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An Assessment of Soybean Seed Production System in Black Cotton Soils of Deccan Plateau of India

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ABSTRACT

In the present study, assessed the participatory soybean seed production in black cotton soils of Deccan plateau of India. Soybean seed of improved varieties is an expensive input, requires intensive pre and post harvest management practices and encouraging participatory soybean seed production in this region meets demand of quality soybean seed to the farmers. A package of pre and post harvest management practices were adopted for participatory soybean seed production with scientific trainings and demonstrations at various stages of seed to seed production. Pre-testing was done to see the reliability and validity of the interview schedule. The participatory soybean seed production produced 1761.5q of processed seed from 330 acres of area, which is sufficient for an area of 7042 acre in this region. The average additional income from per acre of land is Rs 5, 673/-. The small and marginal land holding seed growers recorded the best B: C ratio with Rs 2.72 per Rs 1.0 invested. Benefits of participatory seed production are characterized extensively in the literature; however, understanding the factors in implementation of seed production models especially maintaining soybean seed vigour and viability of soybean seeds, and how they perform compared to conventional practices, has not been sufficiently studied.

Keywords Soybean, Black cotton soil, Participatory seed production, Seed vigour, B: C ratio.

INTRODUCTION

Soybean (*Glycine max*) is the one of the most important oil seed crops of India and an important source of edible oil, protein and physiologically active ingredients. Due to its multiple food uses and nutritional importance, it is widely grown as a valuable vegetable oil seed crop throughout the world. India is the fifth largest producer of soybean (13.26 mmt) after USA, Brazil, Argentina and China. Currently India is producing 13.26 million tonnes of soybean from an area of 11.67 million hectares and the production share accounts 42% of country's total oil seeds production (Rajendar *et al*. 2019). In India, Soybean is cultivated in Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Chhattisgarh, Telangana and some

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parts of Gujarat and Uttar Pradesh. Soybean is mainly produced for defatted soymeal and vegetable oil. Defatted soy protein products or soy protein concentrates or isolates are an important industrial ingredient for several processed foods and protein meal for animal feeds (Xiaoyu *et al*. 2011).

The vigour and viability of soybean seeds depends on pre-harvest management and post-harvest management of seed (Qingnan *et al*. 2020). Soybean seed approximately loses 5 % to 100% of its germination ability due to poor seed vigour (Shou *et al*. 1998). In India high seed rate is very common due to seed vigour lost, which enhances the risk of crop lodging and increased seed cost. Soybean yield is detrimental by the seed rate and the seed mass, both of which are affected by many characteristics, including plant height, effective internode formation, number of branches, number of pods per plant, number of seeds per pod, and seed size (Pedersen and Lauer 2004). Soybean seed of improved varieties is an expensive input and it is a major constraint in most of the oil seed growing countries. With little interest of private sector in soybean seed production is due to reasons such as quick loss of seed vigor, high cost of transportation, high cost of cold storage, low profit margin, and self pollinated nature of the crop (Biradar Patil and Motagi 2010). These problems further, accelerated due to (i) non availability of seeds before onset of monsoon and (ii) disproportionate rise in the cost of seeds. There remains a large gap between the seed demand and seed supply resulting in low area coverage by the improved varieties in these crops. Traditional soybean production in the country involved sowing in June or later, with the bulk of the acreage planted in JS 335, JS 2029, JS 2069, JS 2034, JS 9305 and Basara (ASb-22) cultivars under rainfed conditions in medium to heavy black cotton soils. Hence, the present investigation was carried out to facilitate the availability of improved soybean seed varieties to the farmers by participatory production of soybean seed in the Deccan plateau of India.

MATERIALS AND METHODS

The participatory seed production of soybean was conducted in *Kharif* 2018 - 2019 covering 12 villages of Adilabad district of Deccan plateau of India. Initially, through participatory rural appraisal (PRA) program, interview schedule and questionnaire were used as a tool for selection of farmers from different mandals of the district. A total of 70 farmers from 12 villages come forward for participatory soybean seed production in an area of 330 acres with the target of 70 tones seed production. The survey not only includes measures on adoption of improved participatory soybean seed production to supplement livelihood systems but also on seed delivery system specifically on its institutional arrangements that explains how partnership can further improve the project performance.

