NMOOP
FRONTLINE DEMONSTRATIONS ON OILSEEDS

ICAR- Indian Institute of Oilseeds Research

(Indian Council of Agricultural Research)

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Compiled and edited by
Dr. G.D.S. Kumar
Dr. K.S. Varaprasad

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FOREWORD

The productivity of oilseeds in India is low (1037 kg/ha) except in case of castor (1568 kg/ha). The major constrains for low productivity of oilseeds crops are rainfed cultivation, small operational land holdings, lack of varietal replacement (groundnut and sesame), losses due to pests and diseases and non-adoption of improved technologies. The AICRP centres and oilseeds Directorates have developed location specific improved technologies, which can enhance oilseeds productivity significantly. But, the awareness and adoption of these technologies among farmers is very less. Hence, focused efforts are required to transfer the existing technologies from research system to the farmers' fields through effective and efficient technology transfer programmes to realize immediate gains to the individual farmers and national oilseed production.

In this direction, the Department of Agriculture Cooperation and Farmer Welfare (DAC & FW), Government of India (GOI) under the National Mission on Oilseeds and Oil Palm (NMOOP) is funding the implementation of frontline demonstrations (FLDs) on oilseeds to demonstrate the productivity potential and profitability of latest and improved technologies under real farm situations. The FLDs are being implemented through AICRP centres, voluntary centres, KVKs and NGOs with the active involvement of scientists. An attempt has been made in this publication to review the progress made in frontline demonstrations on nine annual oilseed crops and oilseed based farming systems under varied agro-ecological conditions during 2014-15. Out of 5105 FLDs assigned, 4955 were conducted with 97% implementation.

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IIOR, Hyderabad
May 2016.

(K.S. VARAPRASAD)
Director

List of Contributors

Narayanan, G.
Scientist (Agril. Extension)
ICAR-Directorate of Groundnut Research
Ivnagar road, Junagadh-362 001
Gujarat

S. D. Billore
Principal Scientist (Agronomy)
Directorate of Soybean Research
Khandwa Road, Indore 452 001
Madhya Pradesh

Ashok Kumar Sharma
Principal Scientist (Agril. Extension)
ICAR-Directorate of Rapeseed-Mustard Research
Sewar, Bharatpur-321 303
Rajasthan

G.D.S. Kumar
Principal Scientist (Agril. Extension)
ICAR-Indian Institute of Oilseeds Research
Rajendranagar- 500 030
Telangana

A. Jyothisi
Agronomist
Project Coordinating Unit (Sesame & Niger)
AICRP on Sesame & Niger
JNKVV Campus, Jabalpur-4820004
Madhya Pradesh

M.R. Deshmukh
Jr. Agronomist
Project Coordinating Unit (Sesame & Niger)
AICRP on Sesame & Niger
JNKVV Campus, Jabalpur-4820004
Madhya Pradesh

P.K. Singh
Project Coordinator
Project Coordinating Unit (Linseed)
AICRP on Linseed
CSAUAT Campus, Kanpur- 208 002
Uttar Pradesh

N. Ravisankar
Principal Scientist (Agronomy) & PI, OFR
ICAR-Indian Institute of Farming Systems Research
Modipuram, Meerut- 250 110
Uttar Pradesh

M. Padmaiah
Principal Scientist (Agril. Extension)
ICAR-Indian Institute of Oilseeds Research
Rajendranagar- 500 030
Telangana

S.V. Ramana Rao
Principal Scientist (Agril. Economics)
ICAR-Indian Institute of Oilseeds Research
Rajendranagar- 500 030
Telangana

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INTRODUCTION

In India, oilseeds follow cereals, sharing 14% of the country's gross cropped area and accounting for nearly 3% of the gross domestic product and 5.9% of the value of all agricultural products. Oilseeds are cultivated in an area of 25.73 m ha, with a production of 26.67 m t and productivity of 1037 kg/ha (Directorate of Economics and Statistics, 2015). The diverse agro-ecological regions in the country are favourable for growing all the nine annual oilseeds which include seven edible oilseeds *viz*, soybean, rapeseed-mustard, groundnut, sunflower, sesame, niger and safflower and two non-edible oilseeds *viz*., linseed and castor. Among different oilseeds, soybean, rapeseed-mustard and groundnut account for about 80% of the oilseeds area and 88% of oilseeds production in the country.

Despite the largest cultivator of oilseeds in the world, India imports about 52% of domestic requirements owing to huge demand due to the life style changes in dietary pattern and increasing *per capita* income. The *per capita* consumption of vegetable oil is rising continuously and is 14.4 kg/year in 2014-15 and the consumption growth is expected to be around 4.5 -5% per annum. This demand in the country has created a big gap between domestic production and consumption filled by liberal imports, which is a huge drain on the foreign exchange of the exchequer. In order to increase area and production of oilseeds in the country, the improved technologies developed by research system should reach the farmers. To facilitate faster outreach of technologies to farmers, frontline demonstrations (FLDs) are conducted with the support of the Government of India under various programmes.

Technology Mission on Oilseeds and Impact

The Technology Mission on Oilseeds (TMO) launched by Government of India (GOI) in 1986, had a significant impact on overall production of oilseeds. The TMO covered 183 districts in major oilseed growing states. Subsequently, in 1991 this scheme was extended to few more potential districts. As a result, the oilseed production that was only 10.83 m t in 1985-86 had increased to 24.35 m t in 1996-97. This was achieved through area expansion of oilseed crops as well as increase in productivity from 684 kg/ha in 1985-86 to 926 kg/ha in 1996-97. As a result, the dependence on import of edible oil was reduced to the extent of hardly five percent in 1995-96. The National Dairy Development Board (NDDB) established a large network of oilseed cooperatives with storage and processing capabilities. The procurement of oilseeds was also done with the initiative of NDDB, which provided better price support for oilseed growers. This kind of support provided by NDDB was a crucial factor for the success of TMO till mid-nineties. However, after 1996, the production of oilseeds lagged behind to meet the domestic requirements. The oilseed growers heavily suffered when the price of oilseed crops was at very low level and there was no effective market intervention by NAFED to give support price to oilseeds. In the late 1990s, oilseed prices declined relative to that of other crops, mainly in response to the earlier increase in domestic oilseed supplies and subsequently due to the liberalization of edible oil imports initiated in 1994. The minimum support price (MSP) of food grains was also raised more than that of oilseeds since the mid 1990s. Although, the government had regularly supported rice and wheat MSPs in several states through direct procurement, price support operations for oilseeds was usually not funded. As a result, increasingly favourable monetory returns from rice and wheat have grabbed area away from oilseeds, lowering oilseed production.

Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize (ISOPOM)

To meet the challenges posed through huge demand for vegetable oils production, the Department of Agriculture and Cooperation (DAC) started ISOPOM, mainly to provide flexibility to the states in implementation of oilseed development schemes, on a regionally differential approach, to promote crop diversification and to provide focused approach to the oilseed development programmes. Under ISOPOM, the programme for development of oilseeds was implemented mainly in potential states *viz*., Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. These programmes benefited small and marginal oilseed growers; under this scheme, assistance was given for purchase of breeder seeds, distribution of seed mini kits, distribution of inputs and machinery, conduct of frontline demonstrations *etc.*

National Mission on Oilseeds and Oil Palm (NMOOP)

NMOOP envisaged to increase production of vegetable oils sourced from oilseeds, oil palm and TBOs from 7.06 million t (average of 2007-08 to 2011-12) to 9.51 million t by the end of Twelth five year Plan (2016-17). The Mission is being implemented through three Mini Missions with specific target as detailed below:

Mini Mission (MM)	Target of 12th Plan
MM I on Oilseeds	Achieve production of 35.51 mt and productivity of 1328 kg/ha of oilseeds from the present average production & productivity of 28.93 m t and 1081 kg/ha during the 11th plan period respectively.
MM II on Oil Palm	Bring additional 1.25 lakh ha area under oil palm cultivation through area expansion approach in the States including utilization of wastelands with increase in productivity of fresh fruit bunches (FFBs) from 4927 kg per ha to 15000 kg per ha.
MM III on TBOs	Enhance seed collection of TBOs from 9 lakh t to 14 lakh t and to augment elite planting materials for area expansion under waste land.

Frontline demonstrations (FLDs) by ICAR

ICAR is the nodal agency for conducting frontline demonstrations on oilseeds under the Mission. Frontline demonstrations (FLDs) are conducted by National Agricultural Research System (NARS) FLDs are part of the Annual Action Plan (AAP) prepared by ICAR. Maximum of one demonstration is allowed to one farmer for an area of one hectare under each crop. The size of FLDs plot will be of one ha but not less than 0.4 ha and assistance will be on pro-rata basis. Ten *percent* of FLD fund can be utilized by implementing agency for preparation of report, monitoring and organizing farmers' fair/melas *etc.* Need Based support will be provided to ICAR for undertaking front line demonstration on use of improved farm implements including intercropping at farmers' field.

The extension officers and other field functionaries are first source of information to the farmers. Besides, it is observed that input dealers (seeds, pesticides, fertilizers, machinery *etc*) are also important source of information to the farmers. It is felt that extension officials and input dealers need to be trained and made aware of the new technologies and developments in oilseeds cultivation so that they communicate the same to the farmers. ICAR also organizes such training to them provided that is included in their FLD Annual Action Plan.

Objectives of frontline demonstrations (FLDs)

The major objective of FLDs in oilseeds is to demonstrate the productivity potentials and profitability of the latest and improved oilseed production technologies under real farm situations. These technologies included whole package, component technologies *viz.,* improved cultivars, recommended dose of fertilizers, plant protection measures, thinning, method of sowing, irrigation, weed management, disease management and oilseed based cropping systems. FLDs are conducted under varied agro-ecological conditions and different farming situations.

Demonstrations during 2014-15

The data pertaining to FLDs on nine annual oilseeds and oilseed based farming systems were collected and compiled from various centres located across different agro-ecological and crop growing situations during 2014-15 and presented in this report.

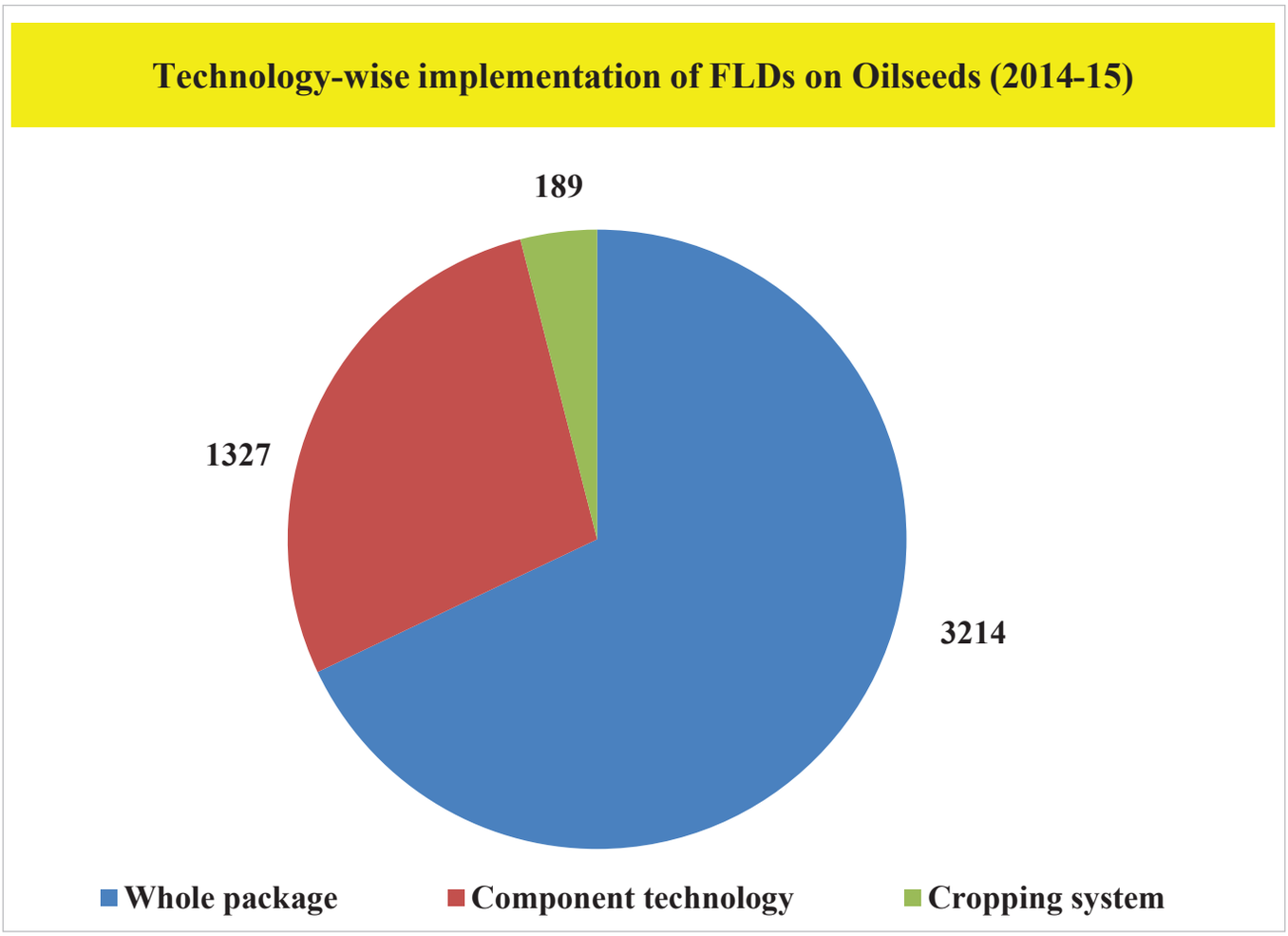
A total of 4955 demonstrations were organized out of 5105 assigned, during 2014-15 with overall implementation of 96%. Highest number of demonstrations (717) was conducted on groundnut followed by soybean (714), safflower (606), sunflower (600), rapeseed-mustard (523), castor (500), linseed (497), sesame (490), Niger (220), and oilseed based cropping systems (88) (Table 1). Maximum number of demonstrations were on whole package technology (3214), followed by component technologies (1327) and cropping systems (189). The remaining demonstrations were vitiated.

Table 1. Crop-wise and component-wise implementation of demonstrations (2014-15)

Crop	No. of FLDs		No. of demonstrations conducted				Successfully conducted (%)
	approved	allotted to centres	WP	CT	CS	Total	
Groundnut	795	886	108	609	-	717	81
Rapeseed Mustard	500	500	134	389	-	523	105
Soybean	700	705	714	-	-	714	101
Castor	500	500	450	-	50	500	100
Linseed	500	500	370	24	48	497	99
Sunflower*	600	600	570	30	-	600	100
Safflower	600	600	576	30	-	606	101

Sesame	490	490	195	142	3	490	100
Niger	220	220	97	103	-	220	100
Cropping system	100	100	-	-	88	88	88
STCR**	100	50	-	-	-	-	-
Total	5105	5151	3214	1327	189	4955	96

WP=Whole package; CT=Component technology; CS=Cropping system; *= will be reported in *Rabi*; **= report not received; the difference in FLDs (225) between alloted and conducted were vitiated



SOYBEAN

S. D. Billore

Directorate of Soybean Research Khandwa Road, Indore-452001, Madhya Pradesh

Soybean (*Glycine max* (L.) Merill) is an important oilseed crop occupying highest area (11.08 m ha) among annual oilseed crops with a total production of 10.53 m t and productivity of 950 kg/ha. Soybean is a major *kharif* season crop in the rainfed agro-ecosystem of central and peninsular India. Introduction of soybean in these areas has led to a shift in the cropping system resulted in enhancement of cropping intensity and increase in the profitability per unit area. The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Telangana, Gujarat and Uttar Pradesh (Table 1). The crop is fast spreading in southern states as well.

The unique chemical composition of soybean seed with 20% oil and 40% protein besides number of nutraceutical compounds such as isoflavons, tocopherol and lecithin has made it one of the most valuable crops in the World. The food derived from soybean provides health benefits due to cheaper source of high quality protein, the crop has potential to alleviate large scale protein malnutrition prevailing in poorer sections of society in the country. If the high quality soybean protein is included in daily diet of Indian masses, it can help in mitigating the wide spread energy-protein malnutrition. Already, the GOI as well as private sector has taken initiatives to increase the food use of soybean in the country.

Soybean plays an important role in the Indian vegetable oil basket after rapeseed-mustard and groundnut. Soybean has high demand due to its high protein and oil content. It has been used in fortified foods and in bakery products. The oil is used in anti-corrosive agents, electrical insulation, hydraulic fluids, printing inks, paints, pesticides, soaps, shampoo, detergents, waterproof cement *etc*,. There is a great potential for improving productivity of soybean in India, by adoption of the improved technologies. It was proved under the FLDs conducted across the country.

Table 1. Area, production and productivity of soybean in different states during 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Chhattisgarh	106	80	753
Gujarat	74	56	759
Karnataka	255	226	886
Madhya Pradesh	5578	6353	1139
Maharashtra	3801	2490	655
Rajasthan	923	957	1036
Telangana	244	264	1082
Uttar Pradesh	52	38	731
Uttarakhand	13	16	1231
All India	11086	10528	950

FLDs on Soybean

According to the technical programme approved by ICAR, 24 centres of AICRP-Soybean, NICT and SOPA, Indore, ITC, Secundarabad and Srijan, Rajasthan conducted a total of 714 FLDs on farmers' fields as compared to the allotment of 705 FLDs in their respective regions/areas. Ranchi, Palampur and Pantnagar centres have conducted more than the allotted FLDs during 2014-15. All the other centres have conducted as per the allotment with 101% implementation. As per the recommendations of the 'Soybean Researchers Group Meeting' all the FLDs were conducted on whole package (Table 2).

Table 2. Implementation of frontline demonstrations on soybean during 2014-15

State	Centre	Assigned	Conducted	% implementation
Bihar	Dholi	10	-	-
Chhattisgarh	Raipur	10	10	100
Gujarat	Bharuch	15	15	100
Himachal Pradesh	Palampur	10	17	170
Jharkhand	Ranchi	10	20	200
Karnataka	Bengaluru	10	10	100
	Dharwad	10	10	100
	Ugarkhurd	75	75	100

Madhya Pradesh	Indore	10	10	100
	Sehore	10	10	100
	SOPA, Indore	150	150	100
	NICT, Indore	165	165	100
	ITC, Secunderabad	25	25	100
Maharashtra	Amravati	15	15	100
	Parbhani	15	15	100
	Pune	10	10	100
	Sangli	20	20	100
Manipur	Imphal	10	10	100
Punjab	Ludhiana	10	10	100
Rajasthan	Kota	10	10	100
	Srijan	75	75	100
Tamil Nadu	Coimbatore	10	10	100
Telangana	Adilabad	10	10	100
Uttarakhand	Pantnagar	10	12	120
Total		705	714	101

Whole package demonstrations

The whole package technology demonstrations were conducted in a wide range of agro-ecological situations *viz*,. Punjab, Chattisgarh, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Gujarat, Rajasthan, Tamil Nadu, Telangana and Uttarakhand (Table 3). The whole package included use of improved variety, balanced use of fertilizers, micronutrients, need based plant protection measures and cultural practices compared to farmers' method of crop management.

Data accrued from 714 FLDs on whole package revealed that the adoption of improved soybean production technology led to an increase in seed yield by 34.76%with Additional Net Returns (ANR) of Rs 10,658/ha as compared to farmers' practice. The B:C ratio improved from 2.23 in farmers' practice to 2.50 in IT indicating the profitability of the improved technologies.

At Sangli, the whole package plots recorded highest soybean seed yield of 2746 kg/ha as compared to 2338 kg/ha in farmers' practice plots. There was 17% increase in seed yield with ANR of Rs. 11,456/ha. The B:C ratio was 1.38 and 1.11 under IT and FP, respectively. Centre-wise details of productivity potential and profitability of whole package are given in Table 3. The lowest seed yield in IT was recorded at Parbhani (1194 kg/ha) centre.

In all 714 FLDs, a total of 26 improved varieties have been demonstrated in farmers' fields (Table 4). Among the varieties, JS 93 05 gave highest yield (3125 kg/ha) followed by JS 335 (at Sangli 3083 kg/ha and at Adilabad 2571 kg/ha) and MACS 450 (2625kg/ha).

Promising soybean cultivars

State	Centre	Variety
Chhattisgarh	Raipur	JS 97 52 JS 93 05 JS 335
Gujarat	Bharuch	NRC 37
Himachal Pradesh	Palampur	Hara Soya Him soya Shivalik
Jharkhand	Ranchi	RKS 18 JS 97 52
Karnataka	Bengaluru	MAUS 2 RKS 18
	Dharwad	DSb 21
	Ugarkhurd	JS 93 05 JS 335 DSb 21
Madhya Pradesh	Indore	JS 95 60
	Sehore	JS 95 60
	SOPA, Indore	JS 95 60 JS 93 05
	NICT, Indore	JS 95 60
	ITC, Secunderabad	JS 95 60
Maharashtra	Amravati	JS 335
	Parbhani	MAUS 162 MAUS 158
	Pune	MACS 1188 RKS 18
	Sangli	KDS 344
Manipur	Imphal	JS335 RKS 18
Punjab	Ludhiana	SL 958 SL 744 SL 525
Rajasthan	Srijan	JS 95 60
Tamil Nadu	Coimbatore	JS 335 CO 3
Telangana	Adilabad	JS335
Uttarakhand	Pantnagar	PS 1368 PS 1092 PS 1347 PS 1225

Exploitable Yield Reservoir

It is observed from the demonstrations conducted in soybean across different agro-ecological situations that there exists considerable yield gap indicating tremendous scope for improving the production levels of the crop by adopting the complete package of recommended practices. An attempt was made to quantify the extent of additional soybean production that could be obtained with complete adoption of improved technology.

The average yield gap I and II was observed to the tune of 34 and 81%, respectively (Table 4). The maximum and minimum yield gap I was recorded with the state of Rajasthan and Maharashtra, however, the corresponding values of yield gap II was with Maharashtra and Madhya Pradesh. It was found that by bridging yield gap-I that exist between IT and FP, the national production could be increased from 10.52 to 14.11 m t. Similarly by bridging the yield gap- II that exists between IT and state average productivity, the national productivity could be increased to 19.07 m t. The details of state-wise yield gaps and the expected production that could be achieved by bridging the yield gap- I and II are provided in Table 4.

