfall (mm) January to November	1117.30	1266.50	1327.00
ii) **Rainfall during Kharif season (mm)**				
	May	00.0	00.0	0.00
	June	00.0	73.08	276.80
	July	102.70	485.54	404.60
	August	638.80	294.78	353.00
	September	868.70	303.80	150.60
	October	1117.30	109.30	178.60
	November	00.0	0.00	0.00
Average Rainfall of the district (mm)		**1117.30**	**1266.50**	**1363.60**
iii)**Area Coverage Kharif (000 ha)**				
	i. Rice	158.60	168.80	3687.58
	ii. Maize	0.46	0.71	225.85
	iii. Pulses	0.87	5.20	355.99
	iv. Oilseeds	0.46	0.87	322.01
iv) **Area of Rice under different ecologies (000 ha)**				
	i. Upland direct seeded Rice	65.046	14.24	0.00
	ii. Shallow Water Rice (0-25 cm)	39.400	28.55	0.00
	iii. Medium deep water Rice (25-50cm)	54.163	28.41	2454.50
	iv. Total area under Rainfed Paddy	36.579	71.21	0.00
	Vii Area under irrigated paddy	126.544	97.57	1347.60
v) Varieties under cultivation				
	i.Upland direct seeded Rice	Swarna, IR-64, MTU-1010, BPT-5207	MTU-1010, IR-64, MTU-1001, Swarna, BPT-5204, Mahamaya, HMT	Swarna, IR-64, MTU-1010, BPT-5207, Karma Mahsuri
ii.	Shallow water Rice (0-25 cm)	-	-	-
iii.	Midium deep water (25-25 cm)	-	-	-
iv	Drought affected paddy	-	-	-
vii	Irrigated paddy (Kharif)	IR-36, IR-64, Mahamaya, MTU-1010		IR-36, IR-64, Mahamaya, MTU-1010, KRH-2
vii.	Irrigated paddy (Rabi)	Swarna, Mahamaya, IR-36		Swarna, Mahamaya, IR-36

Source: State Department of Agriculture, Raipur/Balod

Annexure II

Technology adoption at the sampled farms of Raipur district

S. N.	Technological aspects in Agriculture	Total No. Farmers			
		Test plot (N=16) (Line sowing)		Check plot (N=16) (Broadcasting Method)	
		Yes	No	Yes	No
1.	**Summer ploughing:**				
	(a) 2-3	12 (75)	04 (25)	14 (87.50)	02 (12.50)
	(b) 3-4	04 (25)	12 (75)	02 (12.50)	14 (87.50)
2.	**Ploughing during sowing main field**				
	a. Cultivator	16 (100)	-	16 (100)	-
	b. Rotavator	-	-	-	-
3.	**Rice Variety:**				
	a. Sah-bhagi	16 (100)	-	-	-
	b. Swarna	-	-	16 (100)	-
4.	**Seed quantity applied (In Kg)**				
	a. 60 Kg/ha	16 (100)	-	-	-
	b. 120-150 Kg/ha	-	-	16 (100)	-
5.	**Seed treatment**	02 (12.50)	14 (87.50)	-	16 (100)
6.	**Weed management**				
	a. Manual	16 (100)	-	12 (75)	04 (12.50)
	b. Weedicide	16 (100)	-	13 (81.25)	03 (18.75)
7.	**Use of hand hoe for weeding in rows**	-	16 (100)	-	16 (100)
8.	**Major disease occurrence**				
	a. Sheath blight	06 (37.50)	10 (62.50)	10 (62.50)	06 (37.50)
	b. Blast	07 (43.75)	09 (56.25)	11 (68.75)	05 (31.25)
	Use of fungicide in disease control, If yes, give names				
	a. Propiconozole	06 (37.50)	10 (62.50)	05 (31.25)	11 (68.75)
	b. Current	-	-	04 (25)	12 (75)
	c. Suraksha	06 (37.50)	10 (62.50)	05 (31.25)	11 (68.75)
9.	**Name of major insects and other insects etc**				
	a. Stem borer	07 (43.75)	09 (56.25)	10 (62.50)	06 (37.50)
	b. Aphids	06 (37.50)	10 (62.50)	08 (50)	08 (50)
	c. Brown leaf hopper	03 (18.75)	13 (81.25)	02 (12.50)	14 (87.50)
10.	**Use of insecticides in insect/pest control, If yes, give names:**				
	a. Curt-off	03 (18.75)	13 (81.25)	04 (25)	12 (75)
	b. Flera	03 (18.75)	13 (81.25)	-	-
	c. Chloropy-ripos	06 (37.50)	10 (62.50)	06 (37.50)	10 (62.50)
	d. Azadiractin	16 (100)	00	08 (50)	08 (50)
	e. Nuvan	04 (25)	12 (75)	07 (43.75)	09 (56.25)
12.	**Use of bio-pesticides, if yes, give names**				
	(a) Babariya basiana	16 (100)	-	-	-
Indicate frequency of application of PP chemicals					
	(a) 0-2 time	05 (31.25)	11 (68.75)	03 (18.75)	13 (81.25)
	(b) 2-4 time	11 (68.75)	05 (31.25)	13 (81.25)	03 (18.75)
13.	**Fertilizer topdressing: First**				
	a. Interval-25-30 DAS	16 (100)	-	16 (100)	-
	a. Interval-50-60 DAS	16 (100)	-	16 (100)	-
14.	**Harvesting**				
	a. Manual	01 (6.25)	15 (93.75)	04 (25)	12 (75)
	b. Machine	15 (93.75)	01 (6.25)	12 (75)	04 (25)