Socio economic survey

A personal interview survey was conducted on socio-economic levels, farming practices and livelihood opportunities for farmers in different villages of Adilabad district through Participatory Rural Appraisal (PRA) technique. Diversified information was collected through structured personnel interview schedule was prepared in consultation with the local agricultural extension officers, village key informants and experienced large scale farmers. Pre-testing was done to see the reliability and validity of the interview schedule.

Selection of farmers

Based on survey report and willingness of farmers for seed production of soybean was taken in to account for the final selection of farmers for participatory seed production cum training under seed hub project through nodal agency of ICAR-Indian Institute of Oil Seeds Research, Hyderabad part of National Food Security Mission (NFSM) funded by Directorate of Agricultural Cooperation (DAC) and Farmers welfare, Government of India. A 70 member farmers were selected for the project in the first year 2018 *kharif* season. The following trainings cum demonstrations were conducted from field preparation to post harvest management as shown in the Fig 1.

Training 1: Field preparation and seed treatments
Training 2: Integrated crop management in soybean
Training 3: Pre harvest and post harvest management

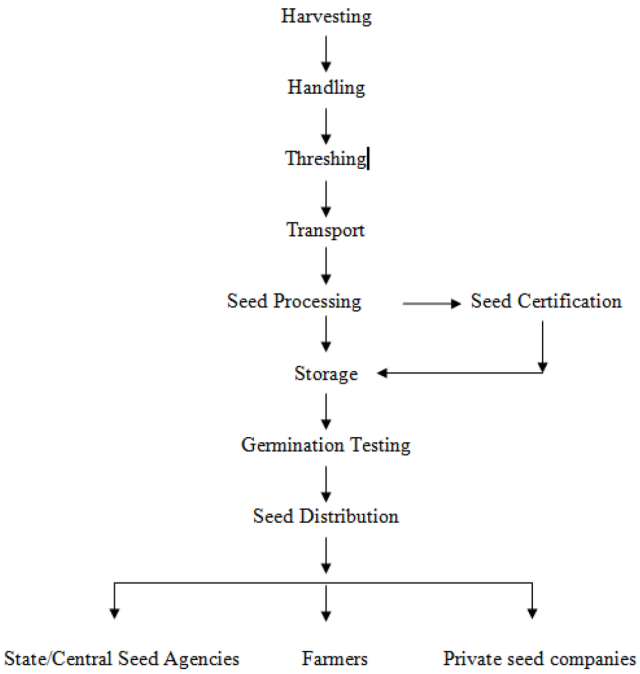

Fig. 1. Post harvest profile of soybean seed production.

practices for quality soybean seed production
Training 4: Seed processing, storage and seed testing of soybean.

RESULTS AND DISCUSSION

During 2018-19 participatory soybean seed production under taken with two varieties viz., JS 335 and Basara (ASb-22) with an area of 59 acres and 101 acres respectively involving 32 practicing farmers as shown in Table 1. A total production was around 992q. Then the seeds were processed and tested for seed certification and the final yield after rejection was 837.1q. Farmers were received an amount of Rs 5,000/- per quintal seed when compared to MSP rate of soybean was Rs.3, 349. The total value of seed produced during 2018-19 was Rs.41, 85,250.00. The total amount received by the farmers towards the sale of rejected seed was Rs 3, 25,458.00. An average increased farm income per acre after soybean seed production was around Rs 6, 776. Participatory soybean seed growers during 2018-19 earned an additional income in the range of Rs 1774 to 16680 per acre. There is a reduced cost of production due to improved management practices and regular monitoring by the scientists working under project.