Table 3. Productivity potential and profitability of whole package technology in soybean demonstrated during 2014-15

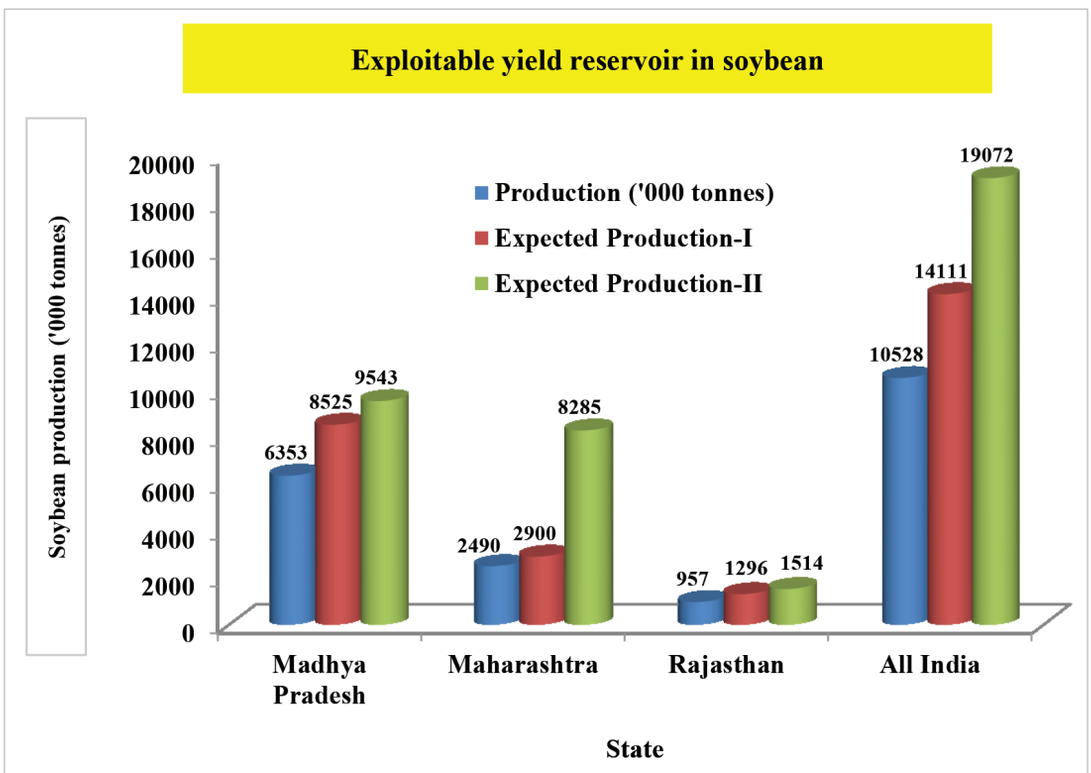
State	Centre	No. of demos	Technology	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
				IT	FP		IT	FP	IT	FP		IT	FP
Chhattisgarh	Raipur	10	JS 97 52 JS 93 05 JS 335	2499	906	176	22057	13360	88400	31780	47923	4.01	2.38
Gujarat	Bharuch	15	NRC 37	1731	1448	20	14712	14091	53675	44884	8170	3.65	3.19
Himachal Pradesh	Palampur	17	Hara soya Him soya Shivalik	1228	931	32	19920	16550	42988	32569	7049	2.16	1.97
Jharkhand	Ranchi	20	RKS 18 JS 97 52	1468	1042	41	17750	12910	38175	27100	6235	2.15	2.10
Karnataka	Bengaluru	10	MAUS 2 RKS 18	1909	1686	13	17750	15944	57270	50580	4884	3.23	3.17
	Dharwad	10	DSb 21	2596	1741	49	33430	28368	77889	52233	20594	2.33	1.84
	Ugarkhurd	75	JS 93 05 JS 335 DSb 21	1547	1314	18	38500	33300	46418	38510	2708	1.21	1.16
Madhya Pradesh	Indore	10	JS 95 60	2320	2035	14	19900	17911	69606	61050	6567	3.50	3.41
	Sehore	10	JS 95 60	1636	1295	26	18164	16017	49065	38850	8068	2.70	2.43
	SOPA, Indore	150	JS 95 60 JS 93 05	1632	1198	36	16500	12000	50582	37129	8953	3.07	3.09
	NICT, Indore	165	JS 95 60	1752	1298	35	20674	15263	56073	41532	9130	2.71	2.72
	ITC, Secun-derabad	25	JS 95 60	1696	1271	33	17215	15621	54266	40659	12013	3.15	2.60
Maharashtra	Amravati*	15	JS 335	-	-	-	-	-	-	-	-	-	-
	Parbhani	15	MAUS 162 MAUS 158	1194	1037	15	25941	24856	39413	34221	4107	1.52	1.38
	Pune	10	MACS 1188 RKS 18	2521	2188	15	31657	29521	75636	65625	7875	2.39	2.22
	Sangli	20	KDS 344	2746	2338	17	41500	39875	57365	44284	11456	1.38	1.11
Manipur	Imphal	10	JS335 RKS 18	1518	931	63	30588	19525	83482	51181	21238	2.73	2.62
Punjab	Ludhiana	10	SL 958 SL 744 SL 525	1983	-	-	25181	-	71400	-	-	2.84	-
Rajasthan	Kota	10	-	1655	1408	18	22202	19390	54599	46448	5339	2.46	2.40
	Srijan	75	JS 95 60	1638	1185	38	22921	22142	49150	35550	12821	2.14	1.61
Tamil Nadu	Coimbatore	10	JS 335 CO 3	1276	1045	22	26377	23715	44643	36586	5395	1.69	1.54
Telangana	Adilabad	10	JS335	1686	1324	27	30914	26867	57237	44936	8254	1.85	1.67
Uttarakhand	Pantnagar	12	PS 1368 PS 1092 PS 1347 PS 1225	1879	1538	22	25510	20300	56375	46125	5040	2.21	2.27

IT=Improved technology; **FP**=Farmers' practices; BC ratio = Benefit cost ratio; *= vitiated

Table 4. Exploitable yield reservoir in soybean

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Madhya Pradesh	360	1711	1275	34	1139	50	6353	8525	9543
Maharashtra	45	2179	1871	16	655	233	2490	2900	8285
Rajasthan	85	1640	1211	35	1036	58	957	1296	1514
All India	714	1721	1284	34	950	81	10528	14111	19072

IT=Improved technology; FP=Farmers' practices; Yield **gap-I**=Increase in IT over FP expressed in percentage; **Yield gap-II**=Increase in IT over state average yield expressed in percentage; **EP-I**=Expected production if Yield gap-I is bridged through complete adoption of improved practices; **EP-II**= Expected production if Yield gap-II is bridged through complete adoption of improved practices.



FLDs on whole package in soybean

RAPESEED-MUSTARD

Ashok Kumar Sharma

Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur-321303, Rajasthan

The country's rapeseed-mustard group of crops comprises a number of oil yielding Brassicas, *viz*., Indian mustard (*Brassica juncea*), *toria*, brown *sarson* and yellow *sarson* (*Brassica campestris*), *taramira* (*Eruca sativa*) and *gobhi sarson* (*Brassica napus*). Rapeseed-mustard is one of the major annual edible oilseed crop and contributed 25% of the total oilseed production in India. It ranks second in area next only to soybean in India as well as in the world. It is a major *rabi* oilseed crop of northern part of the country cultivated in an area of 5.79 m ha with 6.30 m t production and 1089 kg/ha productivity (2014-15). It is being cultivated predominantly in Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, West Bengal, Assam, Jharkhand and Gujarat (Table 1).

The seeds contain 39 to 44% oil. The oil is used in culinary preparations and salad dressings. The yellow mustard is an excellent emulsifying agent and stabilizer and used in sausage preparations. It stimulates appetite and clears the sinuses.

Rapeseed-mustard does fairly well under low input management and low water availability. Hence, the crop is an important component in crop diversification programmes and critical for the well being of small holder producers of rainfed regions of the country. A wide gap exists between the potential yield and the yield realized at the farmers' field in rapeseed mustard cultivation. This difference is mainly attributed to a number of biotic and abiotic stresses. For realizing the potential yield of the rapeseed-mustard, it is important that the farmers adopt improved technology which has been developed by research institutions. The potential of improved technology is demonstrated through FLDs in major rapeseed-mustard growing areas of the country.

Table 1. Area, production and productivity of rapeseed mustard in different states during 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	6	4	660
Assam	270	170	630
Bihar	88	92	1056
Chhattisgarh	46	26	575
Gujarat	184	306	1663
Haryana	496	699	1409
Himachal Pradesh	9	6	600
Jammu & Kashmir	61	42	693
Jharkhand	201	126	625
Karnataka	2	1	500
Madhya Pradesh	713	717	1006
Maharashtra	10	2	200
Odisha	10	3	244
Punjab	31	38	1226
Rajasthan	2474	2895	1170
Telangana	2	2	924
Uttar Pradesh	626	582	930
Uttarakhand	16	11	688
West Bengal	452	490	1084
All India	5792	6309	1089

FLDs on Rapeseed-Mustard

Under the aegis of All India Coordinated Research Project on Rapeseed-Mustard, 21 cooperating centres conducted 523 frontline demonstrations (FLDs) under irrigated as well as rainfed conditions on rapeseed (toria, yellow sarson, taramira, brown sarson and gobhi sarson) and mustard (Indian mustard and karan rai) across 13 states during 2014-15. Rajasthan conducted maximum (145) FLDs followed by Uttar Pradesh (62) and Punjab (50). Of the 21 cooperating centres, four were in Rajasthan and three were in Uttar Pradesh followed by two each in Haryana, Jammu & Kashmir and Manipur and one each in rest of the eight states. The details are presented in Table 2. One hundred thirty one FLDs were conducted on rapeseed and 392 on mustard. Maximum 356 FLDs were conducted on Indian mustard followed by gobhi sarson (54) and karan rai (36). A maximum of 134 FLDs (25.62%) on whole package (WP) and 389 (74.37%) on component technology (CT) were conducted (Table 2). The crop-wise FLDs in rapeseed mustard are presented in Table 2a.

Table 2. Implementation of frontline demonstrations on rapeseed mustard during 2014-15

State	Centre	WP	CT	Total
Bihar	Dholi	-	15	15
Gujarat	SK Nagar	-	20	20
Haryana	Hisar	3	17	20
	Bawal	-	20	20
Himachal Pradesh	Kangra	12	23	35
Jammu & Kashmir	Jammu	26	-	26
	Khudwani	-	10	10
Madhya Pradesh	Morena	-	20	20
Maharashtra	Nagpur	-	20	20
Manipur	Imphal	-	10	10
	DEE, CAU	-	30	30
Punjab	Ludhiana	50	-	50

Rajasthan	Bharatpur	-	100	100
	Jobner	-	15	15
	Srigangan-agar	-	20	20
	Navgaon	10	-	10
Uttar Pradesh	Kanpur	20	-	20
	Varanasi	-	20	20
	Amity Uni-versity	-	22	22
Uttarakhand	Pantnagar	3	17	20
West Bengal	Berhampore	10	10	20
Total		134	389	523

WP= Whole package; **CT**=Component technology

Table 2a. Crop-wise implementation of FLDs on rapeseed mustard

Crop	FLDs (No)	Types of FLDs				
		Whole package		Varietal component		Other component technology
		Irrigat-ed	Rain-fed	Irrigated	Rain-fed	
Toria	21	-	-	03	-	18
Yellow sarson	31	13	-	13	-	05
Gobhi sarson	54	14	12	-	23	05
Brown sarson	10	-	-	-	10	-
Taramira	15	-	-	-	-	15
Indian mustard	356	59	-	179	23	95
Karan rai	36	36	-	00	00	-
Total	**523**	**122**	**12**	**195**	**56**	**138**

Whole package demonstrations

Demonstrations to prove the productivity potentials and profitability of whole package technology were conducted in Himachal Pradesh, Jammu & Kashmir, Haryana, and Maharastra under rainfed conditions. Whereas, under irrigated conditions, the FLDs on whole package were conducted in Bihar, Jammu & Kashmir, Haryana, Jharkhand, Manipur, Gujarat, Madhya Pradesh, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh and West Bengal. The whole package included use of improved variety, balanced use of fertilizers, micronutrients and need based plant protection measures compared to farmers' method of crop management.

Rainfed

Gobhi sarson

At Kangra, the increase in seed yield was 34% with ANR of Rs. 5198/ha in IT plot as compared to FP plot. The B:C ratio was 2.86 and 3.40 with IT and FP, respectively.

Irrigated

Indian mustard

The seed yield in IT plots ranged from 1226 in demonstrations conducted by Jammu to 2276 kg/ha in demonstrations conducted by Navgaon. Highest ANR of Rs. 16342/ha was recorded with IT in the demonstrations conducted by Berhampore. The centre wise details of yield and economics are given in Table 3.

Yellow sarson

Berhampore, Pantnagar and Kanpur centres conducted 13 FLDs on whole package using Pitambari and Pant Sweta varieties. At Berhampore, IT plot recorded 39% higher seed yield with ANR of Rs. 9957/ ha as compared to FP plot. The B:C ratio was 2.77 and 2.65 with IT and FP plots, respectively. At Kanpur, highest seed yield of 2020 kg/ha with ANR of Rs. 15232/ ha was recorded in IT plots. The B:C ratio was 2.32 and 2.00 with IT and FP plots, respectively. At Pantnagar, IT plot recorded 11% higher seed yield with ANR of Rs. 2925/ ha as compared to FP plots. The B:C ratio was 2.13 and 2.06 with IT and FP plots, respectively.

Gobhi sarson

At Ludhiana, 14 FLDs on WP in gobhi sarson with variety GSC 7 recorded an average seed yield of 1761 kg/ha. The seed yield increased by 8% in IT plots with ANR of Rs. 3397/ha as compared to FP plots. The B:C ratio was 2.30 and 2.19 with IT and FP plots, respectively.

Karan rai

At Ludhiana, 36 FLDs on WP in karan rai with variety PC 10, recorded an average seed yield of 1894 kg/ha. The seed yield increased by 12% in IT plots with ANR of Rs. 5783/ha as compared to FP plots. The B:C ratio was 2.56 and 2.37 with IT and FP plots, respectively.

Table 3. Productivity potential and profitability of whole package technology in rapeseed mustard demonstrated during 2014-15

State	Centre	Technology	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
				IT	FP		IT	FP	IT	FP		IT	FP
Gobhi sarson - Rainfed													
Himachal Pradesh	Kangra	ONK 1 GSC 7	12	1334	992	34	14447	9043	41354	30752	5198	2.86	3.40
Indian Mustard-Irrigated													
Rajasthan	Navgaon	Navgold RRN 505 RRN 573 Laxmi	10	2276	2010	13	24500	22370	81936	72360	7446	3.34	3.23
Uttar Pradesh	Kanpur	Maya Urvashi Ashirwad	15	2005	1430	40	31180	24570	70175	50050	13515	2.25	2.04
Haryana	Hisar	-	3	1767	1723	3	28600	27880	53010	51690	600	1.85	1.85
Jammu & Kashmir	Jammu	NRCDR 02	26	1226	872	41	16525	13270	38006	27032	7719	2.30	2.04
West Bengal	Berhampore	Sarama	5	1635	1025	60	21738	15205	61312	38437	16342	2.82	2.53
Yellow sarson													
West Bengal	Berhampore	Pitambari	5	1380	990	39	18673	14005	51750	37125	9957	2.77	2.65
Uttar Pradesh	Kanpur	Pitambari	5	2020	1426	42	30530	24972	70700	49910	15232	2.32	2.00
Uttarakhand	Pantnagar	Pant Sweta	3	1396	1258	11	20303	18950	43276	38998	2925	2.13	2.06
Gobhi sarson													
Punjab	Ludhiana	GSC 7	14	1761	1638	8	24900	24300	57232	53235	3397	2.30	2.19
Karan rai													
Punjab	Ludhiana	PC 10	36	1894	1693	12	24000	23250	61555	55022	5783	2.56	2.37

IT=Improved technology; **FP**=Farmers' practices; B:C ratio = Benefit cost ratio

Component technology demonstrations

Demonstrations to show the productivity potential and profitability of component technologies *viz.*, improved cultivers, manipulation of agronomic practices (application of sulphur, thinning, interculture/weeding, optimum irrigations) management of insect pests and diseases (aphids, painted bug, sclerotinia rot, club root and powder mildew) were conducted on Indian mustard. In rapeseed, demonstrations on improved varieties, agronomic practices (zero tillage, sowing method, optimum seed rate and recommended dose of fertilizers) and plant protection were demonstrated.

Improved cultivars demonstrated under rainfed conditions

Indian mustard

At Bawal, three FLDs were conducted with improved variety, RB 50 as compared to FP of local variety. The IT plots recorded 23% higher seed yield with ANR of Rs. 11040/ha as compared to FP plots. The B:C ratio was 1.92 and 1.56 with IT and FP plots, respectively. At Nagpur, 20 FLDs were conducted with CAN 9 variety. The IT plots recorded 19% higher seed yield with ANR of Rs. 2919/ha as compared to FP plots. The B:C ratio was 1.83 and 1.56 with IT and FP plots, respectively (Table 4).

Gobhi sarson

At Kangra centre, 23 FLDs were conducted with improved varieties ONK 1 and GSC 7. The IT plots recorded 15% higher seed yield with ANR of Rs. 2191/ha as compared to FP plots. The B:C ratio was 3.01 and 3.45 with IT and FP plots, respectively (Table 4).

Brown sarson

At Khudwani centre, 10 FLDs were conducted with improved variety Shalimar Brown and Sarson 1. The IT plots recorded 16% higher seed yield with ANR of Rs. 9920/ha as compared to FP plots. The B:C ratio was 3.62 and 3.12 with IT and FP plots, respectively (Table 4).

Improved cultivars demonstrated under irrigated conditions

Indian mustard

In Rajasthan, 100 FLDs were conducted on improved cultivars. The IT plots recorded 10% higher seed yield with ANR of Rs. 5414/ha as compared to FP plots. The B:C ratio was 2.42 and 2.22 with IT and FP plots, respectively.

In Haryana, seven FLDs were conducted by Hisar and Bawal centres. The IT plots recorded 16% higher seed yield with ANR of Rs. 8845/ha as compared to FP plots. The B:C ratio was 2.04 and 1.77 with IT and FP plots, respectively.

In Gujarat, 20 FLDs were conducted by SK Nagar centre. The IT plots recorded 8% higher seed yield with ANR of Rs. 3630/ha as compared to FP plots. The B:C ratio was 2.59 and 2.40 with IT and FP plots, respectively.

In Madhya Pradesh, four FLDs were conducted by Morena centre. The IT plots recorded 13% higher seed yield with ANR of Rs. 5601/ha as compared to FP plots. The B:C ratio was 1.55 and 1.38 with IT and FP plots, respectively.

In Uttar Pradesh, 42 FLDs were conducted. The FLD plots recorded 18% higher seed yield with ANR of Rs. 8230/ha as compared to FP plots. The B:C ratio was 2.85 and 2.48 with IT and FP plots, respectively.

In Uttarakhand, three FLDs were conducted by Pantnagar centre. The IT plots recorded 31% higher seed yield with ANR of Rs. 7879/ha as compared to FP plots. The B:C ratio was 2.22 and 1.98 with IT and FP plots, respectively.

In Manipur, three FLDs were conducted by Imphal centre. The IT plots recorded 21% higher seed yield with ANR of Rs. 6960/ha as compared to FP plots. The B:C ratio was 1.82 and 1.51 with IT and FP plots, respectively.

Promising rapeseed-mustard cultivars

Crop	State	Irrigated	Rainfed
Indian mustard	Rajasthan	Navgold, RRN 505, RRN 573, Laxmi, RH 749, DRMRIJ 31, NRCDR 02, RGN 73, RGN 229, RGN 236, RGN 48, RGN 145	-
	Haryana	RB 50	RB 50
	Gujarat	GDM 4	-
	Uttarakhand	Kranti, PR 19, PT 303, Uttara	-
	Madhya Pradesh	RVM 2	-
	Maharashtra		CAN 9
	Manipur	NRCHB 101, PM 28, TS 36, TS 38	
	Uttar Pradesh	Maya, Urvashi, Ashirwad, RH 749, NRCDR 02, NRCHB 101, Kranti	-
	Jammu & Kashmir	NRCDR 02	-
	West Bengal	Sarama	-
Karan rai	Punjab	PC 10	
Brown sarson	Jammu & Kashmir	-	Shalimar Brown Sarson 1
Yellow sarson	Manipur	Pitambari, YSH 401	
	Uttarakhand	Pant Sweta	-
	Uttar Pradesh	Pitambari	-
	West Bengal	Pitambari	-
Gobhi sarson	Punjab	GSC 7	-
	Himachal Pradesh	-	ONK 1, GSC 7

Rapeseed

Toria

At Pantnagar, IT plots recorded 6% higher seed yield with ANR of Rs. 1916/ha as compared to FP plots. The cost of cultivation remained same in IT and FP but the B:C ratio marginally increased to 2.07 in IT as compared to 2.0 with FP plot, respectively.

At Imphal, IT plots recorded 10% higher seed yield with ANR of Rs. 3280/ha as compared to FP plots. The cost of cultivation remained same in IT and FP but the B:C ratio was 3.70 and 3.38 with IT and FP plots, respectively.

Yellow sarson

At Pantnagar, IT plots recorded 7% higher seed yield with ANR of Rs. 2651/ha as compared to FP plots. The B:C ratio was 2.05 and 1.92 with IT and FP plots, respectively.

At Imphal, IT plots recorded 9% higher seed yield with ANR of Rs. 3280/ha as compared to FP plots. The cost of cultivation remained same in IT and FP. but the B:C ratio was 4.14 and 3.81 with IT and FP plots, respectively.

Table 4. Productivity potential and profitability of improved rapeseed-mustard cultivars

State	Centre	Technology	FLDs	Mean Yield (kg/ha)		increase in yield over FP (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C ratio	
				IT	FP		IT	FP	IT	FP		IT	FP
Rainfed													
Indian mustard													
Haryana	Bawal	RB 50	3	1934	1566	23	30200	30200	58020	46980	11040	1.92	1.56
Maharashtra	Nagpur	CAN 9	20	621	522	19	10332	10232	18940	15921	2919	1.83	1.56
Gobhi sarson													
Himachal Pradesh	Kangra	ONK 1/ GSC 7	23	1364	1183	15	14065	10645	42284	36673	2191	3.01	3.45
Brown sarson													
Jammu & Kashmir	Khudwani	Shalimar Brown/ Sarson 1	10	1141	982	16	19542	19542	70804	60884	9920	3.62	3.12
Irrigated													
Indian mustard													
Rajasthan	*1	RH 749 DRMRIJ 31 NRCDR 02 RGN 73 RGN 229 RGN 236 RGN 48 RGN 145	100	1800	1630	10	25328	24962	61200	55420	5414	2.42	2.22
Haryana	*2	RH 0749	7	2184	1882	16	32050	31835	65520	56460	8845	2.04	1.77
Gujarat	SK Nagar	GDM 4	20	1600	1479	8	18504	18504	48000	44370	3630	2.59	2.40
Madhya Pradesh	Morena	RVM 2	4	1372	1210	13	31330	31180	48706	42955	5601	1.55	1.38
Uttar Pradesh	*3	RH 749 NRCDR 02 NRCHB 101 Maya Kranti Ashirwad	42	1860	1580	18	20200	19750	57660	48980	8230	2.85	2.48
Uttarakhand	Pantnagar	Kranti PR 19	3	1483	1133	31	20736	17765	45973	35123	7879	2.22	1.98
Manipur	Imphal	NRCHB 101 PM 28	3	1024	850	20	22500	22500	40960	34000	6960	1.82	1.51
Toria													
Uttarakhand	Pantnagar	PT 303 /Uttara	2	1317	1239	6	19696	19194	40827	38409	1916	2.07	2.00
Manipur	Imphal	TS 36 TS 38	1	926	844	10	10000	10000	37040	33760	3280	3.70	3.38
Yellow sarson													
Uttarakhand	Pantnagar	Pant Sweta	12	1332	1246	7	20178	20163	41292	38626	2651	2.05	1.92
Manipur	Imphal	Pitambari YSH 401	1	1034	952	9	10000	10000	41360	38080	3280	4.14	3.81

IT=Improved technology; FP=Farmers' practice; B:C ratio=Benefit cost ratio; *1= Data pertaining to the mean of Bharathpur, Sriganganagar; *2= Data pertaining to the mean of Hisar, Bawal; *3= Data pertaining to the mean of Varanasi, Amity University

Component technologies demonstrated in Indian mustard

A total of 95 FLDs with 12 component technologies in Indian mustard were carried out by Bharatpur (Rajasthan), Morena (Madhya Pradesh), Dholi (Bihar), Bawal (Haryana), and Imphal (Manipur) (Table 5). Among all the component technology, use of weedicide demonstrated by Dholi centre had maximum average seed yield of 2483 kg/ha. However, maximum seed yield increase of 43% was recorded with aphid management demonstrated by Morena and Berhampore centres with ANR of Rs. 10732/ha (Table 5).

Sulphur: Morena, Dholi and Bharatpur centres conducted 32 demonstrations to show the impact of sulphur nutrition in Indian mustard. The seed yield increased by 10% with ANR of Rs. 5413/ha in IT plots as compared to FP plots in IT plots. The B:C ratio was 2.16 and 2.01 with IT and FP plots, respectively.

Timely sowing: Hisar centre conducted five demonstrations. The IT plots recorded 25% higher seed yield with ANR of Rs. 11, 680/ha as compared to FP plots. The B:C ratio was 2.21 and 1.78 with IT and FP plots, respectively.

Thinning: Bawal centre conducted three demonstrations. The IT plots recorded 16% higher seed yield with ANR of Rs. 6240/ha as compared to FP plots. The B:C ratio was 1.96 and 1.88 with IT and FP plots, respectively.

Irrigation: Bawal centre conducted three demonstrations on protective irrigations. The IT plots recorded 14% higher seed yield with ANR of Rs. 6930/ha as compared to FP plots. The B:C ratio was 1.93 and 1.79 with IT and FP plots, respectively.

Interculture: Bawal, Hisar and Morena centres conducted 12 demonstrations on timely interculture. The IT plots recorded 27% higher seed yield with ANR of Rs 7858/ha as compared to FP plots. The B:C ratio was 1.75 and 1.60 with IT and FP plots, respectively.

Plant protection: Hisar centre conducted four demonstrations. The IT plots recorded 9% higher seed yield with ANR of Rs. 2620/ha as compared to FP plots. The B:C ratio was 1.79 and 1.74 with IT and FP plots, respectively.

Painted bug management: Bawal centre conducted four demonstrations. The IT plots recorded 22% higher seed yield with ANR of Rs. 9090/ha as compared to FP plots. The B:C ratio was 1.88 and 1.60 with IT and FP plots, respectively.

Sclerotinia rot management: Morena centre conducted four demonstrations. The IT plots recorded 16% higher seed yield with ANR of Rs. 4240/ha as compared to FP plots. The B:C ratio was 1.43 and 1.33 with IT and FP plots, respectively.

Aphid management: Nine FLDs on aphid management in Indian mustard were conducted by Morena and Berahampore centres. The IT plots recorded 43% higher seed yield with ANR of Rs. 10732/ha as compared to FP plots. The B:C ratio was 1.97 and 1.73 with IT and FP plots, respectively.

Zero tillage: Imphal centre conducted 12 demonstrations on use of zero till seed drill against broadcasting method of sowing, which gave 20% seed yield increase and Rs. 5932/ha additional net returns in IT as compared to FP. The B:C ratio was 3.27 and 3.23 with IT and FP plots, respectively.

Zero till and line sowing: At Dholi, two FLDs were conducted on line sowing. The IT plots recorded 13% higher seed yield with ANR of Rs. 7230/ha as compared to FP plots. The B:C ratio was 2.66 and 2.52 with IT and FP plots, respectively.

Weed control: Five demonstrations were conducted at Dholi. The IT plots recorded 14% higher seed yield with ANR of Rs. 7770/ha as compared to FP plots. The B:C ratio was 2.62 and 2.51 with IT and FP plots, respectively.

Component technologies demonstrated in Toria

Zero tillage: Imphal centre conducted 18 demonstrations on use of zero till seed drill as compared to broadcasting method of sowing, which gave 25% seed yield increase and Rs. 3772/ha additional net returns in IT compared to FP. The B:C ratio was 2.08 and 1.99 with IT and FP plots, respectively.