Note: - Figures in the parenthesis indicate percentages to the total no. of farmers in test plot and check plot

Annexure III

Major weeds in the paddy field at sampled farms for (Gen, OBC, SC, ST) in Raipur district

Sl	Classification of weeds		Line sowing					Broadcasting				
			Marginal	Small	Medium	Large	Average (Per farm)	Marginal	Small	Medium	Large	Average (Per farm)
1.	Annuals	Kanwa-Keni	02	01	02	02	**1.75**	01	02	01	02	**1.50**
		Chouka	01	02	00	01	**1.00**	02	00	02	01	**1.25**
		Mirchivan	01	00	00	02	**0.75**	00	00	00	01	**0.25**
2.	Perennials	Motha (*Cyprus rotandas*)	03	04	04	02	**3.25**	04	04	04	04	**4.00**
3.	Broad leaves	Aloo van (*Alternailhea triardra*)	03	01	00	00	**1.00**	01	03	01	03	**2.00**
		Badori (*Ischeamum lugosum*)	02	03	02	02	**2.25**	03	02	03	02	**2.50**
		Spiny Amaranth (*Amaranths spinous*)	01	03	03	03	**2.50**	03	03	03	01	**2.50**
4.	Grasses	Sanwa (*Echinochloa colona*)	04	04	04	04	**4.00**	04	04	04	04	**4.00**
		Dube grass (*Cynodon doctylon*)	03	04	02	03	**3.00**	04	02	03	03	**3.00**
		Parthenum grass (*Parthenium hysterophorus)*	02	04	03	03	**3.00**	04	03	04	03	**3.50**
Average (Per farm)			**5.50**	**6.50**	**5.00**	**5.50**	**6.00**	**5.20**	**4.60**	**5.00**	**4.80**	**6.13**

Note: Figures are weed occurrence at the farmer's field

Annexure IV

Farmers' observation on the performance of line-sowing of paddy cultivation under NFSM scheme in Raipur district