Whereas in 2019-20, seed production was taken up in an area of 171 acres involving 38 farmers of 10 villages of 7 mandals of Adilabad district and produced 1149.8 q of unprocessed seed (Table 2). Subsequent seed processing and seed certification resulted in 924.4 q of quality processed seed. During this season, farmers were received an amount of Rs 50, 42,160.00 for processed and rejected seed. Practicing farmers earned an average additional amount of Rs 4, 570.00 per acre with minimum and maximum a range of Rs 783-9054/-.per acre. In addition to the additional income; cost of production was also reduced due to improved management practices and regular monitoring by the scientists working under project.

Over all, during 2018 -19 and 2019-20, under participatory soybean seed production produced 1761.5q of processed seed, which is sufficient for an

Table 1. Farmer's income before and after seed production in the district during *kharif* 2018-19**.**

Sl. No.	Farmers	Before seed production Area in acre	Varieties	Production in q	Rs/q	Income in Rs(A)
1	F1	2	JS-335	15.9	3399	53874
2	F2	6	JS-335	37.3	3399	126783
3	F3	2	JS-335	14.9	3399	50645
4	F4	2	JS-335	14.8	3399	50135
5	F5	5	JS-335	25.6	3399	87014
6	F6	3	JS-335	6.4	3399	21754
7	F7	13	JS-335	122.5	3399	416208
8	F8	6	JS-335	21.3	3399	72399
9	F9	14	JS-335	71.3	3399	242179
10	F10	4	JS-335	29.1	3399	98741
11	F11	2	JS-335	12.0	3399	40788
12	F12	6	Basara (ASb-22)	44.7	3399	151765
13	F13	5	Basara (ASb-22)	31.5	3399	106899
14	F14	7	Basara (ASb-22)	57.1	3399	194083
15	F15	6	Basara (ASb-22)	38.0	3399	129162
16	F16	1	Basara (ASb-22)	10.4	3399	35350
17	F17	4	Basara (ASb-22)	19.1	3399	64751
18	F18	5	Basara (ASb-22)	36.0	3399	122364
19	F19	4	Basara (ASb-22)	23.4	3399	79367
20	F20	6	Basara (ASb-22)	37.8	3399	128482
21	F21	4	Basara (ASb-22)	27.2	3399	92453
22	F22	3	Basara (ASb-22)	21.2	3399	72059
23	F23	5	Basara (ASb-22)	22.1	3399	75118
24	F24	5	Basara (ASb-22)	25.5	3399	86675
25	F25	5	Basara (ASb-22)	23.3	3399	79027
26	F26	4	Basara (ASb-22)	35.0	3399	118965
27	F27	5	Basara (ASb-22)	25.4	3399	86165
28	F28	5	Basara (ASb-22)	29.4	3399	99761
29	F29	9	Basara (ASb-22)	37.4	3399	126953
30	F30	4	Basara (ASb-22)	37.7	3399	127972
31	F31	4	Basara (ASb-22)	29.1	3399	98911
32	F32	4	Basara (ASb-22)	27.5	3399	93608
Total		160		1009.2		3430407

Table 1. Continued.

Sl. No.	Farmers	Area in acre	Varieties	After Seed Production Production in (q) Processed seed (q)	Rejected seed(q)	Rs/q Processed seed	Rejected seed	Income in Rs Processed seed	Rejected seed	Total income from Seed production in Rs (B)	Additional income Rs/acre
1	F1	2	JS-335	13.3	2.0	5000	2100	66250	4158	70408	8267
2	F2	6	JS-335	33.0	3.6	5000	2100	165000	7602	172602	7637
3	F3	2	JS-335	13.3	1.2	5000	2100	66250	2478	68728	9041
4	F4	2	JS-335	11.0	3.1	5000	2100	55000	6531	61531	5698
5	F5	5	JS-335	22.0	3.0	5000	2100	110000	6300	116300	5857
6	F6	3	JS-335	5.5	0.6	5000	2100	27500	1302	28802	2349
7	F7	13	JS-335	112.8	7.4	5000	2100	563750	15498	579248	12542
8	F8	6	JS-335	16.8	4.0	5000	2100	83750	8379	92129	3288
9	F9	14	JS-335	61.2	10.9	5000	2100	306000	22806	328806	6188
10	F10	4	JS-335	24.3	3.6	5000	2100	121500	7623	129123	7596

Table 1. Continued.