Component technologies demonstrated in yellow sarson

Sowing method and Seed rate: Imphal centre conducted three demonstrations. The IT plots recorded 40% higher seed yield with ANR of Rs. 10494/ha as compared to FP plots. The B:C ratio was 2.67 and 2.13 with IT and FP plots, respectively.

White rust management: White rust management practices in yellow sarson demonstrated at two locations by Imphal centre. The IT plots recorded 43% higher seed yield with ANR of Rs. 13520/ha as compared to FP plots. The B:C ratio was 2.56 and 1.98 with IT and FP plots, respectively.

Component technologies demonstrated in Gobhi sarson

Club root disease management: Berhampore centre conducted five FLDs on club root disease management in gobhi sarson using resistant variety WBBN-1 in IT. The IT plots recorded 55% higher seed yield with ANR of Rs. 12732/ha as compared to FP plots. The B:C ratio was 2.61 and 2.31 with IT and FP plots, respectively.

Component technologies demonstrated in Taramira

Recommended dose of fertilizer (RDF): Eight FLDs were conducted by Jobner centre on RDF. The IT plots recorded 20% higher seed yield with ANR of Rs. 4340/ha as compared to FP plots. The B:C ratio was 5.10 and 4.96 with IT and FP plots, respectively.

Plant protection with improved variety: Jobner centre also conducted seven FLDs on proper plant protection measures with improved variety under rainfed condition. The IT plots recorded 21% higher seed yield with ANR of Rs. 4499/ha as compared to FP plots. The B:C ratio was 5.01 and 4.80 with IT and FP plots, respectively.

FLDs on whole package in Mustard

Table 5. Productivity potential and profitability of component technologies in rapeseed-mustard

State	Centre	FLDs	Technology	Mean Yield (kg/ha)		increase in yield over FP (%)IT	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ ha) IT	B:C ratio	
				IT	FP		FP	IT	FP			FP	
Indian Mustard													
*1	*1	32	Sulphur fertilization	1944	1775	10	31460	30958	68040	62125	5413	2.16	2.01
Haryana	Hisar	5	Timely sowing	1994	1600	25	27032	26892	59820	48000	11680	2.21	1.78
	Bawal	3	Thinning	2416	2083	16	37000	33250	72480	62490	6240	1.96	1.88
		3	Two irrigations	2384	2083	14	37000	34900	71520	62490	6930	1.93	1.79
*2	*2	12	Interculture/ Weeding	1892	1494	27	34027	29243	59404	46762	7858	1.75	1.60
Haryana	Hisar	4	Plant protection	1636	1498	9	27380	25860	49080	44940	2620	1.79	1.74
	Bawal	4	Painted bug management	1888	1550	22	30200	29150	56640	46500	9090	1.88	1.60
Madhya Pradesh	Morena	4	Sclerotinia rot management (seed treatment with carbandazim @3gm/kg of seed +one spray)	1355	1165	16	33675	31170	48102	41357	4240	1.43	1.33
*3	*3	9	Aphid management (one spray of Oxidemeton methyl/ Diamethioate)	1482	1038	43	27595	21930	54346	37949	10732	1.97	1.73
*4	*4	12	Zero tillage by using zero till seed drill	1160	970	20	14738	12300	48140	39770	5932	3.27	3.23
Bihar	Dholi	2	Zero till Line sowing v/s Broadcast	2266	2002	13	29810	27800	79310	70070	7230	2.66	2.52
		5	Weed control using Pendimethalin 1000g.a.i/ha as Pre emergence 0-3 DAS	2483	2181	14	33180	30380	86905	76335	7770	2.62	2.51
Toria													
*5	*5	18	Zero tillage by using zero till seed dril	682	544	25	14738	12300	30690	24480	3772	2.08	1.99
Yellow sarson													
Manipur	Imphal	3	Sowing method and seed rate	1068	764	40	16000	14334	42720	30560	10494	2.67	2.13
		2	White rust management	1280	892	43	20000	18000	51200	35680	13520	2.56	1.98
Gobhi sarson													
West Bengal	Berhampore	5	Club root management with variety WBBN1 (Kalyan)	1360	880	55	19573	14305	51000	33000	12732	2.61	2.31
Taramira													
Rajasthan	Jobner	8	RDF + improved variety	1100	920	20	6261	5381	31900	26680	4340	5.10	4.96
		7	Plant protection and improved variety	1061	877	21	6137	5300	30769	25433	4499	5.01	4.80

IT=Improved technology; FP=Farmers' practice; B:C ratio=Benefit cost ratio; *1= Data pertaining to the mean of Morena (Madhya Pradesh), Bharatpur

Rajasthan), Dholi (Bihar); *2= Data pertaining to the mean of Bawal & Hisar (Haryana), Morena (Madhya Pradesh); *3= Data pertaining to the mean of Morena (Madhya Pradesh), Berhampore (West Bengal); *4= Data pertaining to the mean of DEE, CAU, Imphal (Manipur); *5= Data pertaining to the mean of DEE, CAU, Imphal (Manipur)

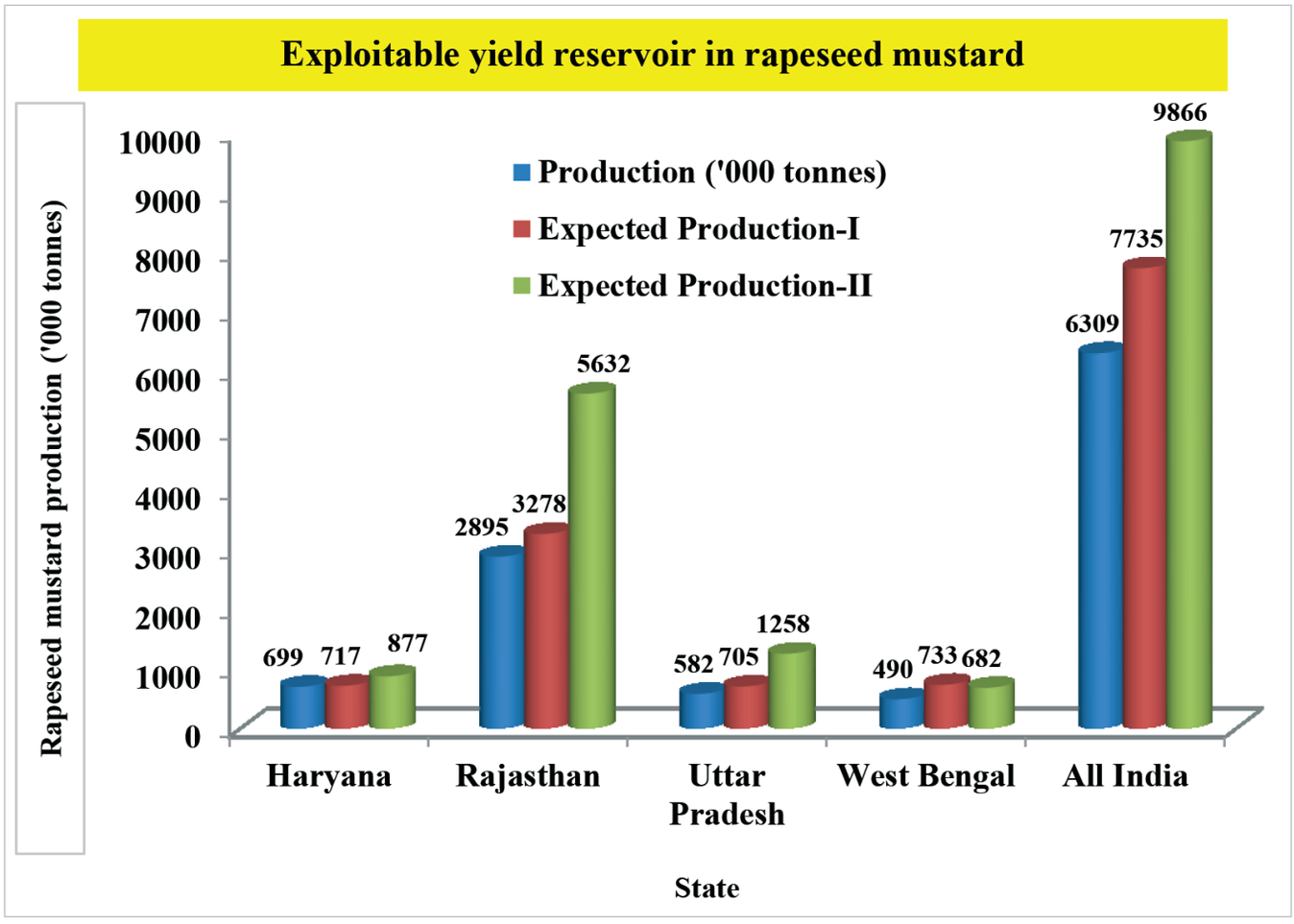
Exploitable Yield Reservoir in Rapeseed-mustard

It is evident from the productivity potentials of improved rapeseed-mustard production technologies that there exists vast potential to improve the rapeseed-mustard productivity under real farm situations. An attempt was made to estimate the extent of such yield reservoir available for exploitation (Table 6). Yield gap-I as a result of demonstration of IT over FP was ranging from 3% in Haryana to 50% in West Bengal whereas, the yield gap-II (between IT and state average productivity) was ranging from 25% in Haryana to 116% in Uttar Pradesh. It could be understood from Table 6, that rapeseed-mustard productivity at national level could be improved by 23 and 56% by bridging the yield gaps I and II respectively. Similarly, the national rapeseed-mustard production could be increased from 6.30 to 7.75 and 9.86 m t by bridging yield gaps I and II respectively. It implies that there is an urgent need for effective transfer of improved rapeseed-mustard production technologies to the rapeseed-mustard growers in order to convince them to adopt such technologies, so that the yield gaps can be bridged and rapeseed-mustard production in the country can be stepped-up.

Table 6. Exploitable yield reservoir in rapeseed mustard

State	No of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Average production ('000 tonnes)	Expected production ('000 tonnes)	
		IT	FP					EP-I	EP-II
Haryana	3	1767	1723	3	1409	25	699	717	877
Rajasthan	10	2276	2010	13	1170	95	2895	3278	5632
Uttar Pradesh	20	2009	1429	21	930	116	582	705	1258
West Bengal	10	1508	1008	50	1084	39	490	733	682
All India	134	1703	1389	23	1089	56	6309	7735	9866

IT=Improved technology; FP= Farmers' practice; **Yield gap-I**= Increase in IT over FP expressed in percentage; **Yield gap-II**= Increase in IT over state average yield expressed in percentage; EP-**I**= Expected production, if yield gap-I is bridged through complete adoption of improved practices; **EP-II**= Expected production, if yield gap-II is bridged through complete adoption of improved practices



FLDs on whole package in Mustard

FLDs showing the productivity potential of improved cultivers

GROUNDNUT

Narayanan, G.

Directorate of Groundnut Research, Ivnagar Road, Junagadh-362001, Gujarat

India is the second largest producer of groundnut (*Arachis hypogaea* L.) after China in the world. Groundnut is the most important oilseed crop in India. During *rabi* season groundnut is grown in an area of 3.93 m ha with a production of 5.07 m t and productivity of 1290 kg/ha (2014-15). Cultivation of this crop in *Rabi* is mostly confined to Andhra Pradesh, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Maharashtra, Odisha, Tamil Nadu, Telangana, Uttar Pradesh and West Bengal (Table 1a). It is grown during *kharif* in an area of 7.49 m ha with a production of 14.82 m t and productivity of 1977 kg/ha (2014-15). It is an important source of edible oil and vegetable protein. Cultivation of this crop in *kharif* is mostly confined to Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana and West Bengal (Table 1b).

Table 1a. Area, production and productivity of groundnut in different states during *Rabi* 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	68	181	2667
Gujarat	50	90	1800
Karnataka	173	180	1040
Maharashtra	46	64	1394
Odisha	26	44	1678
Rajasthan	4	5	1258
Tamil Nadu	154	455	2958
Telangana	141	252	1784
West Bengal	82	198	2415
All India	749	1482	1977

Table 1b. Area, production and productivity of groundnut in different states during *kharif* 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	80	330	410
Bihar	1	1	1022
Chhattisgarh	26	36	1412
Gujarat	1352	2134	1578
Haryana	4	4	1050
Jharkhand	25	25	1013
Karnataka	474	383	808
Kerala	1	1	1433
Madhya Pradesh	231	370	1602
Maharashtra	194	191	985
Odisha	22	23	1030
Punjab	1	3	1857
Rajasthan	501	1011	2019
Tamil Nadu	182	450	2477
Telangana	12	21	1736
Uttar Pradesh	98	84	857
Uttarakhand	1	1	1000
West Bengal	3	2	960
All India	3935	5075	1290

Groundnut pods contain high quality edible oil (50%), easily digestible protein (25%) and carbohydrates (20%). Groundnut is one of the most nourishing foods available in the world. Groundnut flour is becoming increasingly popular and is superior to wheat flour in nutritive value. It is also having curative properties in treating excessive bleeding, obesity, diabetes, diarrhea, teeth disorders, *etc.* However, excessive use of groundnut causes high acidity in the body. The productivity of groundnut is low in India as compared to other countries. Within the country, there is very high regional disparity and inter-regional variations with regard to the productivity, since the crop is cultivated under varying agro-ecological conditions. The demonstrations conducted under AICRP (Groundnut) amply indicated that there is considerable untapped yield reservoir which could be exploited by adopting the improved technologies.

FLDs on Groundnut

In order to prove the productivity potentials and profitability of improved groundnut production technologies under real farm situations, FLDs were organized at identified All India Coordinated Research Project on Groundnut (AICRP-G) and voluntary centres in varied agro-ecological situations during *kharif* and *rabi* 2014-15. Out of the total demonstrations allotted across 12 states and 32 centres, 722 were organized successfully with 82% implementation (Table 2).

Table 2. Implementation of frontline demonstrations on groundnut during 2014-15

State	Centre	No. of demonstrations			Total	% implementation
		Assigned	Conducted			
			WP	CT		
Andhra Pradesh	Jagtial	30	-	29	29	97
	Kadiri	45	-	30	30	67
	KVK Kalikiri	15	-	10	10	67
	KVK Utukuru	15	-	-	-	-
	Tirupathi (RARS)	65	-	32	32	49
	Tirupathi (KVK)	50	-	50	50	100
Gujarat	Junagadh	35	15	20	35	100
	Vyara	10	-	10	10	100
Karnataka	Chintamanai	25	10	15	25	100
	Dharwad	40	5	25	30	75
	Raichur	40	-	30	30	75
Madhya Pradesh	KVK Shivpuri	10	-	10	10	100
	KVK Jhabua	20	-	20	20	100
	Khargone	5	-	-	-	-
Maharashtra	Akola	20	10	10	20	100
	Jalgaon	40	-	45	45	113
	Latur	15	15	-	15	100
	Shirgaon	35	-	35	35	100
	Rahuri	35	-	35	35	100
	Digraj	5	-	5	5	100
Manipur	Imphal	10	-	10	10	100
Odisha	Bhubaneshwar	65	-	60	60	92
Punjab	Ludhiana	10	-	10	10	100
Rajasthan	Durgapura	15	5	10	15	100
	Udaipur	25	-	15	15	60
	Hanumangarh	10	-	10	10	100
Tamil Nadu	Aliyarnagar	15	5	10	15	100
	Bhavanisagar	20	5	-	5	25
	Vriddhachalam	40	30	10	40	100
Uttar Pradesh	Modipuram	20	-	-	-	-
	PDFSR	25	-	-	-	-
West Bengal	Mohanpur	75	8	68	76	101
Total		885*	108	614	722	82

WP=Whole package; CT= Component technology; *= Approved in Annual Action Plan 2014-15 is 675.

The implementation rate was highest (113%) at Jalgaon and lowest at Bhavanisagar (25%). Majority of the demonstrations were on component technologies (614) followed by whole package technology (108). State-wise implementation indicated that highest number of FLDs (155) were conducted in Maharashtra followed by Andhra Pradesh (151) and Karnataka (85).

Whole package demonstrations

The whole package (WP) includes use of improved variety, balanced use of fertilizers, micronutrients and need based plant protection measures compared to farmers' method of crop management. Demonstrations to prove the productivity potentials and profitability of WP were conducted in Gujarat, Maharashtra, Tamil Nadu and West Bengal during *rabi* and Gujarat, Karnataka, Rajasthan, Tamil Nadu and West Bengal during *kharif* (Table 3).

Rabi 2014-15

During *rabi*, 50 FLDs were conducted on WP. The demonstrations showed an increase in pod yield by 11% at Junagadh with additional net returns (ANR) of Rs. 68,307/ha, 54% at Dharwad (TAG 24) with ANR of Rs. 34,118/ha, 44% at Dharwad (DH-86) with ANR of Rs. 24,875/ha, 45% at Dharwad (GPBD-5) with ANR of Rs. 29,250/ha, 36% at Latur with ANR of Rs. 52,228/ha, 26% at Vridhachalam with ANR of Rs. 79,087/ha and 35% at Puducherry with ANR of Rs. 77,147/ha. Highest B:C ratio of 3.0 was reported at Latur followed by Vridhachaklam (2.7) and Junagadh (2.5) in WP as compared to farmers' practice.

Kharif 2014

During *kharif* 2014, 50 FLDs were conducted on WP. At Junagadh WP demonstrations plots recorded 15% increase in pod yield with ANR of Rs. 13,143/ha, 22% at Chintamani with ANR of Rs. 8359/ha, 24% at Dharwad with ANR of Rs. 7955, 26% at Durgapura with ANR of Rs. 21,711/ha, 25% at Aliyarnagar with ANR of Rs. 16,002/ha, 28% at Vriddhachalam with ANR of Rs. 26,615/ha, and 20% at Mohanpur with ANR of Rs. 14,177/ha as compared to farmers' practice plots. Highest B:C ratio of 3.66 was recorded at Durgapura followed by 3.44 at Mohanpur and Aliyarnagar (3.04).

Component technology demonstrations

During *rabi*/summer 2014-15, component technology demonstrations *viz.*, improved varieties, integrated pest management, integrated nutrient management, integrated weed management and plant growth promoting rhizobacteria were conducted, whereas during *kharif* 2014-15 FLDs on improved varieties and integrated pest management were conducted.

Table 3. Productivity potentials and profitability of whole package technologies in groundnut

State	Center	Technology		No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
		IT	FP		IT	FP		IT	FP	IT	FP		IT	FP
Rabi														
Gujarat	Junagadh	GJG 31	GG 2	5	2580	2329	11	44772	46490	113079	99965	68307	2.5	2.2
Karnataka	Dharwad	TAG 24	TMV-2	7	2258	1468	54	35000	28000	69118	52432	34118	2.0	1.9
	Dharwad	DH-86	TMV-2	2	1950	1350	44	35000	28000	59875	48375	24875	1.7	1.7
	Dharwad	GPBD-5	TMV-2	1	2100	1450	45	35000	28000	64250	51750	29250	1.8	1.9
Maharashtra	Latur	LGN 1	SB-XI	15	1738	1278	36	26000	23379	78228	57507	52228	3.0	2.5
Tamil Nadu	Vridhachalam	VRI-2	VRI-2	10	2753	2187	26	47271	45868	126362	100142	79087	2.7	2.2
	Puducherry	JL 24	JL 24	10	3416	2538	35	60145	67466	137301	104042	77147	2.3	1.5
Kharif														
Gujarat	Junagadh	GJG 22	GG 2 TG 37A GG-20	4	2388	2081	15	44250	45187	96556	84350	13143	2.18	1.87
		GJG 17	GG 2 TG 37A GG-20	6	1879	1683	12	43675	44167	76613	66879	10226	1.75	1.51
Karnataka	Chintamani	Chintamani-2	JL-24 TMV-2	10	1725	1419	22	20255	18570	57014	46970	8359	2.81	2.53
	Dharwad	RDF+ micronutri-ents+ weedicide	DAP& Hand weeding at 30 DAS	5	1824	1468	24	29000	25000	65160	53205	7955	2.25	2.13
Rajasthan	Durgapura	TAG 24	TMV 2	5	3268	2592	26	35072	32720	128368	104305	21711	3.66	3.19
Tamil Nadu	Aliyarnagar	VRI 6	Local Pattani	5	1985	1590	25	36097	30384	109575	87860	16002	3.04	2.89
	Vriddhachalam	VRI 6	VRI 6	10	2403	1872	28	45165	44934	123833	96987	26615	2.74	2.16
West Bengal	Mohanpur	TAG 24 TG 37	TMV2 AK 12-24	5	2505	2081	20	27658	25700	95198	79063	14177	3.44	3.08

IT=Improved technology; **FP**=Farmers' practices; B:C ratio = Benefit cost ratio

Improved varieties

FLDs to show the productivity potential and profitability of improved varieties of groundnut were conducted in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu and West Bengal (Table 4).

Rabi/summer 2014-15

During *rabi*/summer 276 FLDs were conducted with improved varieties in comparison to local varieties/farmers' varieties at different centres. The demonstrations showed an average pod yield of 2645 kg/ha in improved variety plot as compared to 2103 kg/ha in farmers' practice plots. The pod yield increased by 27% with ANR of Rs. 24, 986/ha in IT as compared to FP. The B:C ratio was 3.30 in IT and 2.63 in FP indicating the profitability of the IT (Table 4).

Highest pod yield (3468 kg/ha) was recorded with Kadiri Harithandra, followed by K-9 (3385 kg/ha), Dh-101 and TGLPS-3 (3200 kg/ha) each. Highest ANR of Rs. 59,866/ha was obtained with improved variety Chintamani-2, followed by Kadiri Harithandra (Rs 43,029/ha) and Dh-101 (Rs 42,250/ha).

Kharif-2014

During *kharif,* 219 FLDs were conducted with improved varieties in comparison to local varieties/farmers' varieties at different centres. The pod yield increased by 22% with ANR of Rs. 14,107/ha in IT as compared to FP. The B:C ratio was 2.55 in IT and 2.25 in FP indicating the profitability of the IT (Table 4).

Highest pod yield (3099 kg/ha) was recorded with RG-382, RG-425, RG-578, followed by KDG-128 (3005 kg/ha) and Phule unnati (2361 kg/ha). Highest ANR of Rs. 35,205/ha was obtained with improved variety TG-37A, followed by KDG-128 (Rs 29,955/ha) and Kadiri-9 (Rs. 21,536/ha).

Rabi 2014-15

Integrated Nutrient Management (INM)

The INM included recommended dose of NPK, micronutrients and gypsum application compared to farmers' method of nutrient management. Fourteen FLDs were conducted on INM. The demonstrations conducted at Jagityal centre recorded an average pod yield of 2333 kg/ha in INM plots as compared to 1434 kg/ha in farmers' practice plots with ANR of Rs. 54,658/ha. The B:C ratio was 4.92 and 4.02 with IT and FP plots, respectively. Bhubaneshwar centre recorded an average pod yield of 2372 kg/ha in INM plots compared to 1780 kg/ha in farmers' practice plots with ANR of Rs. 18,050/ha. The B:C ratio was 2.17 and 1.78 in IT and FP plots, respectively (Table 5).

Integrated pest and disease management (IPDM)

A total of five FLDs were conducted on IPDM. The IPDM included seed treatment, use of pheromone traps, bird perches, trap crops, neem seed kernel extract and need based pesticide application. The pod yield was 1915 kg/ha in IPDM plots as compared to 1585 kg/ha in farmers' practice plots (Table 5). An ANR of Rs. 6975 was obtained with IPDM. The B:C ratio was 2.4 and 2.2 in IT and FP plots, respectively. At Aliyanagar, IPDM plot recorded 21% increase in pod yield as compared to farmers' practice plots with ANR of Rs. 16,653/ha. The B:C ratio was 3.0 and 2.66 in IT and FP plots, respectively (Table 5).

Integrated Weed Management (IWM)

A total of five FLDs were conducted on IWM. The IWM included application of herbicides, inter-cultivation and hand weeding for management of weeds as compared to farmers' method of weed management (hand weeding). The demonstrations recorded an average pod yield of 2198 kg/ha in IWM plots as compared to 1855 kg/ha in farmers' practice plots with ANR of Rs. 12,777/ha. The B:C ratio was 1.85 and 1.66 in IT and FP plots, respectively (Table 5).

Plant Growth Promoting Rhizobacteria (PGPR)

A total of 15 FLDs were conducted with PGPR. The results showed that an average pod yield of 3194 kg/ha was recorded in PGPR plots as compared to 3014 kg/ha in farmers' practice plots with ANR of Rs. 5316/ha. The B:C ratio was 2.10 and 2.00 in IT and FP plots, respectively (Table 5).