S. N.	Enquiries made	Perception received (N=16)	
		Yes	No
1.	Whether they have grown direct seeded rice in rows for the first time?	00	16 (100)
	If no, paddy sowing in line from		
	a. Last 1-2 years	10 (62.50)	
	b. 2-4 years	06 (37.50)	
2.	Whether less seed is required for line sowing than broadcasting?		
	If yes, how much per cent less		
	a. 20-40%	04 (25)	
	b. 40-50%	12 (75)	
3.	Whether there is any problem in availability of seed drill/Zero till seed drill?	00.0	16 (100)
4.	Whether you have got any yield advantage by growing line seeded rice?	16 (100)	0
5.	What is the main advantage of direct seeding in line sowing?		
	a. Higher yield advantage	16 (100)	
	b. Good germination of seeds	10 (62.50)	
	c. Less seed is required in this method	16 (100)	
	d. Easily application of plant protection chemicals in the crop	14 (87.50)	
	e. Less infestation of pests and diseases in the crop	12 (75)	
6.	What is the yield difference with broadcast rice?		
	a. 5-10 qtl.	12 (75)	
	b. 10-20 qtl.	04 (25)	
7.	Do you think technology is better with regards to weed control in future?	16 (100)	0
9.	Whether sprayer is available for spraying weedicides?	16 (100)	0
10.	Whether weedicides are available in nearby market?	16 (100)	0
11.	What is the main problem of direct seeding in line-sowing?	00.0	16 (100)
12.	Do you think direct seeding in line will require new variety than broadcast rice?	10 (62.50)	06 (37.50)
13.	Will you do direct seeding in the next season?	16 (100)	0
14.	Whether you face any problem in direct seeding of rice in line?	00.0	16 (100)
15.	Do you think this method of direct seeding in line is profitable?	16 (100)	0
16.	Whether fertilizer used as basal has advantage?	10 (62.50)	06 (37.50)

Note: Figures in the parentheses indicate percentages to the total number of farmers

Annexure V

Technology adoption at sampled farm of Balod district

S. N.	Technological aspects in Agriculture	Total No. Farmers			
		Test plot (N=16) (Line sowing)		Check plot (N=16) (Broadcasting Method)	
		Yes	No	Yes	No
1.	**Summer ploughing:**				
	a. 2-3	12 (75)	04 (25)	12 (75)	04 (25)
	b. 3-4	04 (25)	12 (75)	04 (25)	12 (75)
2.	**Ploughing during sowing main field**				
	a. Cultivator	16 (100)	-	16 (100)	-
3.	**Rice Variety:**				
	a. MTU-1010	16 (100)	-	-	-
	b. Swarna	-	-	16 (100)	-
4.	**Seed quantity applied (In Kg)**				
	a. 60 Kg/ha	16 (100)	-	-	-
	b. 120-150 Kg/ha	-	-	16 (100)	-
5.	**Seed treatment**	10 (62.50)	06 (37.50	-	16 (100)
6.	**Weed management**				
	a. Manual	11 (68.75)	-	16 (100)	00 (00)
	b. Weedicide	05 (31.25)	-	05 (31.25	11 (68.75)
7.	**Use of hand hoe for weeding in**	-	16 (100.0)	-	16 (100)
8.	**Major disease occurrence**				
	a. Sheath blight	04 (25)	12 (75)	10 (62.50)	05 37.50)
	b. Blast	04 (25)	09 (75)	11 (68.75)	05 (31.25)
9.	**Use of fungicide in disease control, If yes, give names**				
	a. Propiconozole	06 (37.50)	10 (62.50)	05 (31.25)	11 (68.75)
	b. Current	-	-	04 (25)	12 (75)
	b. Surakcha	06 (37.50)	10 (62.50)	05 (31.25)	11 (68.75)
10	**Name of major insects and other insects etc**				
	a. Stem borer	07 (43.75)	09 (56.25)	12 (75)	04 (25)
	b. Aphid	05 (31.25)	11 (68.75)	08 (50)	08 (50)
11	**Use of insecticides in insect/pest control, If yes, give names:**				
	a. Flera	03 (18.75)	13 (81.25)	-	-
	b. Chloropyripos	06 (37.50)	10 (62.50)	06 (37.50)	10 (62.50)
	c. Azadiractin	16 (100)	00	08 (50)	08 (50)
	d. Nuvan	04 (25)	12 (75)	07 (43.75)	09 (56.25)
12.	**Use of bio-pesticides, if yes, give names**				
	a. *Babariya basiana*	16 (100.0)	-	-	-
	Indicate frequency of application of PP chemicals				
	a. 0-2 time	05 (31.25)	11 (68.75)	03 (18.75)	13 81.25)
	b. 2-4 time	11 (68.75)	05 (31.25)	13 (81.25)	03 (18.75)
13.	**Fertilizer topdressing: First**				
	a. Interval-25-30 DAS	16 (100)	-	16 (100)	-
	b. Interval-50-60 DAS	16 (100)	-	16 (100)	-
14.	**Harvesting**				
	a. Manual	12 (75)	04 (25)	12 (75)	04 (25)
	b. Machine	04 (25)	12 (75)	04 (25)	12 (75)

Note: - Figures in the parenthesis indicate percentages to the total no.of farmers.