Sl. No.	Farmers	Area in acre	Varieties	After seed production Production in (q) Processed seed (q)	Rejected seed(q)	Rs/q Processed seed	Rejected seed	Income in Rs Processed seed	Rejected seed	Total income from seed production in Rs (B)	Additional income Rs/acre
11	F11	2	JS-335	10.1	1.8	5000	2100	50250	3780	54030	6621
12	F12	6	Basara (ASb-22)	37.0	5.5	5000	2100	185000	11445	196445	7447
13	F13	5	Basara (ASb-22)	24.3	5.8	5000	2100	121250	12180	133430	5306
14	F14	7	Basara (ASb-22)	47.3	8.4	5000	2100	236250	17703	253953	8553
15	F15	6	Basara (ASb-22)	30.3	5.7	5000	2100	151250	11949	163199	5673
16	F16	1	Basara (ASb-22)	8.5	1.5	5000	2100	42500	3087	45587	10237
17	F17	4	Basara (ASb-22)	16.0	2.8	5000	2100	80000	5880	85880	5282
18	F18	5	Basara (ASb-22)	28.3	7.0	5000	2100	141250	14700	155950	6717
19	F19	4	Basara (ASb-22)	19.5	3.0	5000	2100	97500	6384	103884	6129
20	F20	6	Basara (ASb-22)	32.8	4.1	5000	2100	163750	8547	172297	7302
21	F21	4	Basara (ASb-22)	20.8	5.3	5000	2100	103750	11193	114943	5623
22	F22	3	Basara (ASb-22)	17.5	3.1	5000	2100	87500	6426	93926	7289
23	F23	5	Basara (ASb-22)	17.8	3.2	5000	2100	88750	6678	95428	4062
24	F24	5	Basara (ASb-22)	21.0	3.3	5000	2100	105000	6951	111951	5055
25	F25	5	Basara (ASb-22)	18.0	4.4	5000	2100	90000	9198	99198	4034
26	F26	4	Basara (ASb-22)	32.5	11.0	5000	2100	162500	23184	185684	16680
27	F27	5	Basara (ASb-22)	19.5	5.1	5000	2100	97500	10689	108189	4405
28	F28	5	Basara (ASb-22)	22.8	5.5	5000	2100	113750	11592	125342	5116
29	F29	9	Basara (ASb-22)	23.3	12.7	5000	2100	116250	26670	142920	1774
30	F30	4	Basara (ASb-22)	30.0	6.9	5000	2100	150000	14469	164469	9124
31	F31	4	Basara (ASb-22)	24.3	4.1	5000	2100	121250	8673	129923	7753
32	F32	4	Basara (ASb-22)	23.0	5.4	5000	2100	115000	11403	126403	8199
Total		160		837.1	155.0			4185250	325458	4510708	216845

area of 7042 acre in this region. During season *kharif* 2018-19 and *kharif* 2019-20 a total of 70 farmers belongs to 12 villages of 9 different mandals of Adilabad district of Deccan plateau were actively involved in

Table 2. Farmer's income before and after seed production in the district during *kharif* 2019-20**.**

Sl.No.	Farmers	Area in acre	Varieties	Before seed production Production in q	Rs/q	Income in Rs(A)
1	F1	10	JS-335	61.5	3710	228165
2	F2	8	JS-335	32.0	3710	118535
3	F3	6	JS-335	35.5	3710	131520
4	F4	7	JS-335	57.4	3710	212769
5	F5	3	JS-335	28.8	3710	106848
6	F6	3	JS-335	21.4	3710	79394
7	F7	3	JS-335	18.4	3710	68264
8	F8	5	JS-335	28.7	3710	106292
9	F9	6	JS-335	28.9	3710	107034
10	F10	2	JS-335	7.8	3710	28753
11	F11	6	JS-335	27.4	3710	101654
12	F12	5	JS-335	36.6	3710	135786
13	F13	5	JS-335	40.2	3710	149142
14	F14	4	JS-335	21.4	3710	79394

Table 2. Continued.