Kharif 2014

Integrated Nutrient Management (INM)

The INM included recommended dose of NPK, micronutrients and gypsum application compared to farmers' method of nutrient management. Fourty five FLDs were conducted on INM. The demonstrations conducted at Jagityal centre recorded an average pod yield of 2296 kg/ha in INM plots as compared to 1595 kg/ha in farmers' practice plots with ANR of Rs. 44,560/ha. The B:C ratio was 5.12 and 4.67 in IT and FP plots, respectively. At Akola centre, INM plots recorded an average pod yield of 2327 kg/ha as compared to 1877 kg/ha in farmers' practice plots with ANR of Rs. 14,691/ha. The B:C ratio was 3.01 and 2.53 in IT and FP plots, respectively. At Bhubaneshwar centre, INM plots recorded an average pod yield of 1927 kg/ha as compared to 1508 kg/ha in farmers' practice plots with ANR of Rs. 15,875/ha. The B:C ratio was 2.47 and 2.17 in IT and FP plots, respectively. Ludhiana centre recorded an average pod yield of 2226 kg/ha in INM

Table 4. Productivity potentials and profitability of improved groundnut cultivars demonstrated during 2014-15

State	Center	Technology		No. of demos	Mean seed yield (kg/ha)		Increase in seed yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
		IT	FP		IT	FP		IT	FP	IT	FP		IT	FP
Rabi														
Andhra Pradesh	Kadiri	Kadiri 9	Kadiri 6	10	3385	2510	35	34705	32650	152303	112928	37320	4.39	3.46
		Kadiri Harithandra	Kadiri 6	10	3468	2453	41	34250	31600	156060	110381	43029	4.56	3.49
		Anantha	Kadiri 6	10	2743	2127	29	34175	31900	123449	95697	25477	3.61	3.00
	Tirupathi (RARS)	Dharani	Kadiri 6 Narayani TMV 2	18	2204	1838	20	31716	29746	108638	72506	34162	3.43	2.44
	Tirupathi (KVK)	Dharani TCGS 1043	Kadiri 6	20	2849	2665	7	63066	64635	94715	88684	7600	1.50	1.37
Gujarat	Junagadh	GJG 31	GG 2 TG 37A TPG 41	10	2535	2423	5	44105	43120	97688	93210	3493	2.21	2.16
	Vyara	TG 37 A	J 11	10	2536	2084	22	28911	26193	137359	112604	22037	4.75	4.30
Karnataka	Chintamani	Chintamani 2(KCG-2)	TMV 2	15	2669	2198	21	28467	26733	132513	70913	59866	4.65	2.65
	Dharwad	TGLPS 3	JL 24	1	3200	2550	25	30000	30000	113800	98350	15450	3.79	3.28
		GPBD 5	JL 24	1	3000	2300	30	30000	30000	130000	99500	30500	4.33	3.32
		Dh 101	TAG 24	1	3200	2550	25	30000	30000	137000	94750	42250	4.57	3.16
		GPBD 4	TMV 2	1	2800	1800	56	30000	30000	121000	80500	40500	4.03	2.68
		Dh 216	TMV 2	1	2500	1500	67	30000	30000	105500	69000	36500	3.52	2.30
	Raichur	R 2001-2 Kadiri 9	TMV 2	10	2375	2000	30	70636	69608	110311	91183	18100	1.56	1.31
Maharashtra	Jalgaon	JL 501	-	25	2375	1951	22	60957	50186	100097	82168	7158	1.64	1.64
	Rahuri	TPG 41	SB XI	12	2108	1791	18	32216	30482	71160	60234	9192	2.21	1.98
		Phule 6021	SB XI	8	2262	1782	27	32443	30691	75898	59934	14212	2.34	1.95
	Shirgaon	TKG Bold	SB XI	15	2341	1969	19	55951	53800	105842	84505	19186	1.89	1.57
Odisha	Bhubaneshwar	Devi	Smruti	30	2298	1754	31	39387	36201	84184	64715	16283	2.14	1.79
Rajasthan	Udaipur	TG 37 A	Local	10	2593	2095	24	34854	32258	121951	90739	28616	3.50	2.81
Tamil Nadu	Aliyarnagar	VRI(Gn)6	TMV 2 TMV 7	5	2130	1780	20	38461	35836	119880	99580	17675	3.12	2.78
Telangana	Jagtial	-	-	10	2071	1603	29	28920	26441	144963	112238	30246	5.01	4.24

West Bengal	Mohanpur	TAG 24 K6 TG 51	TMV 2 AK 12 24	43	3190	2639	21	34732	31305	111639	92378	15834	3.21	2.95
					Kharif									
Andhra Pradesh	Tirupathi (KVK)	Dharani (TCGS 1043)	Kadiri 6	30	1271	1106	15	32263	29698	42942	37410	2967	1.33	1.26
	Tirupathi (RARS)	Dharani	Kadiri 6 Narayani TMV 2	14	1290	1092	18	26533	24200	68364	47154	18877	2.58	1.95
	KVK Kalikiri	Dharani	Kadiri 6 TMV 2	10	1055	963	10	20084	19563	42200	36605	5074	2.10	1.87
Gujarat	Junagadh	GJG 17	GG 2 TG 37A GG 20	4	2313	2100	10	44125	44130	93719	84981	8743	2.12	1.93
		GJG 22	GG 2 TG 37A GG 20	6	2256	2025	11	37375	37375	91753	82465	9288	2.45	2.21
Karnataka	Dharwad	G 2 52	GPBD 4	2	2190	1710	28	33250	25000	78275	61225	8800	2.35	2.45
		DH 101	JL 24	3	1783	1516	18	33250	25000	63875	54250	1375	1.92	2.17
	Raichur	Kadiri 9	TMV 2	10	2183	1558	40	69280	66733	102098	78015	21536	1.47	1.17
Maharashtra	Jalgaon	JL 501	SB XI	20	1788	1460	22	51263	41445	75639	61711	4110	1.48	1.49
	Shirgaon	TKG BOLD	SB XI	15	2123	1822	17	38181	39074	96819	79106	18606	2.54	2.02
	Rahuri	Phule Unnati	SB XI	15	2361	1688	40	37137	36134	79078	57051	21024	2.13	1.58
	Digraj	KDG 128	TMV 10	5	3005	2306	30	43500	42000	135225	103770	29955	3.11	2.47
Madhya Pradesh	KVK Jhabua	GG 2	JGN 3	20	1554	1394	11	19355	18230	66002	56057	8820	3.41	3.07
	KVK Shivpuri	GG 20	Indori	10	2358	1698	39	39618	32143	99066	71316	20275	2.50	2.22
Manipur	Imphal	ICGS 76	JL 24	10	1303	1070	22	49536	46536	95940	79224	13716	1.94	1.70
Odisha	Bhubaneswar	Devi	JL 24	15	1737	1273	36	33580	28480	83423	61927	16396	2.48	2.17
Rajasthan	Durgapura	RG 382 RG 425 RG 578	GG 20 Girnar 2 Samrala	10	3099	2653	17	35160	33118	124314	108370	13902	3.54	3.27
	Hanumangarh	HNG 123	TG 37A HNG 10	10	2215	1915	16	23000	21500	98567	84977	12090	4.29	3.95
	Udaipur	TG 37A	Local	5	2266	1964	15	30879	29759	130905	94580	35205	4.24	3.18
West Bengal	Mohanpur	TAG 24, TG 37A	TMV 2 AK 12 24	5	2213	1845	20	26858	24246	84109	70110	11387	3.13	2.89

IT=Improved technology; **FP**=Farmers' practices; B:C ratio = Benefit cost ratio

Promising cultivars: *Rabi/ summer*

State	Centre	Cultivars
Andhra Pradesh	Kadiri	Kadiri 9, Anantha, Kadiri Harithandra
	Tirupathi (RARS)	Dharani
	Tirupathi (KVK)	Dharani (TCGS 1043)
Gujarat	Junagadh	GJG 31
	Vyara	TG 37 A
Karnataka	Raichur	R 2001-2, Kadiri 9
	Dharwad	TGLPS 3, GPBD 5, Dh 101, GPBD 4, Dh 216
	Chintamani	Chintamani 2 (KCG-2)
Maharashtra	Jalgaon	JL 501
	Rahuri	TPG 41, Phule 6021
	Shirgaon	TKG Bold
Odisha	Bhubaneshwar	Devi
Rajasthan	Udaipur	TG 37A
Tamil Nadu	Aliyarnagar	VRI(Gn) 6
West Bengal	Mohanpur	TAG 24, K6, TG 51

Promising cultivars: *Kharif*

State	Centre	Improved Cultivar
Andhra Pradesh	KVK Kalikiri	Dharani
	Tirupathi (RARS)	Dharani
	Tirupathi (KVK)	Dharani (TCGS 1043)
Gujarat	Junagadh	GJG 22, GJG 17
Karnataka	Dharwad	G 2 52, DH 101
	Raichur	Kadiri 9
Madhya Pradesh	Shivpuri (KVK)	GG 20
	KVK Jhabua	GG 2
Maharashtra	Jalgaon	JL 501
	Shirgaon	TKG BOLD
	Rahuri	Phule Unnati
	Digraj	KDG 128
Manipur	Imphal	ICGS 76
Odhisa	Bhubaneshwar	Devi
Rajasthan	Durgapura	RG 382, RG425, RG 578
	Udaipur	TG 37-A
	Hanumangarh	HNG 123
West Bengal	Mohanpur	TAG 24, TG 37A

plots as compared to 1985 kg/ha in farmers' practice plots with ANR of Rs. 9126/ha. The B:C ratio was 2.33 and 2.15 with IT and FP plots, respectively. At Vridhachalam centre, INM plots recorded an average pod yield of 2317 kg/ha as compared to 1875 kg/ha in farmers' practice plots with ANR of Rs. 23,233/ha. The B:C ratio was 2.86 and 2.27 with IT and FP plots, respectively (Table 5).

Integrated Pest Management (IPM)

The IPM included seed treatment, use of pheromone traps and need based pesticide application compared to farmers' method of nutrient management. Twenty FLDs were conducted on IPM. The demonstrations conducted at Dharwad centre recorded an average pod yield of 1844 kg/ha in IPM plots compared to 1490 kg/ha in farmers' practice plots with ANR of Rs. 6461/ha. The B:C ratio was 2.16 and 2.13 in IT and FP plots, respectively. At Raichur centre IPM plots recorded an average pod yield of 2021 kg/ha as compared to 1737 kg/ha in farmers' practice plots with ANR of Rs. 6594/ha. The B:C ratio was 2.39 and 2.20 with IT and FP plots, respectively. At Vriddhachalam centre IPM plots recorded an average pod yield of 2296 kg/ha as compared to 1807 kg/ha in farmers' practice plots with ANR of Rs. 25,872/ha. The B:C ratio was 2.76 and 2.12 with IT and FP plots, respectively (Table 5).

Integrated Disease Management (IDM)

The IDM included seed treatment and need based fungicide application compared to farmers' method of nutrient management. Five FLDs were conducted on IDM. In the demonstrations conducted at Dharwad centre, IPM plots recorded an average pod yield of 1840 kg/ha as compared to 1516 kg/ha in farmers' practice plots with ANR of Rs. 5860/ha. The B:C ratio was 2.15 and 2.17 in IT and FP plots, respectively (Table 5).

Table 5. Productivity potentials and profitability of component technologies demonstrated during 2014-15

State	Center	Technology		No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of culti-vation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
		IT	FP		IT	FP		IT	FP	IT	FP		IT	FP
Rabi														
Integrant nutrient management														
Andhra Pradesh	Jagtial	INM		4	2333	1434	63	33222	24967	163293	100380	54658	4.92	4.02
Odisha	Bhubaneshwar	Devi with INM	Smruti with INM	10	2372	1780	34	39913	36898	86690	65625	18050	2.17	1.78
Integrant pest disease management														
Tamil Nadu	Aliyarnagar	VRI(Gn)6	TMV 2 & TMV 7	5	1915	1585	21	36122	33515	108450	89190	16653	3.00	2.66
Integrant weed management														
Maharashtra	Shirgaon	IWM		5	2198	1855	198	53297	48834	98485	81245	12777	1.85	1.66
Plant growth promoting rhizobacteria														
West Bengal	Mohanpur	PGPR	No PGPR	15	3194	3014	6	36015	35015	111792	105476	5316	2.10	2.00
Kharif														
Integrated nutrient management														
Andhra Pradesh	Jagtial	Maharashtra Gulabi with INM	-	15	2296	1595	44	33635	25640	172205	119650	44560	5.12	4.67
Maharashtra	Akola	AK 303 with INM	Gopi	10	2327	1877	24	27040	25967	81456	65692	14691	3.01	2.53
Odisha	Bhubaneswar	SG 99	SG 99	5	1927	1508	28	37320	33360	92195	72360	15875	2.47	2.17
Punjab	Ludhiana	VRI 2	VRI 2	10	2226	1985	12	42000	40666	97917	87457	9126	2.33	2.15
Tamil Nadu	Vriddhachalam	-	-	5	2317	1875	24	41681	42707	119198	96991	23233	2.86	2.27
Integrated pest management														
Karnataka	Dharwad	Tebuconazole, Thiodicarb & dimethoate	Conventional pesticide	5	1814	1490	22	30000	25000	64746	53285	6461	2.16	2.13
	Raichur	Kadiri 9	TMV 2	10	2021	1737	16	33376	33115	79755	72900	6594	2.39	2.20
Tamil Nadu	Vriddhachalam	VRI 2	VRI 2	5	2296	1807	27	42844	44058	118260	93602	25872	2.76	2.12
Integrated disease management														
Karnataka	Dharwad	Carboxin+Thiram, Tebucona zole, Thiodicarb & dimethoate	Conventional Pesticide	5	1840	1516	21	30600	25000	65670	54210	5860	2.15	2.17
Plant Growth Promoting Rhizobacteria														
West Bengal	Mohanpur	TAG 24 TG 37 with PGPR	TAG 24 TG 37	5	2276	2087	9	27658	26858	86503	79291	6412	3.13	2.95

IT=Improved technology; **FP**=Farmers' practices; B:C ratio = Benefit cost ratio

Plant Growth Promoting Rhizobacteria (PGPR)

A total of five FLDs were conducted with PGPR. The results showed that an average pod yield of 2276 kg/ha was recorded in PGPR plots as compared to 2087 kg/ha in farmers' practice plots with ANR of Rs. 6412/ha. The B:C ratio was 3.13 and 2.95 in IT and FP plots, respectively (Table 5).

Exploitable Yield Reservoir in Groundnut

The impact of improved groundnut production technologies under real farm situations indicated that there is a huge gap existing between actual and attainable-yields, which can be filled through complete adoption of the whole package technology in groundnut. An attempt was made to estimate the extent of yield reservoir that can be exploited through complete adoption of technologies. For this purpose, the whole package demonstrations conducted in Andhra Pradesh (68), Gujarat (05), Maharashtra (25), Telangana (10), West Bengal (03) and all India (136) during *rabi* were considered (Table 6). The yield gap-I (between IT and FP) was 22% in Andhra Pradesh, 9% in Gujarat, 26% in Maharashtra, 29% in Telangana and 17% in West Bengal. The national groundnut production could be increased to 17.5 lakh t from 14.82 lakh t, if the yield gap-I is bridged through complete adoption of recommended technologies. Similarly, national groundnut production could be increased to 17.63 lakh t by bridging the yield gap- II through complete adoption of recommended technologies by all the farmers.

In *kharif*, the groundnut production in India could be increased to 62.03 lakh t and 86.56 lakh t by by bridging yield gap I and II, respectively even without increasing the area under ground nut. The details of state-wise exploitable yield is given in Table 7.

Table 6. Exploitable yield reservoir in groundnut during *rabi*

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Andhra Pradesh	68	2833	2313	22	2667	6	181	222	192
Gujarat	5	2580	2362	9	1800	43	90	98	129
Maharashtra	25	2363	1875	26	1394	70	64	80	108
Telangana	10	2071	1603	29	1784	16	252	326	293
West Bengal	3	3303	2813	17	2415	37	198	232	271
All India	136	2353	1992	18	1977	19	1482	1750	1763

IT=Improved technology; **FP**=Farmers' practices; **Yield gap-I**=Increase in IT over FP expressed in percentage; **Yield gap-II**= Increase in IT over state average yield expressed in percentage; **EP-I**=Expected production, if Yield gap-I is bridged through complete adoption of improved practices; **EP-II**= Expected production, if Yield gap-II is bridged through complete adoption of improved practices.

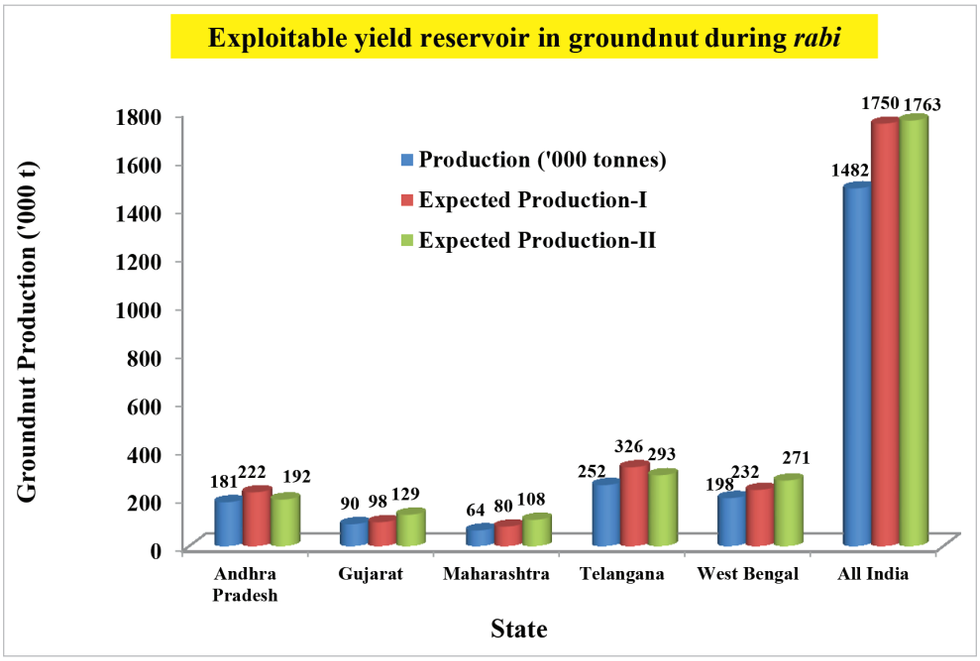
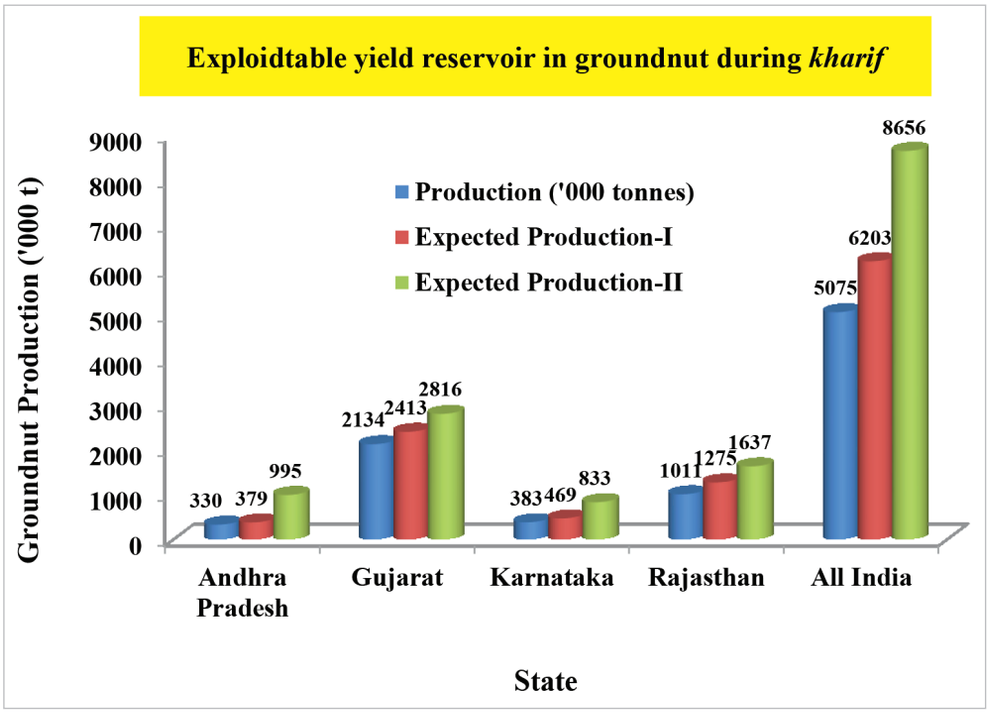


Table 7. Exploitable yield reservoir in groundnut during *kharif*

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Andhra Pradesh	54	1236	1076	15	410	201	330	379	995
Gujarat	10	2083	1842	13	1578	32	2134	2413	2816
Karnataka	15	1758	1435	23	808	118	383	469	833
Rajasthan	5	3268	2592	26	2019	62	1011	1275	1637
All India	104	2200	1800	22	1290	71	5075	6203	8656

IT=Improved technology; **FP**=Farmers' practices; **Yield gap-I**=Increase in IT over FP expressed in percentage; **Yield gap-II**= Increase in IT over state average yield expressed in percentage; **EP-I**=Expected production, if Yield gap-I is bridged through complete adoption of improved practices; **EP-II**= Expected production, if Yield gap-II is bridged through complete adoption of improved practices



FLD on whole package in Groundnut

FLDs on Groundnut+Pigeonpea intercropping

2014-15 Rabi-summer FLD farmer in Badami, Karnataka

2014-15 Groundnut FLD plots: Interaction with farmers of Bagalkot, Karnataka

Inter – cultural operations in Odisha

Rabi-summer FLD in Bhubaneswar

Interaction with Groundnut Farmers

SESAME

M.R. Deshmukh and A. Jyothisi

Project Coordinating Unit (Sesame & Niger), JNKVV Campus, Jabalpur-4820004, Madhya Pradesh

Sesame (*Sesamum indicum* L.) is mainly cultivated in the states of Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, West Bengal, Andhra Pradesh, Karnataka and Maharashtra. During 2014-2015, sesame was grown on an area of 17.79 lakh ha producing 8.11 lakh t seed with an yield of 456 kg/ha (Table 1). Sesame seed contains approximately 50% oil of an excellent quality which is acclaimed for its medicinal qualities besides other commercial uses. Oil is used in a wide range of culinary items, confectionery, preparation of pickles and in a wide spectrum of culinary dishes. Sesame being a short duration crop fits well in different cropping sequences. Being extremely sensitive to excess moisture, it is often damaged by water stagnation on heavy soils. The crop requires little fertilizers and is not severely damaged by pests. The *rabi*-summer sown sesame results in more than double seed yield as compared to traditional *kharif* crop due to less damage by insect pests. The crop is mainly cultivated by resource-poor farmers, unable to invest on inputs under rainfed conditions. Frontline demonstrations laidout on farmers' fields have proved the potential of improved technology.

Table 1. Area, production and productivity of sesame in different states during 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	79	22	547
Assam	12	8	667
Bihar	3	3	872
Chhattisgarh	18	7	382
Gujarat	204	95	466
Haryana	2	1	500
Himachal Pradesh	3	1	355
Jammu & Kashmir	5	2	382
Jharkhand	6	2	359
Karnataka	44	22	500
Madhya Pradesh	359	186	518
Maharashtra	30	6	184
Odisha	26	7	261
Punjab	5	1	298
Rajasthan	330	113	341
Tamil Nadu	69	41	595
Telangana	18	5	278
Uttar Pradesh	323	64	198
Uttarakhand	2	1	270
West Bengal	217	212	975
All India	1779	811	456

FLDs on Sesame

Out of the alloted 490 FLDs, 328 were conducted by AICRP (sesame) and voluntary centers during *kharif* 2014 with 67% overall implementation (Table 2). The implementation was 125% at Ballowal saunkhri, 120% at Gumla, 100% at Adhaura, Mandya, Parbhani, Agra, Kanpur, Kayamkulam and Bubaneshwar. The centers reported low implementation were Vridhachalam (36%), Dharwad (32%), Mauranipur (30%) and Amreli (26%). Maximum numbers of FLDs (183) were conducted on whole package followed by component technology (142) and cropping systems (03).

Table 2. Implementation of frontline demonstrations on sesame during 2014-15

State	Centre	No. of Demonstrations					Implementation (%)
		Assigned	Conducted				
			WP	CT	CS	TOTAL	
Bihar	Adhaura	15	8	7	-	15	100
Gujarat	Amreli	50	-	10	3	13	26
Jharkhand	Gumla	10	5	7	-	12	120
Karnataka	Dharwad	50	6	10	-	16	32
	Mandya	50	50	-	-	50	100
	Raichur	35	10	10	-	20	57

Kerala	Kayamkulam	20	10	10	-	20	100
Maharashtra	Jalgaon	20	5	9	-	14	70
	Nagpur	20	12	-	-	12	60
	Parbhani	20	10	10	-	20	100
Odisha	Bhubaneshwar	20	10	10	-	20	100
Punjab	Ballowal saunkhri	20	15	10	-	25	125
Rajasthan	Mandor	20	6	12	-	18	90
Tamil Nadu	Vridhachalam	50	4	14	-	18	36
Uttar Pradesh	Agra	20	8	12	-	20	100
	Kanpur	20	20	-	-	20	100
	Mauranipur	50	4	11	-	15	30
Total		490	183	142	3	328*	67

WP= whole package: CT= component technology CS= Cropping system; *= Rest were vitiated due to drought

Whole package demonstrations

Summer 2013-14: During summer 2013-14, FLDs on whole package technology were conducted in Tamil Nadu, Maharashtra and Odisha (Table 3).