Annexure VI

Major weeds in the paddy field at sampled farms of Balod district for (Gen, OBC, SC, ST)

S. N	Classification of weeds		Line sowing					Broadcasting				
			Marginal	Small	Medium	Large	Average (Per farm)	Margi nal	Small	Medium	Large)	Average (Per farm)
1.	Annuals	Kanwa-Keni	02	01	00	00	**0.75**	01	02	01	02	**1.50**
		Chouka	01	02	00	01	**1.00**	02	00	02	01	**1.25**
		Mirchivan	01	00	00	02	**0.75**	00	00	00	01	**0.25**
2.	Perennials	Motha (*Cyprus rotandas*)	03	04	04	02	**3.25**	04	04	03	04	**3.75**
3.	Broad leaves	Aloo van (*Alternailhea triardra*)	02	01	00	00	**0.75**	01	00	01	00	**0.50**
		Badori (*Ischeamum lugosum*)	02	00	00	01	**0.75**	03	02	03	02	**2.50**
		Spiny Amaranth (*Amaranths spinous*)	00	00	00	00	**0.00**	00	00	00	00	**0.00**
4.	Grasses	Sanwa (*Echinochloa colona*)	04	04	04	04	**4.00**	04	04	02	04	**3.50**
		Dube grass (*Cynodon doctylon*)	03	04	02	03	**3.00**	04	02	03	03	**3.00**
		Parthenum grass (*Parthenium hysterophorus)*	02	04	03	03	**3.00**	04	03	04	03	**3.50**
Average (Per farm)			**5.00**	**5.00**	**3.25**	**4.00**	**4.31**	**5.75**	**4.25**	**4.75**	**5.00**	**4.94**

* Weeds occurrence at the farmer's field.

Annexure VII

Farmers' observation on line-sowing of paddy under BGREI in Balod district

S. No.	Question Asked	Perception received (N=16)	
		Yes	No
1.	Whether they have grown direct seeded rice in rows for the first time?	0	16 (100)
	If no, paddy sowing in line from		
	c. Last 1-2 years	08 (50)	
	d. 2-4 years	08 (50)	
2.	Whether less seed is required for line sowing than broadcasting?		
	If yes, how much per cent less		
	c. 20-40%	0	
	d. 40-50%	16 (100)	
3.	Whether there is any problem in availability of seed drill/Zero till seed drill?	12 (75)	04 (25)
4.	Whether you have got any yield advantage by growing line seeded rice?	16 (100)	0
5.	What is the main advantage of direct seeding in line sowing?		
	f. Higher yield advantage	16 (100)	
	g. Good germination of seeds	12 (75)	
	h. Less seed is required in this method	16 (100)	
	i. Easily application of plant protection chemicals in the crop	12 (75)	
	j. Less infestation of pests and diseases in the crop	12 (75)	
6.	What is the yield difference with broadcast rice?		
	c. 5-10 qtl.	14 (87.50)	
	d. 10-20 qtl.	02 (12.50)	
7.	Do you think technology is better with regards to weed control in future?	16 (100)	0
9.	Whether sprayer is available for spraying weedicides?	16 (100)	0
10.	Whether weedicides are available in nearby market?	16 (100)	0
11.	What is the main problem of direct seeding in line-sowing?	00.0	16 (100)
12.	Do you think direct seeding in line will require new variety than broadcast rice?	08 (50)	08 (50)
13.	Will you do direct seeding in the next season?	16 (100)	0
14.	Whether you face any problem in direct seeding of rice in line?	0	16 (100)
15.	Do you think this method of direct seeding in line is profitable?	16 (100)	0
16.	Whether fertilizer used as basal has advantage?	10 (62.50)	06 (37.50)

Note: Figures in the parenthesis indicate percentages to the total number of farmers.