Sl.No.	Farmers	Area in acre	Varieties	Before seed production Production in q	Rs/q	Income in Rs(A)
15	F15	1	JS-335	11.1	3710	40996
16	F16	3	JS-335	32.2	3710	119462
17	F17	3	JS-335	15.5	3710	57616
18	F18	2	JS-335	6.0	3710	22260
19	F19	2	JS-335	8.5	3710	31535
20	F20	8	JS-335	73.1	3710	271201
21	F21	4	JS-335	28.5	3710	105809
22	F22	4	Basara	36.5	3710	135415
23	F23	8	Basara	54.7	3710	202937
24	F24	3	Basara	15.6	3710	57876
25	F25	4	Basara	34.9	3710	129294
26	F26	6	Basara	47.5	3710	176225
27	F27	6	Basara	14.5	3710	53795
28	F28	3	Basara	24.1	3710	89226
29	F29	3	Basara	20.5	3710	75870
30	F30	4	Basara	18.9	3710	69934
31	F31	3	Basara	31.6	3710	117051
32	F32	3	Basara	25.1	3710	93121
33	F33	3	Basara	20.1	3710	74571
34	F34	4	Basara	33.0	3710	122245
35	F35	6	JS 93- 05	63.5	3710	235585
36	F36	5	JS 93- 05	27.0	3710	100170
37	F37	8	JS 93- 05	46.4	3710	172144
38	F38	2	JS 93- 05	15.6	3710	57876
Total		171		1149.8		4265758

Table 2. Continued.

Sl. No.	Farmers	Area in Acre	Varieties	After seed production Production in (q) Processed seed (q)	Rejected seed (q)	Rs/q Processed seed	Rejected seed	Income in Rs Processed seed	Rejected seed	Total income from seed production in Rs (B)	Additional income Rs/acre
1	F1	10	JS-335	50.8	9.1	5000	2250	253750	20408	274158	4599
2	F2	8	JS-335	28.5	2.5	5000	2250	142500	5625	148125	3699
3	F3	6	JS-335	29.5	4.4	5000	2250	147500	9788	157288	4295
4	F4	7	JS-335	47.5	7.8	5000	2250	237500	17640	255140	6053
5	F5	3	JS-335	24.0	4.2	5000	2250	120000	9428	129428	7527
6	F6	3	JS-335	18.8	1.6	5000	2250	93750	3645	97395	6000
7	F7	3	JS-335	16.3	1.7	5000	2250	81250	3848	85098	5611
8	F8	5	JS-335	21.0	6.4	5000	2250	105000	14310	119310	2604
9	F9	6	JS-335	20.8	5.7	5000	2250	103750	12758	116508	1579
10	F10	2	JS-335	6.3	0.9	5000	2250	31250	1913	33163	2205
11	F11	6	JS-335	17.8	8.1	5000	2250	88750	18248	106998	891
12	F12	5	JS-335	29.3	6.1	5000	2250	146250	13770	160020	4847
13	F13	5	JS-335	33.5	5.9	5000	2250	167500	13298	180798	6331
14	F14	4	JS-335	18.0	2.5	5000	2250	90000	5625	95625	4058
15	F15	1	JS-335	8.8	1.4	5000	2250	43750	3128	46878	5882
16	F16	3	JS-335	27.8	3.5	5000	2250	138750	7875	146625	9054

Table 2. Continued.