***Kharif* 2014:** At Gumla, demonstrations on IT recorded 50% increase in seed yield over FP with ANR of Rs. 6160/ha. The B:C ratio was 2.11 and 2.02 with IT and FP, respectively under rainfed situations. At Parbhani, IT recorded 39% increase in seed yield as compared to FP with ANR of Rs. 10,037/ha. The B:C ratio was 2.75 and 2.30 with IT and FP, respectively. At Jalgaon, IT registered 37% increase in seed yield over FP with ANR of Rs. 15,641/ha. The B:C ratio was 3.32 and

FLDs on whole package technology in sesame

2.55 in IT and FP, respectively under rainfed condition. Adoption of whole package at Mandor recorded 27% higher yield over FP. The B:C ratio of 4.30 and 4.14 was observed with IT and FP, respectively. At Agra, whole package recorded 90% increase in seed yield over FP with ANR of Rs. 13,119/ha. The B:C ratio of 2.59 and 1.62 was noted with IT and FP respectively. At Kanpur, whole package fetched 36% higher seed yield as compared to FP with ANR of Rs. 10,420/ha. The B:C ratio of 3.17 recorded with whole package was higher than 3.02 in FP. At Mauranipur, the whole package demonstration recorded 45% higher seed yield than FP. The B:C ratio was 3.27 in whole package and 2.16 in FP. At Kayamkulam, the whole package demonstration recorded 112% higher seed yield than FP with ANR of Rs. 23,438/ha. The B:C ratio was 1.76 and 1.13 in whole package and FP, respectively (Table 3).

Component technology demonstrations

Component technology demonstrations on improved varieties, recommended dose of fertilizer, plant protection, weed control, method of sowing and intercropping were conducted during 2014-15.

Improved varieties

At Amreli under rainfed conditions, adoption of improved variety recorded 26 % higher seed yield over FP (Local variety) with ANR of Rs. 9841/ha. The B:C ratio was 1.25 and 0.85 in IT and FP, respectively. At Gumla, IT recorded 19% higher seed yield over FP with ANR of Rs. 2850/ha and the B:C ratio was 2.17 and 2.01 respectively in IT and FP. At Parbhani, increase in seed yield in IT was 26% than seed yield in FP which also resulted in higher B:C ratio of 2.88 as compared to 2.43 in FP. At Jalgaon, IT recorded 16 % higher seed yield as compared to FP with ANR of Rs. 7863/ha. The B:C ratio was 3.01 and 2.56 with IT and FP respectively. At Mandor, improved varieties yielded 17% higher seed yield over FP with ANR of Rs. 7044/ha. The B:C ratio was 3.20 with IT and 2.72 in FP. At Vriddhachalam, improved variety yielded 43% higher seed yield as compared to FP with ANR of Rs. 16,398/ha. The B:C ratio was 2.01 with IT and 1.34 with FP. At Agra, IT yielded 12% more as compared to FP with ANR of Rs. 3474/ha. The B:C ratio recorded with IT and FP was 2.92 and 2.61, respectively. At Mauranipur, IT recorded 21% higher seed yield as compared to FP with ANR of Rs. 13,512/ha. The B:C ratio was 3.46 and 2.74 with IT and FP respectively. At Kayamkulam, improved varieties resulted in 51% higher seed yield over FP with ANR of Rs. 12,176/ha. The B:C ratio was 1.51 and 1.14 with IT and FP, respectively. At Vriddhachalam, during summer 2013-14, IT recorded 63% increase in seed yield as compared to FP with ANR of Rs. 21,757/ha. The B:C ratio recorded was 2.37 and 1.23 with IT and FP respectively (Table 4).

Promising sesame varieties used for cultivation in different states

State	Centre	Varieties
Bihar	Adhaura	TKG 206
Gujarat	Amreli	Gujrat Til 4
Jharkhand	Gumla	Tarun
Karnataka	Dharwad	DS 5 and DS 1
	Mandya	GT 10
	Raichur	DS 5
Maharashtra	Jalgaon	JLT 408
	Nagpur	PKVNT 11
	Parbhani	JLT 408
Punjab	Ballowal Saunkhri	RT 46
Rajasthan	Mandor	RT 315, RT 127, RT 346
Tamil Nadu	Vridhachalam	VRI (SV) 2
Uttar Pradesh	Agra	T 78, RT 46
	Kanpur	T 78, Tarun, Pragati, T 12 and T 13
	Mauranipur	MT 75, T 78
Kerala	Kayamkulam	Thilak

Recommended dose of fertilizers

***Kharif* 2014:** At Gumla, adoption of RDF recorded 26% higher seed yield as compared to FP under rainfed conditions with ANR of Rs. 3960/ha. The B:C ratio was 2.15 and 1.98 with IT and FP respectively. At Parbhani, the seed yield increased by 23% with an ANR of Rs. 6249/ha. The B:C ratio was 2.42 and 2.16 with IT and FP, respectively. At Mandor, the IT recorded 23% higher seed yield compared to FP with ANR of Rs. 7326/ha. The B:C ratio was 2.95 and 2.68 with IT and FP, respectively. FLDs on recommended dose of fertilizers conducted at Vridhachalam, showed that in IT, seed yield increase was to the tune of 46% over FP plots with ANR of Rs. 15,944/ha. The B:C ratio was 2.01 and 1.45 with IT and FP respectively. At Agra, IT recorded 77% higher seed yield compared to FP with ANR of Rs. 11,411/ha. The B:C ratio was 2.52 and 1.58 with IT and FP, respectively. At Mauranipur, IT recorded 39% more seed yield than FP with ANR of Rs. 20,169/ha. The B:C ratio was 3.27 and 2.48 with IT and FP, respectively. At Kayamkulam, IT recorded 46% higher seed yield compared to FP with ANR of Rs. 12176/ha. The B:C ratio was 1.51 and 1.14 with IT and FP plots, respectively (Table 5).

Summer 2013-14: FLDs on recommended dose of fertilizers conducted at Vriddhachalam, showed that

in IT, seed yield increased by 70% as compared to FP with ANR of Rs. 13,632/ha. The B:C ratio was 1.70 and 1.28 with IT and FP, respectively. At Bubaneshwar IT recorded 71% higher seed yield compared to FP with ANR of Rs. 6442/ha. The B:C ratio was 1.90 and 1.66 with IT and FP, respectively (Table 5).

Plant protection

At Amreli, IT recorded 24% higher seed yield over FP with ANR of Rs. 8564/ha. The B:C ratio was 1.70 and 1.64 with IT and FP, respectively. At Jalgaon, adoption of plant protection practices recorded 16% higher seed yield than FP with ANR of Rs. 4240/ha. The B:C ratio in IT and FP was 2.26 and 2.14, respectively. At Mandor, IT recorded 13% higher seed yield over FP with ANR of Rs. 2982/ha. The B:C ratio was 2.45 and 2.42 with IT and FP, respectively (Table 5).

Summer 2013-14: FLDs on plant protection conducted at Vriddhachalam showed that in IT, seed yield increased by 66% as compared to FP with ANR of Rs. 20,827/ha. The B:C ratio was 2.57 and 1.39 with IT and FP, respectively. At Bubaneshwar, IT recorded 50% higher seed yield compared to FP with ANR of Rs. 2778/ha. The B:C ratio was 1.40 and 1.25 with IT and FP, respectively (Table 5).

Weed management

Importance of controlling weeds in sesame was demonstrated in Tamil Nadu by Vridhachalam centre during *kharif* 2014. The seed yield increase was 54% due to adoption of weed control over FP with ANR of Rs. 17,348/ha. The B:C ratio was 2.10 and 1.38 with IT and FP, respectively.

The weed management demonstrations under irrigated condition at Vriddhachalam during *rabi/summer* 2013-14 were undertaken. The seed yield increase was 70% due to adoption of weed control over FP with ANR of Rs. 21,553/ha. The B:C ratio was 2.46 and 1.32 with IT and FP, respectively (Table 5).

Cropping systems demonstrations

Profitable sesame based intercropping systems were demonstrated under rainfed conditions at Amreli, The seed yield increase was 32% as compared to FP with ANR of Rs. 7989/ha. The B:C ratio was 1.02 and 1.00 with IT and FP, respectively (Table 5).

Table 3. Productivity potential and profitability of whole package technology in sesame demonstrated during 2014-15

State	Centre	No. of FLDs	Mean Seed Yield (Kg/ha)		Increase in yield (%)	Cost of cultivation (Rs/ha)		Gross monetary returns (Rs/ha)		Additional net returns (Rs/ha)	B:C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Bihar	Adhaura*	08										
Jharkhand	Gumla	05	484	322	50	14890	10340	31460	20930	6160	2.11	2.02
Karnataka	Raichur*	10										
	Dharwad*	06										
Maharashtra	Parbhani	10	350	252	39	15939	13727	43775	31525	10037	2.75	2.30
	Jalgaon	05	438	320	37	17143	15617	57000	39780	15641	3.32	2.55
Punjab	Ballowal Saunkhari*	15										
Rajasthan	Mandor	06	610	479	27	13950	11359	59958	47083	10284	4.30	4.14
Uttar Pradesh	Agra	08	331	174	90	12257	10304	31776	16704	13119	2.59	1.62
	Kanpur	20	610	450	36	17330	13410	54900	40500	10420	3.17	3.02
	Mauranipur	04	705	487	45	21592	18610	70500	40265	27253	3.27	2.16
Kerala	Kayamkulam	10	496	234	112	35220	259099	62000	29250	23438	1.76	1.13
Summer 2013-14												
Maharashtra	Nagpur	12	484	325	49	16166	12345	62898	35759	23318	3.89	2.90
Odisha	Bhubaneshwar	10	768	432	77	15917	10190	30720	17280	8433	1.93	1.69
Tamil Nadu	Vridhachalam	12	913	607	41	30046	26612	50201	33367	13391	1.68	1.26
Early/pre-*kharif*												
Karnataka	Mandya	50										

IT=Improved technology; **FP**=Farmers' practices; B:C ratio = Benefit cost ratio : FLDs were vitiated due to heavy rains

Table 4. Productivity potential and profitability of improved sesame cultivars

State	Centre	No. of FLDs	Technology	Mean Seed Yield (Kg/ha)		Increase in yield (%)	Cost of cultivation (Rs/ha)		Gross monetary returns (Rs/ha)		Additional net Returns (Rs/ha)	B:C Ratio	
				IT	FP		IT	FP	IT	FP		IT	FP
Bihar	Adhaura	07	TKG-206	data not considered									
Gujarat	Amreli	06	Gujrat Til-4	585	467	26	23474	22754	52710	42148	9841	1.25	0.85
Jharkhand	Gumla	03	Tarun	380	322	19	11390	10340	24700	20800	2850	2.17	2.01
Karnataka	Raichur	05	DS-5	data not considered									
	Dharwad	04	DS-5 DS-1	data not considered									
Maharashtra	Parbhani	05	JLT-408	344	279	26	15145	14318	43650	34825	7998	2.88	2.43
	Jalgaon	07	JLT-408	433	354	16	17517	16144	53085	41385	7863	3.01	2.56
Rajasthan	Mandor	05	RT-315 RT-127 RT-346	480	410	17	14960	15029	47800	40825	7044	3.20	2.72
Tamil Nadu	Vridhachalam	04	VRI (SV)-2	839	587	43	25156	26419	50355	35220	16398	2.01	1.34
Uttar Pradesh	Agra	06	T-78 RT-46	364	325	12	11942	11942	34944	31200	3474	2.92	2.61
	Mauranipur	07	MT-75 T-78	634	523	21	18306	18103	63400	49685	13512	3.46	2.74
Kerala	Kayamkulam	05	Thilak	367	243	51	30214	26432	44774	28831	12176	1.51	1.14
SUMMER 2013-14													
Tamil Nadu	Vridhachalam	03	VRI (SV)-2	847	521	63	19496	23323	46603	28679	21757	2.37	1.23

IT=Improved technology; **FP**=Farmers' practices; B:C ratio = Benefit cost ratio

Table 5. Productivity potential and profitability of component technologies on sesame

State	Centre	No. of FLDs	Mean Seed Yield (Kg/ha)		Increase in yield (%)	Cost of cultivation (Rs/ha)		Gross monetary returns (Rs/ha)		Additional net Returns (Rs/ha)	B : C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Recommended dose of Fertilizer												
Jharkhand	Gumla	04	440	350	26	13280	11390	28600	22750	3960	2.15	1.98
Karnataka	Raichur	05										
	Dharwad	03	data not considered									
Maharashtra	Parbhani	05	335	273	23	17321	15820	41875	34125	6249	2.42	2.16
Punjab	Ballowal Saunkhari	10	data not considered									
Rajasthan	Mandor	04	481	391	23	16287	14551	48125	39063	7326	2.95	2.68
Tamil Nadu	Vridhachalam	02	913	626	46	27219	28972	54750	37560	15944	2.01	1.45
Uttar	Agra	06	301	170	77	11469	10304	28896	16320	11411	2.52	1.58
Pradesh	Mauranipur	04	707	510	39	21604	19523	70700	48450	20169	3.27	2.48
Kerala	Kayamkulam	05	375	256	46	30214	26432	45875	30375	12176	1.51	1.14
Summer 2013-14												
Odisha	Bhubaneshwar	05	662	385	71	13915	9277	26480	15400	6442	1.90	1.66
Tamil Nadu	Vridhachalam	02	876	516	70	28374	22207	48153	28353	13632	1.70	1.28
Plant protection												
Gujarat	Amreli	04	726	583	24	24194	19948	65443	52633	8564	1.70	1.64
Maharashtra	Jalgaon	02	370	320	16	19530	17770	44400	38400	4240	2.26	2.14
Rajasthan	Mandor	03	335	287	13	13628	11860	33500	28750	2982	2.45	2.42
Karnataka	Dharwad	03										
Summer 2013-14												
Odisha	Bhubaneshwar	05	450	300	50	12802	9580	18000	12000	2778	1.40	1.25
Tamil Nadu	Vridhachalam	03	854	515	66	18284	20504	46952	28343	20827	2.57	1.39
Weed management												
Tamil Nadu	Vridhachalam (kh.)	02	828	538	54	23612	23569	49650	32250	17348	2.10	1.38
	Vridhachalam (*Rabi*/summer)	02	870	513	70	19491	21410	47823	28188	21553	2.46	1.32
Intercropping												
Gujarat	Amreli	03	706	535	32	31575	24168	63673	48276	7989	1.02	1.00

IT=Improved technology; FP=Farmers' practices; B:C ratio = Benefit cost ratio

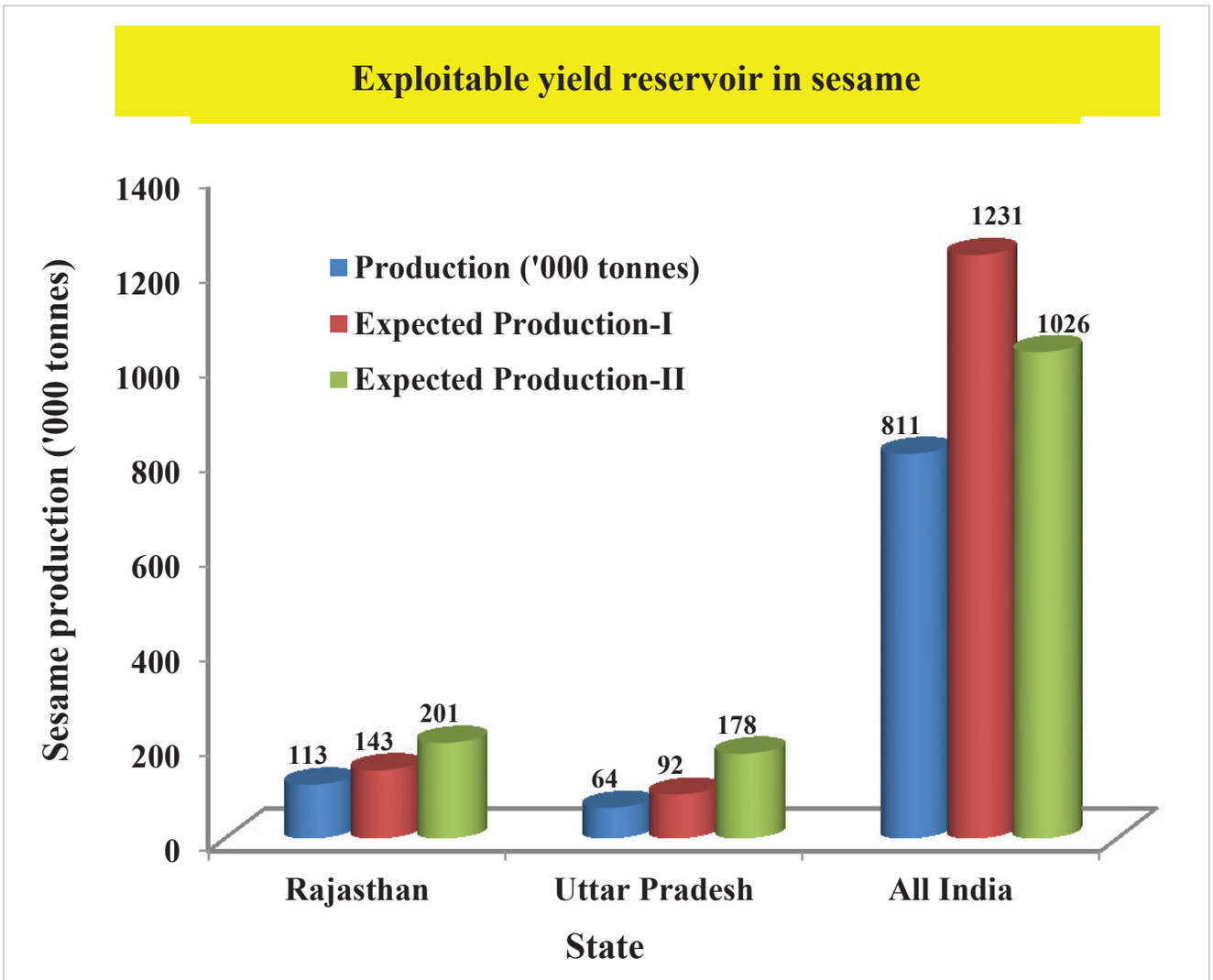
Exploitable Yield Reservoir

The impact of improved sesame production technologies under real farm situations indicated that there is a huge gap available between actual and attainable yields, which can be bridged through complete adoption of improved technologies. An attempt was made to estimate the extent of yield reservoir available through complete adoption of technologies. For this purpose, the whole package demonstrations conducted in Uttar Pradesh (32), Rajasthan (06) and all India (195) were considered (Table 6). The yield Gap-I (between IT and FP) was ranging from 27% in Rajasthan to 43% in Uttar Pradesh. The national sesame production could be increased to 12.31 lakh tonnes from 8.11lakh t, if the yield gap-I was bridged. Similarly, the yield gap-II (between IT and state average productivity) was ranging from 79% in Rajasthan to 179% in Uttar Pradesh. The national sesame production could be increased to 10.26 lakh t by bridging the yield gap II. This situation warrants an urgent need to effectively transfer the improved sesame production technologies among the sesame growers, so that the huge exploitable yields reservoir is harnessed.

Table 6. Exploitable yield reservoir in sesame

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Rajasthan	6	610	479	27	341	79	113	143	201
Uttar Pradesh	32	552	386	43	198	179	64	92	178
All India	195	577	380	52	456	27	811	1231	1026

IT=Improved technology; **FP**=Farmers' practices; **Yield gap-I**=Increase in IT over FP expressed in percentage; **Yield gap-II**=Increase in IT over state average yield expressed in percentage; **EP-I**=Expected production if Yield gap-I is bridged through complete adoption of improved practices; **EP-II**= Expected production if Yield gap-II is bridged through complete adoption of improved practices.



CASTOR

G.D.S. Kumar and M. Padmaiah

Indian Institute of Oilseeds Research (ICAR-IIOR), Rajendranagar, Hyderabad-500 030 Telangana

Castor (*Ricinnus communis* L.) occupies an important place in the country's vegetable oil economy. India is the leading castor growing country in the World with an area of 11.05 lakh ha and production of 17.33 lakh t. The productivity of castor is 1568 kg/ha (2014-15). Castor seed is the source of castor oil containing 35-58% oil that is rich in triglycerides. The oil, due to unique hydroxyl fatty acid;ricinoleic acid, is one the important non-edible industrial oils used in a number of products. Castor oil and its derivatives have applications in the manufacturing of soaps, lubricants, hydraulic and brake fluids, paints, dyes, coatings, inks, cold resistant plastics, waxes, polishes, nylon, pharmaceuticals and perfumes. Castor oil is commonly used in medicines as a laxative and to treat skin disorders. Castor cake is an excellent source of organic fertilizer. In eri silk producing areas, leaves are fed to eri silkworms.

In India, castor is mostly confined to Gujarat, Rajasthan, Telangana and Andhra Pradesh. Although other states like, parts of Madhya Pradesh, Maharashtra, Karnataka and Odisha cultivate castor, their contribution to either area or production is limited. Despite the phenomenal increase witnessed in the production and productivity of castor over the last three decades, still there exists wide gap in the per hectare yields of castor across states (Table 1).

1. Area, production and productivity of castor in different states during 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	46	26	574
Assam	1	1	500
Gujarat	683	1298	1900
Karnataka	12	7	583
Madhya Pradesh	21	1	48
Maharashtra	17	4	235
Odisha	11	7	639
Punjab	28	21	752
Rajasthan	226	335	1481
Tamil Nadu	6	2	312
Telangana	51	30	588
All India	1105	1733	1568

Frontline demonstrations on castor

In order to show productivity potential and profitability of the latest improved cultivars and production technologies of castor, frontline demonstrations were conducted in seven states during 2014-15. Five hundred FLDs were conducted on improved castor production technologies during *rabi* 2013-14 and *kharif* 2014 at AICRP (Castor) and voluntary centres with an overall implementation of 98% (Table 1). As per the recommendations of the earlier group meetings, all of the demonstrations were conducted on whole package technology (450) followed by few on castor based cropping systems (50).

Whole package demonstrations

Four hundred and fifty FLDs were conducted on whole package. Whole package included improved cultivar, optimum spacing, recommended dose of fertilizers and need based plant protection for the respective regions/centres.

Rabi 2013-14

Demonstrations conducted by Navsari centre recorded 18% increase in seed yield in improved technology (IT) plots (2444 kg/ha) as compared to farmers practice (FP) plots with additional net returns (ANR) of Rs. 10,055/ha. The B:C ratio was 2.93 and 2.73 with IT and FP, respectively. The details are presented in Table 2.

Kharif 2014

The FLDs conducted over the locations on whole package demonstrations during *kharif* 2014, recorded an overall increase in seed yield by 28% as compared to FP with ANR of Rs. 18,104/ha. The B:C ratio was 3.23 and 2.69 with IT and FP, respectively. The centre-wise details of demonstrations are presented in Table 3.

Palem centre has conducted demonstrations on component technology *i.e.* application of micronutrient ($ZnSO_4$) which resulted in 24% increase in seed yield in IT (2625 kg/ha) as compared to FP (2125 kg/ha) with ANR of Rs. 18,163/ha. The B:C ratio was 3.07 and 2.43 with IT and FP, respectively (Table 4).

Intercropping systems

Remunerative intercropping systems were demonstrated in Gujarat and Uttar Pradesh. Demonstrations conducted by Junagadh on castor (GCH-7) + groundnut (GG-20) (1:2/1:3) intercropping recorded 148% increase in castor equivalent yield as

compared to sole groundnut. The IT gave an ANR of Rs. 1,04,979/ha and the B:C ratio of 5.57 as compared to FP (4.86) indicating the high profitability. Demonstrations conducted by Kanpur on castor + chilli (1:8) recorded 164% increase in castor equivalent yield as compared to FP. The IT gave an ANR of Rs. 79,411/ha with B:C ratio of 4.92 as compared to FP (3.14).

Based on the demonstrations on whole package, it was estimated that castor production in the country could be increased from 16.89 lakh t to 21.70 and 27.00 lakh t by bridging the yield gaps I (yield gap between improved technology and farmers' practice) and II (yield gap between improved technology and state average yield), respectively. In Andhra Pradesh, castor production could be increased from 0.81 lakh t to 3.09 lakh t by bridging the yield gap II. In Gujarat and Rajasthan, it could be increased to 19.89 lakh t and 7.53 lakh t, respectively (Table 5).

Table 2. Implementation of frontline demonstrations in castor during 2014-15

State	Centre	FLDs assigned			FLDs conducted			Implementation (%)
		Whole package	CS	Total	Whole package	CS	Total	
Telangana	Palem[a]	30	-	30	25	5	30	100
Bengaluru	Mandya[b]	15	-	15	-	-	15	100
Chhattisgarh	Bhatapura[c]	5	-	5	-	-	-	-
Gujarat	Anand	20	-	20	20	-	20	100
	Junagadh	15	10	25	15	10	25	100
	Navsari	20	-	20	15	-	15	75
	SK Nagar	25	-	25	25	-	25	100
Haryana	Bawal	40	15	55	40	15	55	100
Karnataka	Dharwad	10	-	10	10	-	10	100
	Hiriyur	25	-	25	25	-	25	100
Madhya Pradesh	Chhindwara[b]	20	-	20	20	-	20	100
Odisha	Bhavanipatna	20	-	20	20	-	20	100
Rajasthan	Mandor	80	10	90	90	-	90	100
Tamil Nadu	Yethapur	40	10	50	40	10	50	100
Telangana	DOR, Hyderabad[b]	80	-	80	80	-	80	100
Uttar Pradesh	Kanpur	10	10	20	10	10	20	100
Total		455	55	510	450	50	500	98

CS= Cropping system; a= 15 FLDs conducted in *rabi* 2014-15; b= vitiated; c= FLDs not conducted

Promising castor cultivars demonstrated in farmers' fields

State	Centre	Cultivars
Gujarat	Anand	GCH-7
	Junagadh	GCH-7
	Navsari	GCH 7
	SK Nagar	GCH 7
Karnataka	Hiriyur	DCH-177/ DCH-519
Odisha	Bhavanipatnam	DCH-177
Rajasthan	Mandor	GCH-7
Tamil Nadu	Yethapur	YRCH 1
Telangana	Palem	DCH-177, PCH-111
Uttar Pradesh	Kanpur	DCH-177

Remunerative castor based intercropping systems

State	Intercropping system
Gujarat	Castor + groundnut (1:2 or1:3)
Uttar Pradesh	Castor + chillies (1:8)

Table 3. Productivity potential and profitability of whole package technology in castor during 2014-15

State	Centre	No. of demos	Technology		Mean seed yield (kg/ha)		% increase in yield	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C ratio	
			IT	FP	IT	FP		IT	FP	IT	FP		IT	FP
***Rabi* (2013-14)**														
Gujarat	Navsari	15	GCH-7 spacing: 120x60 cm, RDF (80:40:0 NP), need based plant protection	GCH-4	2444	2077	18	28801	26445	84474	72063	10055	2.93	2.73
Kharif														
Telangana	Palem	5	DCH-177, RDF recommended spacing and management of sucking pests and capsule borer	Local variety	2390	2085	15	28168	29328	83650	72975	11835	2.97	2.49
		4	PCH-111, RDF recommended spacing and management of sucking pests and capsule borer	Local variety	2444	2088	17	28014	29174	85969	73063	14066	3.07	2.5
Gujarat	Anand	15	GCH-7, spacing: 120X60 cm, RDF and need based plant protection	GCH-4	3775	3258	16	34416	34214	56628	48876	7550	1.65	1.43
	Junagadh	6	GCH-7, spacing: 150-180 cm x 60 cm, RDF (150-250:50:0 NP)	GCH-4	4063	3563	14	27543	26342	162500	142500	18799	5.9	5.41
	SK Nagar	20	GCH7-, spacing: 150x120 cm, 25 kg/ha Sulphur application with wider	GCH-4	2409	2105	14	40734	40221	89120	77897	10710	2.19	1.94
Karnataka	Hiriyur	20	DCH-177/ DCH-519 spacing: 90x60cm 40:40:20 NPK	Local variety	988	658	50	11300	6538	36538	24328	7448	3.23	3.72
Odisha	Bhavanipatna	20	DCH-177	Chitki	768	451	70	19952	12006	30720	18040	4734	1.54	1.5
Rajasthan	Mandor	80	GCH-7, spacing: 120x60 cm, RDF application of gypsum, need based	Local variety	3855	3046	27	40000	38000	146490	115758	28733	3.66	3.05
Tamil Nadu	Yethapur	10	YRCH-1, spacing: 120x90 cm, RDF (45:15:15) and need based plant protection	Local variety	2570	927	177	18875	14375	101430	37070	59860	5.37	2.58
Uttar Pradesh	Kanpur	10	DCH-177, Spacing: 90x90 cm	Local variety	2058	1531	34	19978	17803	76128	56647	17306	3.81	3.18

T=Improved technology; FP=Farmers' practices; B:C ratio = Benefit cost ratio

Table 4. Productivity potential and profitability of component technologies in castor

State	Centre	No. of demos	Mean seed yield (kg/ha)		% increase in yield	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Micro nutrient management (ZnSo4)												
Telangana	Palem	1	2625	2125	24	29945	30608	91875	74375	18163	3.07	2.43

IT=Improved technology; FP=Farmers' practices; I=Irrigated; R=Rainfed; B:C ratio = Benefit cost ratio

Table 5. Productivity potential and profitability of intercropping systems in castor

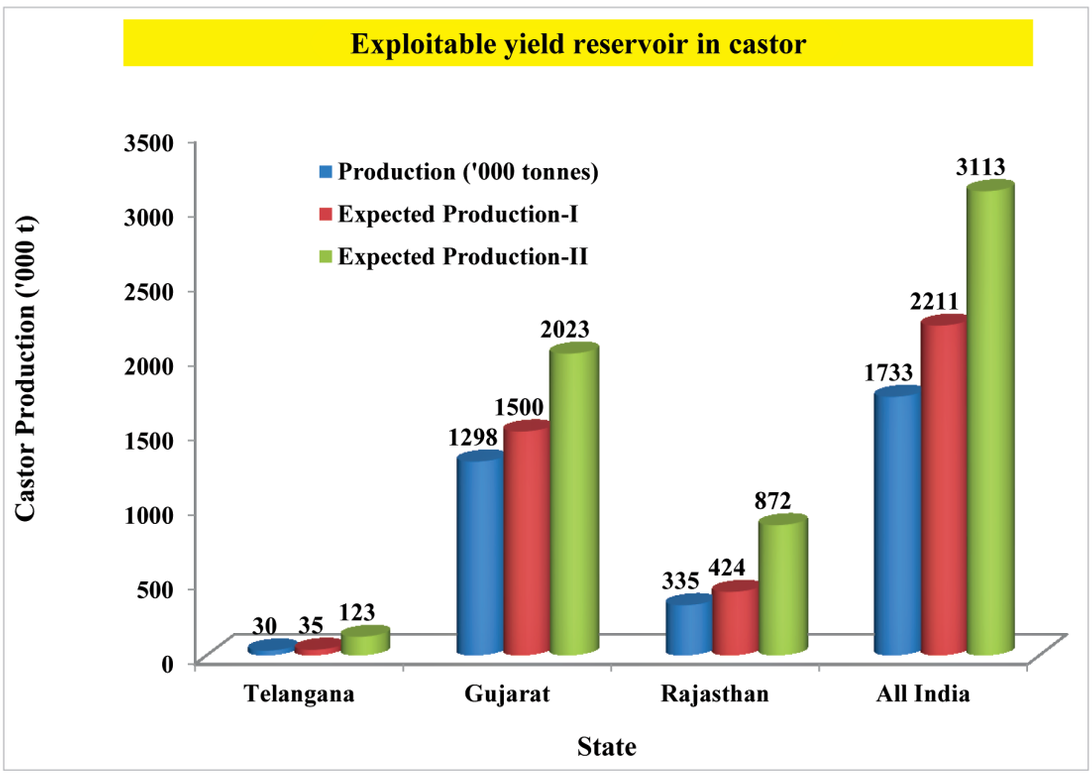
State	Centre	Technology	No. of demos	Castor equivalent yield (kg/ha)		% increase in yield	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C ratio	
				IT	FP		IT	FP	IT	FP		IT	FP
Gujarat	Junagadh	Castor + groundnut (1 :2 / 1 :3)	5	5266	2125	148	38121	17913	212188	87000	104979	5.57	4.86
Uttar Pradesh	Kanpur	Castor + chilli (1:8)	10	3987	1512	164	30000	17803	147534	55926	79411	4.92	3.14

IT=Improved technology; FP=Farmers' practices; I=Irrigated; R=Rainfed; B:C ratio = Benefit cost ratio

Table 6. Exploitable yield reservoir in castor

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Telangana	9	2414	2086	16	588	311	30	35	123
Gujarat	56	2961	2563	16	1900	56	1298	1500	2023
Rajasthan	80	3855	3046	27	1481	160	335	424	872
All India	205	2816	2208	28	1568	80	1733	2211	3113

IT=Improved technology; FP=Farmers' practices; Yield gap-I=Increase in IT over FP expressed in percentage;
Yield gap-II=Increase IT over state average yield expressed in percentage; EP-I=Expected production if Yield gap-I is bridged through complete adoption of improved practices; EP-II=Expected production if Yield gap-II is bridged through complete adoption of improved practices.



Frontline Demonstrations conducted at different locations

SUNFLOWER

G.D.S. Kumar

Indian Institute of Oilseeds Research (ICAR-IIOR)
Rajendranagar, Hyderabad-500 030 Telangana

Sunflower (*Helianthus annuus* L.) is an important oilseed crop cultivated for its premier oil and has manifold uses of both industrial and pharmaceutical importance. Its wider adaptability, day neutral nature, responsiveness to better management practices have played a significant role in its cultivation across varied agro-climatic zones within a span of four decades of its introduction in the country. In India, it is grown in an area of 3.52 lakh ha with production of 3.09 lakh t and a productivity of 877 kg/ha during *rabi* (2014-15, Table 1a) and in an area of 1.99 lakh ha, with a production of 1.06 lakh t and productivity of 532 kg/ha in *kharif* (Table 1b). Though, sunflower is traditionally cultivated in Karnataka, Maharashtra, Andhra Pradesh and Tamil Nadu, it has gained momentum in Punjab, Haryana, Uttar Pradesh, Uttarakhand, Bihar, West Bengal and Odisha (Table 1). It can be grown during any part of the year and comes up well with timely and proper management of inputs. Sunflower seed contains 38 to 40% oil. The oil commands premium price due to high level of unsaturated fatty acids and lack of linolenic acid, odourlessness and light colour. Sunflower cake as a feed fits well to the bovines, swine and poultry. Sunflower also finds place in the industrial sector and is used in paints, varnishes and plastics.

The impressive strides made in the production front in sunflower could not be sustained and hence there was stagnation in the production over the years. Although, there are several reasons contributing to the stagnation in productivity, its cultivation restricted to marginal and sub-marginal lands with poor management practices, monocropping year after year, poor supplementary and complementary nutrient-related issues, lack of quality, biotic stresses *etc.*, are the most important ones. The researchers involved in the AICRP (Sunflower) have addressed several of the above issues for harnessing the productivity, which are easily replicable under farmers' field conditions. Several newer interventions and technologies have emerged under the umbrella of the AICRP network suitable to specific agro-ecological situations. The impacts of such interventions under different agro-ecological situations in real farm conditions during 2014-15 are discussed here.

Table 1a. Area, production and productivity of sunflower during *Rabi* 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	38	33	864
Bihar	10	15	1447
Haryana	9	19	2111
Jharkhand	0.5	0.2	500
Karnataka	200	130	650
Maharashtra	20	10	501
Odisha	21	26	1202
Punjab	9	16	1802
Tamil Nadu	7	11	1509
Telangana	13	13	1043
Uttar Pradesh	3	5	1667
West Bengal	15	22	1467
All India	352	309	877

Table 1b. Area, production and productivity of sunflower during *kharif* 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	11	6	539
Bihar	3.1	4	1291
Jharkhand	0.2	0.2	870
Karnataka	155	82	529
Maharashtra	27	10	370
Odisha	0.3	0.2	719
Tamil Nadu	1.3	2.3	1777
Telangana	1	1	912
All India	199	106	532

FLDs on Sunflower

FLDs on improved sunflower production technologies were demonstrated during *rabi*/spring/ 2013-14 and *kharif* 2014 at various agro-ecological situations of the country.

A total of 499 FLDs were conducted during the period of report (Table 1). Out of which, 404 FLDs were conducted during *rabi*/spring/ 2013-14 and the remaining during *kharif* 2014. Majority of demonstrations (469) were on whole package followed by component technology (30).

FLDs conducted during *rabi*/spring/ 2013-14

The details of productivity potential and profitability of whole package and component technology demonstrations conducted at various centres in *rabi*/spring/ 2013-14 are given in Table 2.

Demonstrations on whole package were conducted at 11 centres. The results showed that the mean seed yield increased by 19% in demonstration plots as compared to farmers' practice (FP) plots. The mean additional net returns (ANR) accrued to farmers with improved technology (IT) were Rs. 8,118/ha. The overall cost benefit ratio was in favour of IT with 2.06 as compared to FP.

Highest seed yield of 2945 kg/ha was reported by ARKVK, Chittoor under irrigated conditions using hybrid APSH-66 in IT compared to 2662 kg/ha in FP. Gorakhpur centre has reported highest increase in seed yield (88%) in IT as compared to FP (Table 2). Akola centre has reported highest ANR of Rs. 12,140/ha with IT. All the public hybrids (DRSH-1, APSH-66, KBSH-53, LSFH-171 and PSH-996) outperformed private hybrids (SB-275, Siri, Sandoz, Ganga kaveri and PAC-361).

Demonstrations on improved cultivars conducted by ARKVK, Chittoor recorded seed yield of 3277 kg/ha in IT plot (APSH-66) as compared to 2699 kg/ha in FP plot (SB-275). ANR accrued with IT were Rs. 15,405/ha. The B:C ratio was 2.82 and 2.45 with IT and FP respectively indicating the profitability of the improved cultivars (Table 2).

Demonstrations on site specific nutrient management conducted by IIOR increased the seed yield by 19% as compared to FP of applying urea and DAP. In IT (Rs. 24,250/ha) the cost of cultivation also decreased as compared to FP (Rs. 26,000/ha). ANR accrued were Rs. 13,000/ha with IT. The B:C ratio was 2.86 and 2.24 with IT and FP, respectively. Simple practice of application of boron @ 2 ml/l as directed spray on capitulum at 55 days after sowing resulted in 12% increase in seed yield in IT plot as compared to FP. An ANR of Rs. 4,813/ha was accrued with IT. The B:C ratio was 2.13 and 1.98 with IT and FP, respectively. Soil application of sulphur @ 20 kg/ha increased the seed yield by 13% in IT plot as compared to FP. An ANR of Rs. 6,063/ha was obtained with IT. The B:C ratio was 2.49 and 2.24 with IT and FP, respectively.

FLDs conducted during *kharif* 2014

During *kharif* 2014, the whole package demonstrations resulted in 24% increase in mean seed yield in IT plots as compared to FP plots. An ANR of Rs. 5,851/ha were accrued with IT. The B:C ratio was 1.53 and 1.33 with IT and FP, respectively. Highest seed yield of 2127 kg/ha was reported by Coimbatore centre using TNAUSFH CO2 in whole package as compared to FP (1690 kg/ha) under irrigated conditions. An ANR of Rs. 9960/ha was obtained. The B:C ratio was 1.48 and 1.31 with IT and FP, respectively (Table 3).

Under rainfed conditions, Raichur centre reported highest seed yield of 1314 kg/ha in IT plot as compared to 1071 kg/ha in FP plot. An ANR of Rs. 3,645/ha were accrued with IT. The B:C ratio was 2.10 and 1.86 in IT and FP, respectively.

Exploitable yield reservoir

The state-wise yield gap-I (yield gap between improved technology and farmers' practice), yield gap-II (yield gap between improved technology and state average yield) and expected productions of sunflower, if yield gaps I and II are filled during *rabi*/spring season are given in Table 4. Overall, the yield gaps I and II were 19% and 108% respectively. Sunflower production during *rabi*/spring season can be increased to 4.68 and 8.19 lakh t, if the yield gaps I and II are bridged respectively.

The state-wise yield gaps I and II and expected productions of sunflower, if yield gaps I and II are filled during *kharif* are given in Table 5. Overall, the yield gaps I and II were 32% and 102%, respectively. Sunflower production during *kharif* can be increased to 2.01 and 3.09 lakh t, if the yield gaps I and II are bridged, respectively.

Table 2. Season-wise implementation of FLDs in sunflower

Centres	Whole package		Component technology	Total
	rabi/spring	*kharif*	*rabi*/spring	
Akola	16	15	-	31
Banaglore	50	-	-	50
Berhampore*	20	-	-	20
Chittoor	5	-	15	20
Coimbatore	-	25	-	25
Dholi	13	-	-	13
IIOR	50	-	15	65
Gorakhpur**	40	-	-	40
Hisar	20	-	-	20
Latur	40	-	-	40
Ludhiana***	50	-	-	50
Nimpith	50	-	-	50
Pantnagar*	30	-	-	30
Prakasham	20	-	-	20
Raichur	-	25	-	25
Total	404	65	30	499

*= All FLDs were vitiated, **= 8 were vitiated, ***= 4 were vitiated

Promising sunflower cultivars

State	Centre	Cultivars
	Rabi	
Andhra Pradesh	Chittoor	APSH-66
	IIOR (Prakhasam)	DRSH-1
	Prakasam	DRSH-1
Bihar	Dholi	KBSH-53, KBSH-41
Haryana	Hisar	Private hybrid
Karnataka	Bengaluru	KBSH-53
Maharashtra	Akola	LSFH-171
	Latur	DRSH-1, LSFH-71
Punjab	Ludhiana	PSH-996
Uttar Pradesh	Gorakhpur	SUN-7171
West Bengal	Nimpith	DRSH-1
	Kharif	
Karnataka	Raichur	RSFH-130
Maharashtra	Akola	LSFH-171, DRSH-1, PKVSH-952
Tamil Nadu	Coimbatore	TNAU SFH CO2

Training of farmers on sunflower production technologies

Table 3. Productivity potentials and profitability of whole package technologies in sunflower during 2014-15

State	Centre	FLDs	Technology		Mean Yield (kg/ha)		increase in yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C ratio	
			IT	FP	IT	FP		IT	FP	IT	FP		IT	FP
Whole package-*rabi*/spring														
Andhra Pradesh	Chittoor (ARKVK)	5	APSH-66, Fertilizers: 45 X 20 cm, Application of Pendimethalin @ 2.5 lt/ha, basal application of Sulphur @ 25 kg/ha and spraying of boron micro nutrient at ray floret opening stage @ 2 gm/lt	SB-275	2945	2662	11	34239	32074	88350	81060	5125	2.58	2.53
	IIOR	50	DRSH-1, RDF and need based plant protection	Siri/Sandoz	1960	1575	24	28500	26000	73500	59063	11938	2.58	2.27
Prakasam (IIOR)	Prakasam (REEDS)	20	DRSH-1, RDF need based plant protection	Siri/Sandoz	1925	1600	20	28500	25500	72188	60000	9188	2.53	2.35
Bihar	Dholi	3	KBSH-53	-	2031	1690	20	24858	21776	46713	38870	4761	1.88	1.79
		10	KBSH-41	-	1687	1309	29	24728	22586	38806	30107	6557	1.57	1.33
Haryana	Hisar	20	Private hybrid, spacing: 60 x 30 cm, Urea (70 kg), DAP (50 kg), Gypsum (100 kg), ZnSO4 (10 kg), Two sprays Quinalphos	Local variety, spacing: 60 x 30 cm, Urea (30 kg), DAP (50 kg), ZnSO4 (10 kg), One spray of Cypermithrin	2399	2059	17	14765	13718	28335	24223	3065	1.92	1.77
Karnataka	Bengaluru	50	KBSH-53, Spacing: 60 x 30 cm, Fertilizers: 10:26:26-50 - basal dose, thinning, weeding & irrigation	-	2440	2009	21	43364	38757	73125	60195	8323	1.69	1.55
Maharashtra	Akola	9	LSFH-171, spacing: 60 x 30 cm, fertilizers: SSP & Urea	Spacing: 60 x 30 cm, fertilizers: SSP &Urea	1625	1149	41	28867	25286	53625	37904	12140	1.86	1.50
		7	DRSH-1, spacing: 60x30 cm, fertilizers: DAP	Spacing: 60x30 cm, fertilizers: DAP	1371	1013	35	28168	24393	45257	33413	8070	1.61	1.37
	Latur	40	LSFH-71	Private hybrid	1352	979	38	22515	21015	47311	34269	11543	2.10	1.63
Punjab	Ludhiana	50	PSH 996	-	1961	1863	5	25440	26537	72568	68930	4736	2.85	2.60
Uttar Pradesh	Gorakhpur	40	SUN-7171, spacing: 45 x 30 cm, Fertilizers: 40:30:20	Local variety	881	469	88	16936	11593	34950	18515	11092	2.06	1.60
West Bengal	Nimpith	50	DRSH-1, FYM application @ 10.0 t/ha, seed treatment with *Trichoderma viride*&*Pseudomonasfluorescens*& foliar application of Boron @ 1.5 g/lit at star bud stage, RDF: 80:40:40, Pesticide application- Need based.	Ganga-Kaveri, PAC-361 & Siri seeds, fertilizer: 60:30:30	1395	1074	30	27695	26426	44627	34364	8994	1.61	1.30
Whole package-*kharif*														
Karnataka	Raichur	25	RSFH-130, spacing: 60X 30 cm, Urea (120 kg), DAP (196 kg), MOP (100 kg)	SB-207, spacing: 60x30cm, DAP (200 kg)	1314	1071	23	13393	12813	28077	23851	3645	2.10	1.86
Maharashtra	Akola	6	DRSH-1, spacing: 60X30 cm, fertilizers: Urea & DAP	Spacing: 60x30 cm, fertilizers: SSP	883	621	42	18844	16123	264751	18163	5142	1.40	1.15
		3	LSFH-171, spacing: 60x30 cm, fertilizers: Urea & SSP	Spacing: 60x30 cm, fertilizers: Urea & DAP	898	647	39	20038	16835	26925	19400	4323	1.34	1.15
		6	PKVSH-952, spacing: 60x30 cm, fertilizers: Urea & SSP	Spacing : 60x30 cm fertilizers: Urea & DAP	1038	728	43	19636	16494	31150	21825	6184	1.59	1.32
Tamil Nadu	Coimbatore	25	TNAU SFH CO2, spacing: 60x30 cm, fertilizers: 60:90:60 kg/ha NPK	Local variety	2127	1690	26	49000	44000	72488	57528	9960	1.48	1.31

IT=Improved technology; FP=Farmers' practices; BC ratio = Benefit cost ratio

Table 4. Productivity potentials and profitability of improved sunflower cultivars during 2013-14

State	Centre	FLDs	Technology		Mean Yield (kg/ha)		(%) increase in yield	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C ratio	
			IT	FP	IT	FP		IT	FP	IT	FP		IT	FP
Improved variety														
Andhra Pradesh	Chittoor	15 (I)	APSH-66, Pre emergence application of Pendimethalin @ 2.5 lt/ha	SB-275	3277	2699	21	34914	33090	98320	81090	15405	2.82	2.45
Site specific nutrient management (SSNM)														
Andhra Pradesh	Prakasam (IIOR)	5	SSNM	Application of Urea & DAP	1850	1550	19	24250	26000	69375	58125	13000	2.86	2.24
Spray of boron														
Andhra Pradesh	Prakasam (IIOR)	5	Spray of Boron @ 2ml/lit	No boron	1450	1295	12	25500	24500	54375	48563	4813	2.13	1.98
Soil application of sulphur														
Andhra Pradesh	Prakasam (IIOR)	5	Sulphur @ 20 kg/ ha	No sulphur	1475	1300	13	22250	21750	55313	48750	6063	2.49	2.24

IT=Improved technology; FP=Farmers' practices; BC ratio = Benefit cost ratio; I=Irrigated

Table 6. Exploitable yield reservoir in sunflower during *rabi*/spring

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Andhra Pradesh	75	2016	1654	22	864	133	33	40	77
Karnataka	50	2440	2009	21	650	275	130	158	488
All India	354	1767	1430	24	877	101	309	382	623

IT=Improved technology; **FP**=Farmers' practices; **Yield gap-I**=Increase in IT over FP expressed in percentage; **Yield gap-II**= Increase in IT over state average yield expressed in percentage; **EP-I**=Expected production if Yield gap-I is bridged through complete adoption of improved practices; **EP-II**= Expected production if Yield gap-II is bridged through complete adoption of improved practices

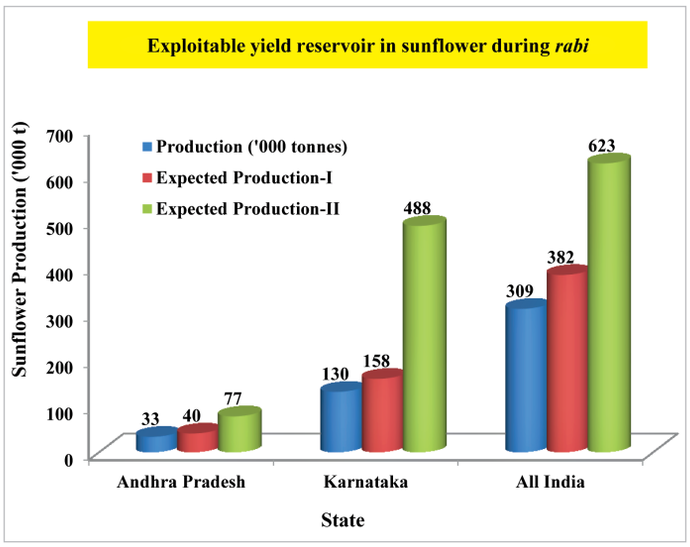
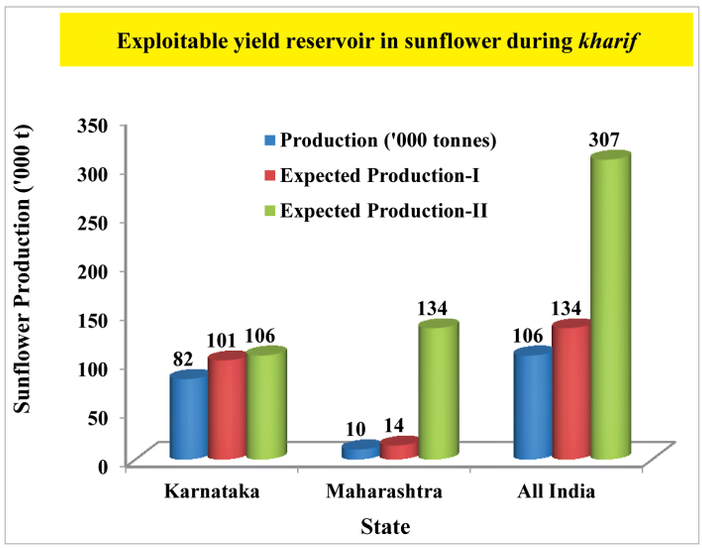


Table 7. Exploitable yield reservoir in sunflower during *kharif*

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Karnataka	25	1314	1071	23	529	148	82	101	204
Maharashtra	15	948	669	42	370	156	10	14	26
All India	65	1542	1216	27	532	190	106	134	307

IT=Improved technology; FP=Farmers' practices; Yield gap-I=Increase in IT over FP expressed in percentage; Yield gap-II= Increase in IT over state average yield expressed in percentage; EP-I=Expected production if Yield gap-I is bridged through complete adoption of improved practices; EP-II= Expected production if Yield gap-II is bridged through complete adoption of improved practices.