Sl. No.	Farmers	Area in acre	Varieties	Production in (q)		After seed production Rs/q		Income in Rs		Total income from seed production in Rs (B)	Additional income Rs/acre
				Processed seed (q)	Rejected seed (q)	Processed seed	Rejected seed	Processed seed	Rejected seed		
17	F17	3	JS-335	13.2	2.1	5000	2250	66150	4725	70875	4420
18	F18	2	JS-335	4.0	1.7	5000	2250	20000	3825	23825	783
19	F19	2	JS-335	7.1	1.2	5000	2250	35250	2723	37973	3219
20	F20	8	JS-335	62.3	9.7	5000	2250	311250	21825	333075	7734
21	F21	4	JS-335	25.5	2.5	5000	2250	127600	5625	133225	6854
22	F22	4	Basara	27.8	6.9	5000	2250	138750	15413	154163	4599
23	F23	8	Basara	39.7	12.3	5000	2250	198500	27675	226175	3699
24	F24	3	Basara	12.0	3.5	5000	2250	60000	7920	67920	4295
25	F25	4	Basara	25.3	9.2	5000	2250	126250	20768	147018	6053
26	F26	6	Basara	36.5	9.8	5000	2250	182500	22140	204640	7527
27	F27	6	Basara	10.8	2.7	5000	2250	53750	6030	59780	6000
28	F28	3	Basara	16.8	7.1	5000	2250	83750	16020	99770	5611
29	F29	3	Basara	15.5	3.9	5000	2250	77500	8820	86320	2604
30	F30	4	Basara	14.5	3.7	5000	2250	72500	8393	80893	1579
31	F31	3	Basara	26.5	3.4	5000	2250	132500	7740	140240	2205
32	F32	3	Basara	18.8	5.5	5000	2250	93750	12465	106215	891
33	F33	3	Basara	15.5	3.4	5000	2250	77500	7740	85240	4847
34	F34	4	Basara	27.5	4.1	5000	2250	137500	9225	146725	6331
35	F35	6	JS 93- 05	50.2	12.3	5000	2250	251000	27698	278698	7185
36	F36	5	JS 93- 05	23.1	3.5	5000	2250	115500	7898	123398	4646
37	F37	8	JS 93- 05	40.6	4.9	5000	2250	203000	11070	214070	5241
38	F38	2	JS 93- 05	13.2	1.4	5000	2250	66200	3173	69373	5748
Total		171		924.4	186.8			4621950	420210	5042160	

participatory soybean seed production with the total area of 330 acres. The total value generated through soybean seed production is Rs 95, 52,688.00 with average additional returns of Rs 5,673 per acre when compared to traditional soybean cultivation.

Benefit Cost Ratio of soybean Seed Production

The B:C ratio on total cost basis was calculated to determine the benefit derived by farmer involved in participatory soybean seed production (Mula et al., 2014). Results revealed that small and marginal land holding farmer's seed growers with 2-4 ha land showed the best B; C ratio with Rs 2.72 per Rs 1.0 invested in seed production. However, it can be deduced from the B: C ratio of all land classification that seed production is economically viable for smallholder farmers to venture in for improving their livelihoods. The detailed economic sustainability of soybean seed production under rainfed situation in black cotton soils of Deccan plateau region of India is explained in Fig. 2 and Table 3 through SWOT analysis in Table 4.

Table 3. Tukey's honest significance test of multiple comparison results of soybean seed production**.**

	Area in acre	Income before seed production in rupees total	Total in rupees income after seed production in rupees
Mean	4.4643	92125.1429	119511.7143
Standard error	0.3313	7302.4429	9651.6186
P values		<0.001	<0.001

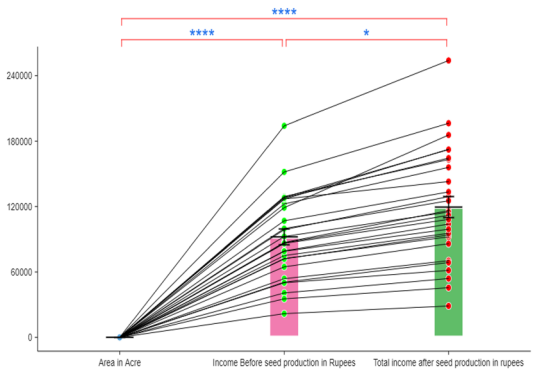

Fig. 2. Changes in the income of farmers before and after harvesting.