FLDs with DRSH-1 in Telangana State

Famers' field school on Sunflower

Shri S. Ashok Reddy, MLA, Andhra Pradesh providing critical inputs to FLD farmers in Prakasham, Andhra Pradesh

Farmers field school and training on sunflower

FLD on whole package in sunflower at Giddalur, Andhra Pradesh

FLD on Whole Package in Sunflower

LINSEED

P.K. Singh

Project Coordinating Unit (Linseed), CSAUAT Campus, Kanpur-208002, Uttar Pradesh

In India, Linseed (*Linum usitatissimum* L.) is cultivated in an area of 2.84 lakh ha with a production of 1.53 lakh t and productivity of 539 kg/ha (2014-15). It is a *rabi* oilseed crop confined to Assam, Bihar, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Uttar Pradesh and West Bengal (Table 1). The oil is primarily used in the industrial sector. Linseed contains 35-40% of oil, while stem yields good quality fiber with high strength and durability. Linseed oil is mostly used in the manufacture of paints, varnishes, oil cloth, linoleum, pad-ink, painting ink *etc.* The oil cake is used as cattle feed. The fiber is lustrous and blends very well with wool, silk, cotton, strong twines, canvas *etc.* The productivity of linseed is very low and can be substantially increased by adoption of improved production technologies.

Table 1. Area, Production and productivity of linseed in different states during 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Assam	6	4	667
Bihar	19	16	861
Chhattisgarh	31	12	397
Himachal Pradesh	1	0	319
Jharkhand	29	17	599
Karnataka	5	2	400
Madhya Pradesh	111	60	541
Maharashtra	19	4	211
Odisha	24	12	478
Rajasthan	3	3	1285
Uttar Pradesh	25	14	560
West Bengal	5	2	400
All India	284	153	539

FLDs on Linseed

A total of 500 demonstrations were allocated to 23 centres spread in 12 states, *viz.*, Uttar Pradesh, Bihar, Madhya Pradesh, Chhatisgarh, Rajasthan, Karnataka, Maharashtra, Odisha, Jharkhand, Assam, Nagaland and Himachal Pradesh. A total of 497 FLDs were conducted with implementation percent of 99 (Table 2).

The implementation rate was 133% at Raichur, 120% at Azamgarh, 96% at Dholi, 90% at Dimapur. Jagdalpur centre have not conducted the FLDs. All the remaining centres reported 100% implementation. Maximum number of FLDs were conducted on whole package technologies (425) followed by component technology (24) and cropping systems (48) (Table 2).

Table 2. Implementation of frontline demonstrations in linseed during 2014-15

State	Centre	FLDs assigned	FLDs conducted			Total	Implementation %
			WP	CT	CS		
Assam	Shillongoni	30	30	-	-	30	100
Bihar	Dholi	25	7	-	17	24	96
	Sabour	40	40	-	-	40	100
Chhattisgarh	Bilaspur*	15	15	-	-	15	100
	Jagdalpur	10	0	-	-	-	-
	Raipur	25	20	-	5	25	100
Himachal Pradesh	Palampur	10	10	-	-	10	100
Jharkhand	Kanke*	20	24	-	-	24	120
Karnataka	Raichur	15	10	5	5	20	133
Madhya Pradesh	Tikamgarh	10	10	-	-	10	100
Maharashtra	Latur	10	10	-	-	10	100
	Nagpur	15	10	3	2	15	100
	Sagar	35	20	5	10	35	100

Nagaland	Dimapur	40	36	-	-	36	90
Odisha	Kionjhar	15	15	-	-	15	100
Rajasthan	Durgapura	10	10	-	-	10	100
	Kota	15	18	-	-	18	120
Uttar Pradesh	Azamgarh	25	25	-	-	25	100
	Bhadohi*	40	40	-	-	40	100
	Kanpur	15	5	5	5	15	100
	Mouranipur	25	15	6	4	25	100
	PRDF Gora-khpur	30	30	-	-	30	100
	Varanasi	25	25	-	-	25	100
Total		500	425	24	48	497	99

WP= Whole package; CT= Component technology; CS= Cropping system;*=vitiated

Whole Package Demonstrations

Demonstrations to prove the productivity potentials and profitability of whole package technology were conducted in all the three situations *i.e.* irrigated; rainfed and *utera*. A total of 425 FLDs were conducted on whole package; irrigated, rainfed and *utera* situations shared 127, 185 and 35 FLDs, respectively (Table 3). The situation-wise information is discussed here:

A. Irrigated situation

A total of 127 FLDs were conducted at 12 locations namely; Sabour, Raipur, Palampur, Sagar, Tikamgarh, Latur, Kota, Azamgarh, Kanpur, Mauranipur, Gorakhpur and Varanasi. The mean seed yield was 1153 kg/ha with additional net returns (ANR) of Rs 13,007/ ha with improved technology (IT) as compared to 719 kg/ha with farmers' practice (FP). The B:C ratio was 2.91 and 2.35 with IT and FP, respectively. Highest seed yield was recorded in demonstrations conducted by Sagar (2240 kg/ha) in IT against 1350 kg/ha in FP. The centre-wise details of productivity potential and profitability are given in Table 3.

B. Rainfed situation

A total of 185 FLDs were conducted at 12 locations namely; Shillongani, Sabour, Raipur, Raichur, Sagar, Nagpur, Jharnapani, Keonjhar, Durgapura, Kota, Mauranipur and Gorakhpur. The mean seed yield was 823 kg/ha with ANR of Rs 8077/ha in IT as compared to 614 kg/ha with FP. The B:C ratio was 2.64 and 2.14 with IT and FP, respectively. Highest seed yield was recorded in demonstrations conducted by Sagar (1333kg/ha) with IT against 1112 kg/ha with FP. The B:C ratio was 4.05 and 2.30 with IT and FP, respectively. The centre-wise details of productivity potential and profitability are given in Table 3.

C. *Utera* situation

A total of 35 FLDs were conducted at four locations namely; Raipur, Palampur, Nagpur, and Gorakhpur. The mean seed yield was 533 kg/ha with ANR of Rs 9547/ha with IT as compared to 311 kg/ha with FP. The B:C ratio was 2.42 and 2.07 with IT and FP, respectively. Highest seed yield was recorded in demonstrations conducted by Gorakhpur (787 kg/ha) with IT against 474 kg/ha with FP. The B:C ratio was 2.33 and 1.93 with IT and FP, respectively. The centre-wise details of productivity potential and profitability are given in Table 3.

Component technology demonstrations

FLDs were conducted on component technologies such as improved varieties, application of sulphur and integrated pest and disease management.

Improved cultivars

A total of 19 FLDs were conducted at four locations namely; Sagar, Nagpur, Kanpur and Mauranipur. The mean seed yield was 43% higher with ANR of Rs 15,332/ ha under IT as compared to FP. The B:C ratio was 2.93 and 2.29 with IT and FP, respectively. Highest seed yield was recorded in demonstrations conducted by Sagar (1830kg/ha) in IT as compared to FP with ANR of Rs 23,139/ha. The B:C ratio was 4.18 and 3.42 with IT and FP, respectively. The centre-wise details of productivity potential and profitability are given in Table 4.

Integrated pest and disease management

Raichur centre conducted five FLDs (Table 5). Integrated pest and disease management practices in linseed increased the seed yield by 21% over farmers' practice with ANR of Rs. 4339 /ha (Table 5).

Application of sulphur

Dholi centre conducted seven FLDs on sulphur management. Sulphur management increased the seed yield by 11% over farmers' practice with ANR of Rs. 1457/ha (Table 5).

Cropping system demonstrations

A total of 53 FLDs were conducted on linseed-based intercropping systems (Table 6). The most remunerative system was linseed + chickpea with an ANR of Rs. 44,177/ha demonstrated by Sagar centre. The centre-wise details of linseed equivalent yield and profitability of inter cropping systems are given in Table 6.

Remunerative intercropping systems in linseed

State	Centre	Irrigated	Rainfed
Bihar	Dholi Patna	Linseed+ sugarcane (3:1)	-
Chattisgarh	Raipur	Linseed + gram (4:4)	-
Madhya Pradesh	Sagar	Linseed + chickpea (4:2)	Linseed + chickpea (4:2)
Maharashtra	Nagpur	Linseed + chickpea (4:2)	-
Uttar Pradesh	Fatehpur Mouranipur Kanpur	Linseed + chickpea (3:1) Linseed + gram (4:2)	Linseed + gram (4:2)

Exploitable Yield Reservoir

It is evident from the productivity potentials and economics of improved linseed production technologies that there exists vast potential to improve the linseed productivity under real farm situations. An attempt was made to explore the extent of such available yield reservoir (Table 7). Yield gap-I as a result of demonstration of IT over FP was ranging from 34% in Madhya Pradesh to 91% in Odisha whereas, the yield gap-II (between IT and state average productivity) was ranging from 25% in Chhattisgarh to 300% in Maharashtra. It could be understood from table 7 that linseed productivity at national level could be improved by 51 and 61% by bridging the yield gaps I and II, respectively. Similarly, the national linseed production could be increased from 1.53 to 2.31 and 2.46 lakh t by bridging the yield gaps I and II, respectively. That there is an urgent need for effective transfer of improved linseed production technologies to the linseed growers in order to convince them to adopt such technologies, so that the yield gaps can be bridged.

FLD on Whole Package in Linseed

Table 3. Productivity potential and profitability of whole package in linseed

State	Centre	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Irrigated												
Bihar	Sabour	20	1086	780	39	18250	14732	38019	27282	7219	2.08	1.85
Chhattisgarh	Raipur	5	678	400	70	11860	7722	29133	17200	7795	2.46	2.23
Himachal Pradesh	Palampur	5	1031	479	115	16256	13190	30924	14376	13482	1.90	1.09
Madhya Pradesh	Sagar	5	2240	1350	66	19721	16531	100800	52373	45237	5.11	3.17
	Tikamgarh	10	1393	1022	36	13590	10534	44410	32290	9064	3.27	3.07
Maharshtra	Latur	10	1058	821	29	7200	6100	46909	36332	9477	6.52	5.96
Rajasthan	Kota	8	1527	1249	22	16970	14350	64129	50260	11249	3.78	3.50
Uttar Pradesh	Azamgarh	25	1197	326	267	17162	9299	35969	9781	18325	2.10	1.05
	Kanpur	5	865	620	40	28046	22635	40426	27223	7792	1.44	1.20
	Mauranipur	4	907	610	49	20486	16291	38079	24799	9085	1.86	1.52
	PRDF Gorakhpur	5	1105	563	96	21446	12739	34753	19033	7013	1.62	1.49
	Varanasi	25	751	415	81	12283	10305	34332	22003	10351	2.80	2.14
Rainfed												
Assam	Shillongani	30	570	329	73	11600	9200	23721	15475	5846	2.04	1.68
Bihar	Sabour	20	885	616	44	16050	12478	30966	21560	5834	1.93	1.73
Chhattisgarh	Raipur	5	534	340	57	8627	5947	22962	14280	6002	2.66	2.40
Karnataka	Raichur	10	564	459	23	8932	7400	25368	18349	5487	2.84	2.48
Madhya Pradesh	Sagar	15	1333	1112	20	12913	11370	52351	26178	24630	4.05	2.30
Maharashtra	Nagpur	5	800	550	45	13978	13012	43540	29300	13274	3.11	2.25
Nagaland	Jharnapani	36	851	730	17	16000	15500	45769	41050	4219	2.86	2.65
Odisha	Keonjhar	23	622	325	91	9075	7075	21770	11361	8409	2.40	1.61
Rajasthan	Durgapura	10	947	799	19	-	-	18011	14978	3033	-	-
	Kota	10	1167	961	21	13850	12000	48993	40362	6781	3.54	3.36
Uttar Pradesh	Mauranipur	11	771	616	25	17091	14708	35816	24655	8778	2.10	1.68
	PRDF Gorakhpur	10	826	530	56	17571	12196	27490	17485	4630	1.56	1.43
Utera												
Chhattisgarh	Raipur*	10	390	280	39	4751	3475	16359	11760	3323	3.44	3.38
Himachal Pradesh	Palampur	5	501	206	143	9390	7667	15030	9166	4141	1.60	1.20
Maharashtra	Nagpur	5	454	285	59	10897	8786	25424	15090	7800	2.33	1.77
Uttar Pradesh	PRDF Gorakhpur	15	787	474	66	11202	8055	26069	15513	22922	2.33	1.93

IT= Improved technology; FP= Farmers' practice; B:C ratio= Benefit cost ratio; *= *utera* yields are low as compared to state average yield

Table 4. Productivity potential and profitability of improved cultivars of linseed demonstrated during 2014-15

State	Centre	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Madhya Pradesh	Sagar	5	1830	1240	48	19721	16300	82360	55800	23139	4.18	3.42
Maharashtra	Nagpur	3	1100	800	38	16430	15410	60440	43200	16220	3.68	2.80
Uttar Pradesh	Kanpur	5	1006	650	55	27403	22352	46811	28425	13335	1.71	1.27
	Mauranipur	6	863	653	32	16875	15451	36260	26200	8636	2.15	1.70

IT= Improved technology; FP= Farmers' practice; B:C ratio= Benefit cost ratio

Table 5. Productivity potential and profitability of component technologies demonstrated during 2014-15

State	Centre	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Integrated pest and disease management												
Karnataka	Raichur	5	510	422	21	9432	7721	22950	16900	4339	2.43	2.19
Sulphur												
Bihar	Dholi	7	891	806	11	11551	10951	21394	19337	1457	1.85	1.77

IT= Improved technology; FP= Farmers' practice; B:C Ratio= Benefit cost ratio

Table 6. Productivity potential and profitability of linseed based intercropping systems demonstrated during 2014-15

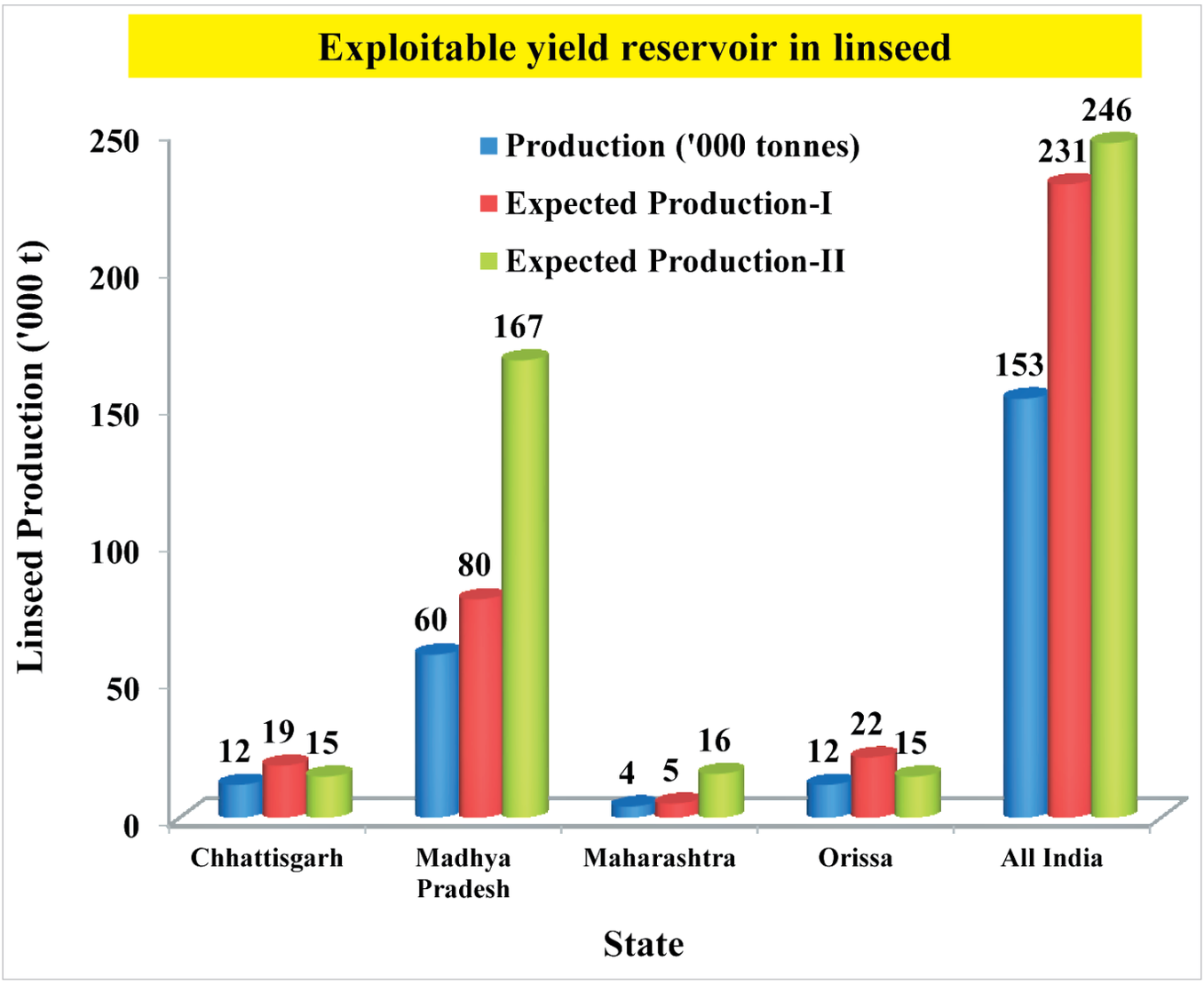
State	Centre	Technology	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
				IT	FP		IT	FP	IT	FP		IT	FP
Bihar	Dholi	S+L (1:3)	17	715	-	-	-	-	-	-	-	-	-
		S+L (1:3)	5	7589	7038	8	99028	79288	182141	151652	10749	1.84	1.91
Chhattisgarh	Raipur	L+G (4:2)	5	879	680	29	13364	11860	36932	28560	6868	2.76	2.41
Karnataka	Raichur	L+G (4:2)	5	897	500	79	9561	7362	29775	20600	6976	3.11	2.80
Madhya Pradesh	Sagar	L+G (4:2)	10	2480	1405	77	20513	16310	111605	63225	44177	5.44	3.88
Maharashtra	Nagpur	L+G (4:2)	2	1654	1405	18	25292	24087	93999	78199	14595	3.72	3.25
Uttar Pradesh	Kanpur	L+G (4:2)	5	782	561	39	27453	24016	37834	26842	7555	1.38	1.12
	Mauranipur	L+G (4:2)	4	860	674	28	18896	16637	36030	17530	16241	1.91	1.05

IT= Improved technology; FP= Farmers' practice; B:C Ratio: Benefit cost ratio; L= linseed; S= Sugarcane; G=Gram

Table 7. Exploitable yield reservoir in linseed

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Chhattisgarh	20	498	325	53	397	25	12	19	15
Madhya Pradesh	30	1504	1122	34	541	178	60	80	167
Maharashtra	20	843	619	36	211	300	4	5	16
Odisha	23	622	325	91	478	30	12	22	15
All India	371	867	574	51	539	61	153	231	246

IT=Improved technology; FP=Farmers' practices; Yield gap-I=Increase in IT over FP expressed in percentage; Yield gap-II=Increase in IT over state average yield expressed in percentage; EP-I=Expected production if Yield gap-I s bridged through complete adoption of improved practices; EP-II= Expected production if Yield gap-II is bridged through complete adoption of improved practices



NIGER

A. Jyothisi and M.R. Deshmukh

Project Coordinating Unit (Sesame & Niger), JNKVV Campus, Jabalpur-4820004 Madhya Pradesh

Niger (*Guizotia abyissinica* (L.f.) Cass.) occupied an area of 2.34 lakh ha and production of 0.73 lakh t with a productivity of 310 kg/ha in India during 2014-15 (Table 1). Niger export was to the tune of 17.904 thousand t, earning foreign exchange of Rs 90.13 crores. niger cultivation is predominant in the states of Madhya Pradesh, Odisha, Maharashtra and Chhattishgarh (Table 1). Requirement of low levels of management in crop production, cultivation in poor and marginal lands, resistance to drought are its important features in favouring niger crop for its cultivation by the farming community. It gives sustained seed yield even under harsh situations. Niger seed has nearly 40% of oil which is used in paints, soft soap, lighting, lubrication and cosmetics besides its culinary use. Oil cake is nutritious for miltch animals. Since, the crop is cultivated by poor farmers in the interiors of villages in scattered fields the extension agencies are not efficient in providing the necessary package of practices to the farmers besides quality seed and required inputs. Front line demonstrations (FLDs) on farmers field to show the role of full package of practices and the component technologies has been an efficient method for farmers to adopt new technologies and increase production and profits.

However, the role of extension education is very essential for boosting up the productivity levels of this crop confined to the down trodden poor farmers. In this context, the productivity potentials and profitability of improved niger crop production technologies under real farm situations becomes all the more important for rapid outreach of production technologies.

Table 1. Area, production and productivity of niger in different states during 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	7	3	462
Assam	8	4	500
Chhattisgarh	64	11	178
Gujarat	7	2	286
Jharkhand	4	2	603
Karnataka	8	2	250
Madhya Pradesh	43	16	372
Maharashtra	20	4	200
Odisha	69	25	362
West Bengal	4	3	700
All India	234	73	310

Frontline demonstrations on Niger

The AICRP (Niger) and voluntary centres have conducted 220 FLDs on niger during 2014-15, out of 220 allotted, resulting in 100% overall implementation (Table 2).

Table 2. Implementation of frontline demonstrations on niger during 2014-15

State	Centre	No. of Demonstrations				Implementation (%)
		Assigned	Conducted			
			WP	CT	TOTAL	
Bihar	Adhaura	25	10	15	25	100
Gujarat	Vanarasi	20	20	-	20	100
Jharkhand	Gumla	25	10	15	25	100
	Kanke	45	21	24	45	100
Karnataka	Raichur	20	8	12	20	100
Madhya Pradesh	Chhindwara	25	10	15	25	100
Maharashtra	Igatpuri	25	10	15	25	100
	Parbhani	20	10	10	20	100
West Bengal	Kapgiri	15	8	7	15	100
Total		220	107	113	220	100

WP= Whole package; **CT**=Component technology

Whole package demonstrations

The whole package technology demonstrations were conducted at Adhaura, Varanasi, Gumla, Kanke, Raichur, Igatpuri, Chhindwara, Parbhani and Kapgiri during 2014-15 (Table 3). At Adhaura, the seed yield increase was 110% in improved technology (IT) as compared to farmers' practice (FP) with additional net returns (ANR) of Rs. 5300/ha. The B:C ratio was 1.80 and 1.35 with IT and FP, respectively. At Varanasi, the seed yield increase was 70% in IT over FP with ANR of Rs. 6274/ha. The B:C ratio was 2.74 and 2.46 with IT and FP, respectively. At Raichur, the seed yield increase was 52% in IT over to FP. The B:C ratio was 2.80 and 1.90 with IT and FP, respectively. At Igatpuri, the seed yield increase was 55% with full package as compared to FP with ANR of Rs. 3041/ha. The B:C ratio was 1.57 and 1.38 with IT and FP, respectively. At Chhindwara, the seed yield increase was 193% in IT as compared to FP with ANR of Rs. 15,467/ha. The B:C ratio was 2.82 and 1.86 with IT and FP, respectively. At Parbhani, the seed yield was 72% higher in IT as compared to FP with ANR of Rs. 6699/ha. The B:C ratio was 1.81 and 1.12 with IT and FP, respectively (Table 3).

Component technology demonstrations

Component technology demonstrations on improved varieties, recommended dose of fertilizers, line sowing and plant protection were conducted during *kharif* 2014.

Improved varieties

At Adhaura, the seed yield increase was 72% in IT as compared to FP with ANR of Rs. 2400/ha. The B:C ratio was 1.43 and 1.25 with IT and FP, respectively. In Madhya Pradesh, the seed yield increase was 208% at Chhindwara with an ANR of Rs. 11, 525/ha. The B:C ratio was 2.92 and 1.63 with IT and FP, respectively at these centre. At Raichur, the increase in seed yield in IT was 50% over FP with ANR of Rs. 10,260/ha. The B:C ratio was 2.8 and 1.9 with IT and FP, respectively. At Parbhani, the seed yield increase was 25% in IT as compared to FP with ANR of Rs. 3128/ha. The B:C ratio was 1.7 and 1.52 with IT and FP, respectively (Table 4).

Recommended dose of fertilizers

Demonstrations to show the benefit of application of recommended dose of fertilizers were conducted at Adhaura, Kanke, Gumla, Raichur, Chhindwara, Igatpuri, and Parbhani (Table 5). The seed yield increase was 100% in IT as compared to FP with ANR of Rs. 4040/ha at Adhaura. The B:C ratio was 1.62 and 1.28 with IT and FP, respectively. At Raichur, IT recorded 44% higher seed yield as compared to FP with ANR of Rs. 8020 /ha. The B:C ratio was 2.4 and 1.7 with IT and FP, respectively. at Chhindwara, IT recorded 197% higher seed yield as compared to FP with ANR of Rs. 11,063 /ha. The B:C ratio was 2.73 and 1.76 with IT and FP, respectively. At Igatpuri, IT recorded 30% higher seed yield compared to FP with ANR of Rs. 2605 /ha. The B:C ratio was 1.98 and 1.72 with IT and FP, respectively. At Parbhani, IT recorded 49% higher seed yield compared to FP with ANR of Rs. 5506 /ha. The B:C ratio was 1.34 and 1.26 with IT and FP, respectively.