Due to its short duration, export potential and commercial importance, this crop will continue to remain as major rainfed oilseed crop of the region and the area may further likely to increase in coming years. The simulation studies and on-farm demonstrations conducted across India under rainfed conditions indicate that with current varieties, the yield potential of soybean is about 2.1 t/ha against the present average productivity of just 1.2 t/ha (Patil and Motagi 2010). Hence, large yield gaps exist between the potential and the actual yields harvested by the farmers. Among the various factors contributing for lower productivity of soybean, lack of timely availability of quality seed is one of the important constraints. Seed is a major contributor in production component and is the prime mover that drives the utilization and efficiency of all other production factors in any given production environment.

CONCLUSION

The traditional soybean cultivation by the farmers in the country mostly relies on self-saved seeds and utilizing this for next season. Due to non availability of soybean in this region, annually the government is

Table 4. SWOT analysis of participatory soybean seed production.

Strength	Fertile soils in the district
	Farmers have the skill set for production of soybean
	Even distribution of rainfall
	Women farmers and Rural youth
	Access to mechanization
	Access to scientific advisories from KVK, DAATTC and ARS of Adilabad
	Marketing facilities for soybean grains
Weakness	Rain fed situations
	Non availability of high yielding varieties
	Procurement of seeds from other states
	Non adoption of improved management practices
	Non availability of Mechanical harvester for soybean
	Non availability of Cold storage infrastructure
	Non availability of seed and grain processing units
	Lack of awareness on seed certification process
Opportunity	Developing resistant varieties to biotic (steam fly, stem girdler and anthracnose pod blight) and abiotic (moisture, high or cold temperature) stresses
	Development of high yielding medium duration genotypes
	Promotion of Broad Bed Furrow (BBF) for improvement of yield and seed quality by utilizing natural resources
	Development of high yielding varieties resistant to pre-harvest sprouting
	Untapped local markets and seed to seed value chain development
	Rising soybean seed demand in future
	Increasing area under soybean in nontraditional districts
	Green vegetable soybean
	Better control of seed inventory of district as well as state for soybean
	Doubling of farm income
Threats	Climate change and unfavorable rainfall (delayed, erratic, improper distribution)
	Poor germination and pre harvest sprouting
	High incidence of pod blight and stem fly
	Higher rejection rate during seed certification
	Competition from seed agencies and private companies

procuring 95% of soybean seed from other parts of the country. Hence, encouraging soybean seed production in this region meets demand of quality soybean seed to the farmers. In conventional agriculture practice soybean farmer earns a gross income of Rs 19800-20200 per acre whereas income in commercial seed production of soybean per acre is Rs 28000-32000. The cost of cultivation lowered to 10% in seed production of soybean due to scientific demonstration cum trainings. However, there are still limitations in the soybean production that needs to be addressed to ensure the sustainability of the seed delivery system of the project. The small and marginal land holding farmer's seed growers with 2-4 ha land recorded the best B: C ratio with Rs 2.72 per Rs 1.0 invested in seed production. However, it can be deduced from the B: C ratio of all land classification that seed production is economically viable for smallholder farmers to venture in for improving their livelihoods. The most pressing constraints of soybean seed production are inherent low viability, highly prone to mechanical injury during processing and transportation. The seed is also so sensitive that even before its harvest, it can be adversely affected by field weathering. These factors affect seed germination and vigor severely and at times even maintaining the minimum germination standard (70%) till next season becomes difficult. The seed multiplication ratio in soybean is low and this coupled with high seed requirement, forms the major bottleneck in augmenting the availability of quality seed. There is also an urgent need to regulate prices of soybean seed in the market to obtain benefit from the cultivation of soybean for smallholder farmers in this region.

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