Promising niger cultivars for different states

State	Centre	Cultivars
Bihar	Adhaura	JNC-1, BNS-3
Gujarat	Varanasi	Gujarat Niger-1
Jharkhand	Gumla	Birsa Niger-3
	Kanke	Birsa Niger-1, Birsa Niger-2
Karnataka	Raichur	RCR-18
Madhya Pradesh	Chhindwara	JNS-9, JNC-6
Maharashtra	Igatpuri	IGPN-2004-1
	Parbhani	DNS-6
West Bengal	Kapgiri	Birsa Niger-3

Line sowing

FLDs to prove the benefit of line sowing in niger were conducted at Adhaura, Kanke, Gumla, Igatpuri and Raichur (Table 5). At Adhaura, IT recorded 66% higher seed yield compared to FP with ANR of Rs. 1580 /ha. The B:C ratio was 1.34 and 1.26 with IT and FP, respectively. At Raichur, IT recorded 86% higher seed yield compared to FP with ANR of Rs. 12,400 /ha. The B:C ratio was 2.8 and 1.9 with IT and FP, respectively.

Plant protection

During kharif 2012 these FLDs were conducted under rainfed conditions at Chhindwara (Madhya Pradesh). The seed yield increase was 207% due to IT as compared to FP with ANR of Rs. 10,415/ha. The B:C ratio were 2.65 and 1.54 with IT and FP, respectively (Table 5).

Exploitable yield reservoir

The impact of improved niger production technologies implied that there exists a vast yield gap that could have been harnessed by the adoption of recommended niger production practices. The efforts were made to work out the extent of exploitable yield reservoir that could be harnessed in niger. For this purpose, the whole package demonstrations conducted in Madya Pradesh (10), Maharastra (20) and all India (97) were considered (Table 6). The yield Gap-I (between IT and FP) was ranging from 81% in Maharastra to 193% in Madya Pradesh. The national niger production could be

increased to 1.30 lakh tonnes from 0.37 lakh t, if the yield gap-I was bridged. Similarly, the yield gap-II (between IT and state average productivity) was ranging from 47% in Madya Pradesh to 81% in Maharastra. The national niger production could be increased to 1.00 lakh t by bridging the yield gap II. This situation warrants an urgent need to effectively transfer the improved niger production technologies among the niger growers, so that the huge exploitable yields reservoir is harnessed.

Demonstration of improved technologies of niger in farmers fields

Table 3. Productivity potential and profitability of whole package technologies of niger

State	Centre	No. of FLDs	Mean Seed Yield (Kg/ha)		Increase in yield of IT over FP (%)	Cost of cultivation (Rs/ha)		Gross Monetary return (Rs/ha)		Additional Net Returns (Rs/ha)	B : C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Bihar	Adhaura	10	415	198	110	9270	5890	16600	7920	5300	1.80	1.35
Gujarat	Vanarasi	20	368	217	70	8050	5300	22059	13035	6274	2.74	2.46
Jharkhand	Kanke*	11	vitiated									
	Gumla *	10										
Karnataka	Raichur	08	542	356	52	11550	11050	32520	21360	10660	2.80	1.90
Madhya Pradesh	Chhindwara	10	545	186	193	8671	4500	24525	8370	15467	2.82	1.86
Maharashtra	Igatpuri	10	253	163	55	16445	10660	10346	7692	3041	1.57	1.38
	Parbhani	10	469	236	72	11632	9506	21083	10620	6699	1.81	1.12
West Bengal	Kapgiri *	08	vitiated									

IT=Improved technology; FP=Farmers' practices; B:C ratio = Benefit cost ratio; *= vitiated due to low palnt stand and severe drought

Table 4. Productivity potential and profitability of improved varieties of niger

State	Centre	No. of FLDs	Mean seed yield (Kg/ha)		Increase in yield of IT over FP (%)	Cost of cultivation (Rs/ha)		Gross monetary returns (Rs/ha)		Additional net returns (Rs/ha)	B:C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Bihar	Adhaura	5	330	192	72	9280	6160	13200	7680	2400	1.43	1.25
Jharkhand	Kanke*	5										
	Gumla *	5										
Karnataka	Raichur	4	521	348	50	11170	11050	31260	20880	10260	2.8	1.9
Madhya Pradesh	Chhindwara	5	481	156	208	7400	4300	21645	7020	11525	2.92	1.63
Maharashtra	Parbhani	5	513	409	25	13604	12070	23067	18405	3128	1.7	1.52
West Bengal	Kapgiri *	7										

IT=Improved technology; FP=Farmers' practices; B:C ratio = Benefit cost ratio; *= vitiated due to low germination and severe drought

Table 5. Productivity potential and profitability of component technologies on niger

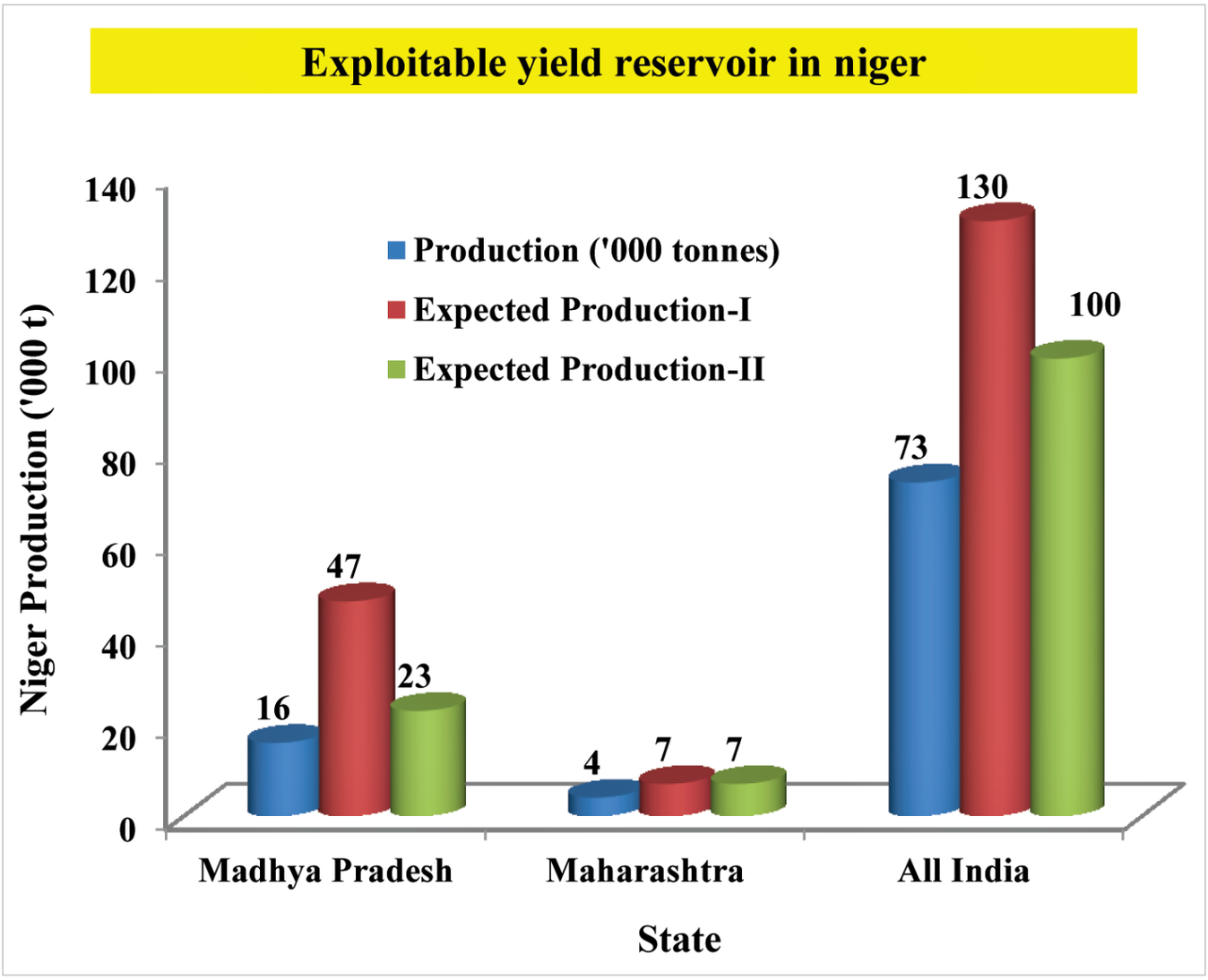
State	Centre	No. of FLDs	Mean seed Yield (Kg/ha)		Increase in yield of IT over FP (%)	Cost of cultivation (Rs/ha)		Gross Monetary returns (Rs/ha)		Additional Net Returns (Rs/ha)	B:C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Fertilizer												
Bihar	Adhaura	5	371	186	100	9180	5820	14840	7440	4040	1.62	1.28
Jharkhand	Kanke	6	vitiated									
	Gumla	4										
Karnataka	Raichur	4	460	320	44	11430	11050	27600	19200	8020	2.4	1.7
Madhya Pradesh	Chhindwara	5	503	169	197	8267	4300	22635	7605	11063	2.73	1.76
Maharashtra	Igatpuri	5	230	117	30	14950	11505	7520	6680	2605	1.98	1.72
	Parbhani	5	475	320	49	11610	10150	21366	14400	5506	1.84	1.42
Line sowing												
Bihar	Adhaura	5	306	185	66	9160	5900	12240	7400	1580	1.34	1.26
Jharkhand	Kanke	5	vitiated									
	Gumla	4										
Maharashtra	Igatpuri	10	vitiated									
Karnataka	Raichur	4	520	280	86	11050	9050	31200	16800	12400	2.8	1.9
Plant protection												
Madhya Pradesh	Chhindwara	5	455	148	207	7700	4300	20475	6660	10415	2.65	1.54

IT=Improved technology; FP=Farmers' practices; B:C ratio=Benefit cost ratio

Table 6. Exploitable yield reservoir in niger

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Madhya Pradesh	10	545	186	193	372	47	16	47	23
Maharashtra	20	361	200	81	200	81	4	7	7
All India	97	425	237	79	310	37	73	130	100

IT=Improved technology; FP=Farmers' practices; Yield gap-I=Increase in IT over FP expressed in percentage; Yield gap-II=Increase in IT over state average yield expressed in percentage; EP-I=Expected production if Yieldgap-I is bridged through complete adoption of improved practices; EP-II= Expected production if Yield gap-II is bridged through complete adoption of improved practices



SAFFLOWER

G.D.S. Kumar and S.V. Ramana Rao

Indian Institute of Oilseeds Research (ICAR-IIOR), Rajendranagar, Hyderabad-500 030 Telangana

Safflower (*Carthamus tinctorius* L.) is one of the important *rabi* oilseed crops of India, cultivated in vertisols under residual moisture in Karnataka, Andhra Pradesh, Chhattisgarh, Madhya Pradesh and Bihar. Traditionally, the crop was grown for its seeds. Flower petals were used for colouring and flavouring foods. For the last fifty years, the crop was cultivated mainly for the vegetable oil extracted from its seeds. All the parts of the plant find useful applications in herbal medicine specifically in preparations to treat physical disorders. Safflower is known for its cultivation since time immemorial, either for orange red dye (carthamin) extracted from its brilliantly coloured florets and/or for its much valued oil. The crop has superior adaptability to scanty moisture conditions. It produces oil that is rich in polyunsaturated fatty acids (linoleic acid 78%) that plays an important role in reducing the blood cholesterol level in human beings. Dried red or orange flowers are still sold as substitute for saffron in the markets of Middle East and are used to colour foods and beverages. Oil is used in the preparation of margarine, mayonnaise and salad dressings and in the manufacture of paints, varnishes and linoleum. Un-decorticated safflower cake is generally used as manure and decorticated safflower cake is used as cattle feed. Safflower hulls can be used in the manufacturing cellulose. Worldwide the demand for seed, oil and safflower based herbal medicine is expected to rise and there is urgent need to increase production of safflower seed and safflower plant parts and oil-based products by value-addition.

India is one of the largest producers of safflower in the world with an area of 2.11 lakh ha, production of 0.96 lakh t and a productivity of 457 kg/ha (2014-15, Table 1).

Table 1. Area, production and productivity of safflower in different states during 2014-15

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh and Telangana	5	4	800
Bihar	1	1	806
Gujarat	15	3	200
Jharkhand	1	1	828
Karnataka	33	17	515
Madhya Pradesh	29	21	724
Maharashtra	125	49	390
West Bengal	1	1	1000
All India	211	96	457

FLDs on Safflower

FLDs were conducted on improved safflower production technologies in various agro-ecological situations of the country during *rabi* 2014-15. A total of 600 FLDs were allotted to 13 centres situated in seven States of India. All the centres have conducted the FLDs as per allotment, but Akola, Bhuj and Phaltan centres have vitiated a total of 47 FLDs. The overall implementation rate was 101%. The details of the FLDs allotted and conducted are presented in Table 2.

Table 2. Implementation of frontline demonstrations on safflower

State	Centre	Demonstrations				Implementation (%)
		Assigned	Laid Out		Total	
			WP	V		
Chhattisgarh	Raipur	30	30	-	30	100
Gujarat	KVK, Bhuj	25	25	25	25	100
ICAR-IIOR		275	275	-	275	100
Andhra Pradesh	Anantapuram	100	100	-	100	100

Karnataka	KVK, Hulkoti	20	20	-	20	100
	KVK, Gangavathi	20	20	-	20	100
	KVK, Kalaburgi	20	20	-	20	100
	KVK, Raddewadegi	25	25	-	25	100
	KVK, Hiriyur	25	25	-	25	100
	KVK, Hirehalli	10	5	5	10	100
	KVK, Lingsugur	15	15	-	15	100
	KVK, Vijayapur	25	25	-	25	100
Maharashtra	Adarsh Agriclinic, Latur	15	15	-	15	100
Karnataka	Annigeri	25	25	-	25	100
Madhya Pradesh	Indore	20	20	-	20	100
Maharashtra	Akola	40	35	5	40	100
	Latur	30	30	-	30	100
	Parbhani	30	30	-	30	100
	Phaltan	25	8	17	25	100
	Solapur*	30	30	-	30	100
Telangana	Tandur	40	40	-	40	100
Uttar Pradesh	Gorakhpur	20	26	-	26	130
	Mouranipur	10	10	-	10	100
Total		600	599	52	606	101

WP= whole package; V= vitiated; *= includes component technology demonstrations

The results of FLDs on whole package and component technologies are reported here under. The improved technology (IT), whole package, included the recommended cultivar for the region, recommended agronomic practices and need based plant protection measures.

Irrigated conditions

FLDs on whole package under irrigated conditions, recorded a mean safflower seed yield of 1240 kg/ha in improved technology (IT) plots and 931 kg/ha in farmers' practice (FP) plots. The cost of cultivation was Rs. 18,756 and Rs. 15,969 with FLDs and FP, respectively. There was increase in cost of cultivation by 17.4% with FLDs. The gross monetary returns (GMR) increased from Rs. 26,477/ha with FP to Rs. 37,676/ha with FLDs indicating a raise of 42%. The mean additional net returns (ANR) obtained were Rs. 8,412/ha with a benefit cost ratio (BCR) of 2.01 with FLDs.

The seed yield ranged from 756 kg/ha in FLDs conducted by Raipur to 1638 kg/ha in FLDs conducted by Akola. The increase in mean seed yield was highest (118%) in FLDs conducted by Phaltan as compared to FP followed by Gorakhpur (95%) and Parbhani (32%) under irrigated conditions (Table 3).

The mean cost of cultivation with IT showed wide variation ranging from Rs. 11,126/ha at Raipur to Rs. 27,068/ha at Phaltan as compared to Rs. 9,930/ha to Rs. 21,558/ha in FP. The GMR with IT ranged from Rs. 22,676/ha in FLDs conducted by Raipur to Rs. 48,331/ha (Akola). The highest ANR of Rs. 17,158/ha was recorded at Phaltan. The B:C ratio ranged from 1.55 to 2.8 with IT as compared to 1.3 to 2.8 with FP.

At Mouranipur, the IT of growing safflower was demonstrated as compared to FP of growing chickpea. In IT, the safflower equivalent yield was lower (1119 kg/ha) compared to FP (1193 kg/ha) but an ANR of Rs. 7441/ha was accrued due to lower cost of cultivation of safflower.

Rainfed conditions

FLDs on whole package under rainfed conditions recorded a mean safflower seed yield of 1084 kg/ha in IT as compared to 884 kg/ha in FP plots. The increase in mean seed yield was 23% in IT as compared to FP plots. The mean cost of cultivation was marginally lower with IT (Rs. 15,430/ha) as compared to FP (Rs. 15,804/ha) mainly due to high cost of cultivation of chickpea.

The GMR increased from Rs. 27,517/ha with FP to Rs. 32,776/ha in IT with ANR of Rs. 5,633/ha. The B:C ratio was 2.12 and 1.74 with IT and FP plots, respectively (Table 4).

The seed yield of safflower in IT ranged from 870 kg/ha (Raichur and Gulbarga) to 1590 kg/ha (Latur) and 500 kg/ha (Phaltan) to 1130 kg/ha (Vijayapur) in FP of growing local varieties of safflower. The increase in mean seed yield was highest (113%) in FLDs conducted by Phaltan as compared to FP.

At Anantapur, when IT of growing safflower was compared with FP of growing chickpea (959 kg/ha safflower equivalent yield), safflower seed yield was lower (750 kg/ha) but an ANR of Rs. 4395 was accrued mainly due to low cost of cultivation of safflower (Rs. 11,250/ha) compared to chickpea (Rs. 21,540/ha). At Tumkur, safflower was not profitable when compared to chickpea, but at Indore safflower recorded higher equivalent yield (800 kg/ha) and ANR (Rs. 4689/ha) compared to FP of growing chickpea (566 kg/ha) (Table 4).

Component technologies

Solapur centre has conducted FLDs on components technologies such as RDF, need based plant protection and revised fertilizer recommendation under rainfed conditions. The FLDs on RDF increased the safflower seed yield by 18% in IT (1067 kg/ha) as compared to FP (902 kg/ha). The ANR accrued in IT was Rs. 3401/ha with B:C ratio of 1.78. When need based plant protection was demonstrated, the safflower seed yield (1083 kg/ha) increased by 34% as compared to FP of aphid management (808 kg/ha). The ANR accrued was Rs. 5295/ha. The revised fertilizer management increased safflower seed yield by 7% compared to FP of RDF (Table 5).

Exploitable yield reservoir in safflower

Based on the mean seed yield of safflower recorded with whole package in various safflower growing states, the yield gap I (increase in IT over FP expressed in percentage) and yield gap II (increase in IT over state average yield expressed in percentage) were estimated. It was noticed that there exists a vast realizable yield gap 1 in India to the tune of 26%. Safflower productivity at national level could be improved from 1.14 to 1.43 lakh t, if the yield gap I is bridged. The yield gap II was 76%, and if this can be bridged (a remote possibility), the safflower productivity at national level could be increased to 2.01 lakh t without increasing the area (Table 6).

Promising safflower cultivars demonstrated in farmers' fields

State	Centre	Irrigated	Rainfed
Andhra Pradesh	Anantapur (IIOR)	-	PBNS-12
Chattisgarh	Raipur	PBNS-12	-
Karnataka	Annigeri	-	A-1
	Chitradurga (IIOR)	-	PBNS-12
	Gadag (IIOR)	-	PBNS-12
	Kalburgi (IIOR)	-	PBNS-12
	Raddewadegi (IIOR)	-	PBNS-12
	Koppala (IIOR)	-	PBNS-12
	Raichur (IIOR)	-	PBNS-12
	Tumkur (IIOR)	-	PBNS-12
	Vijayapur (IIOR)	-	PBNS-12
Maharashtra	Akola	PKV Pink and AKS-207	PKV Pink and AKS-207
	Latur	-	PBNS-12
	Parbhani	PBNS-12	-
	Phaltan	NARI-6	NARI-38
Madhya Pradesh	Indore	-	JSI-97
Telangana	Tandur	-	PBNS-12
Uttar Pradesh	Gorakhpur	JSI-99/97	-
	Mouranipur	A-1	-

Table 3. Productivity potentials and profitability of whole package demonstrations (irrigated) under real farm situations during 2014-15

State	Centre	No. of demos	Technology		Mean Yield (kg/ha)		(%) increase in yield over FP	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
			IT	FP	IT	FP		IT	FP	IT	FP		IT	FP
Chhattisgarh	Raipur	14	PBNS-12, spacing: 45X20 cm, RDF (Urea, SSP & MOP) & control of aphids and *Alterneria*	Local variety	756	595	27	11126	9930	22676	17863	3617	2.04	1.80
Maharashtra	Akola	9	PKV Pink, spacing: 45X20 cm, RDF (45:25:0 NPK) & management of aphids	Local variety	1638	1306	25	22396	19293	48331	38514	6713	2.16	2.00
		12	AKS-207, spacing: 45X20 cm, RDF (40:25:0 NPK) through Urea and SSP and management of aphids	Local variety	1607	1340	20	21755	19303	47397	39524	5421	2.18	2.05
	Parb-hani	30	PBNS-12	Local variety	1336	1012	32	15616	11873	43432	32906	6783	2.78	2.77
	Phaltan	6	NARI-6, spacing: 30x20, RDF (60:30:0 NPK) and management of aphids and *Alterneria*	NARI-6	1352	621	118	27068	21558	41915	19246	17158	1.55	0.89
Uttar Pradesh	Gorakh-pur	26	JSI-99/97, spacing: 45x20 cm, RDF(40:40:20 NPK)	Local Variety	871	447	95	18712	13814	34245	17596	11751	1.83	1.27
	Moura-nipur	10	A-1, spacing: 40x20 cm and management of aphids	Chick pea/ wheat	1119	1193	-6	14618	16010	25737	19688	7441	1.76	1.23

IT=Improved technology; FP=Farmers' practice; B:C ratio = Benefit Cost ratio

Table 4. Productivity potentials and profitability of whole package demonstrations (rainfed) under real farm situations during 2014-15

State	Centre	No. of demos	Technology		Mean Yield (kg/ha)		Increase in yield over FP (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
			IT	FP	IT	FP		IT	FP	IT	FP		IT	FP
Andhra Pradesh	Anantapur (IIOR)	100*	PBNS-12, RDF, need based plant protection	chickpea	750	959*	-22	11250	21540	22875	28770	4395	2.03	1.34
Karnataka	Annigeri	25	A-1, RDF, need based plant protection	PBNS-12	1265	1127	12	12631	12631	34167	30429	3738	2.70	2.41
	Chitradurga (IIOR)	25	PBNS-12, RDF, need based plant protection	Local variety	1090	780	40	11750	9320	33868	24258	7180	2.88	2.60
	Gadag (IIOR)	20	PBNS-12, RDF, need based plant protection	Local variety	1050	890	18	20148	17615	28350	23963	1854	1.41	1.36
	Kalburgi (IIOR)	20	PBNS-12, RDF, need based plant protection	Local variety	870	780	12	12600	12900	31257	28211	3346	2.48	2.19
	Raddewadegi (IIOR)	25	PBNS-12, RDF, need based plant protection	Local variety	1380	860	60	14592	15618	41460	25860	16626	2.84	1.66
	Koppala (IIOR)	20	PBNS-12, RDF, need based plant protection	Local variety	1110	960	16	-	-	-	-	-	-	-
	Raichur (IIOR)	15	PBNS-12, RDF, need based plant protection	Local variety	870	750	16	11385	10673	24520	21140	2668	2.15	1.98
	Tumkur (IIOR)	10*	PBNS-12, RDF, need based plant protection	chickpea	690	982*	-30	14375	20625	18232	29215	-4733	1.27	1.42
	Vijayapur (IIOR)	25	PBNS-12, RDF, need based plant protection	Local variety	1320	1130	17	14474	12651	42296	36086	4387	2.92	2.85
Madhya Pradesh	Indore	20	JSI-97, spacing:45X20 cm, RDF and management of aphids	Chickpea	800	566*	41	14475	15043	22989	18868	4689	1.59	1.25
Maharashtra	Akola	10	PKV Pink, spacing: 45X20 cm, RDF (25:25:0 NP K) through Urea and SSP and management of aphids	Local variety	992	820	21	18288	16586	29257	24183	3372	1.60	1.46
		4	AKS-207, spacing: 45X20 cm RDF (25:25:0 NPK) through Urea and SSP and management of aphids	Local variety	1194	1034	15	19991	18121	35234	30514	2851	1.76	1.68
	Latur	30	PBNS-12, RDF, need based plant protection	Local variety	1082	815	33	16000	14700	43285	32609	9376	2.71	2.22
Maharashtra	Latur (IIOR)	15	PBNS-12, RDF, need based plant protection	Local variety	1590	1115	43	19670	27433	44985	42236	10512	2.29	1.54
	Phaltan	2	NARI-38, spacing: 30x20 cm, RDF (60:30 :30 NPK) and management of aphids and *Alterneria*	NARI-38 Urea/ DAP (50 kg/ha)	1063	500	113	20119	13944	32938	15500	11263	1.64	1.11
Telangana	Tandur	40	PBNS-12	Local variety	1312	964	36	15140	13471	38704	28431	8604	2.56	2.11

IT=Improved technology; FP=Farmers' practices ; B:C ratio = Benefit Cost ratio

Table 5. Productivity potentials and profitability of component technologies in safflower

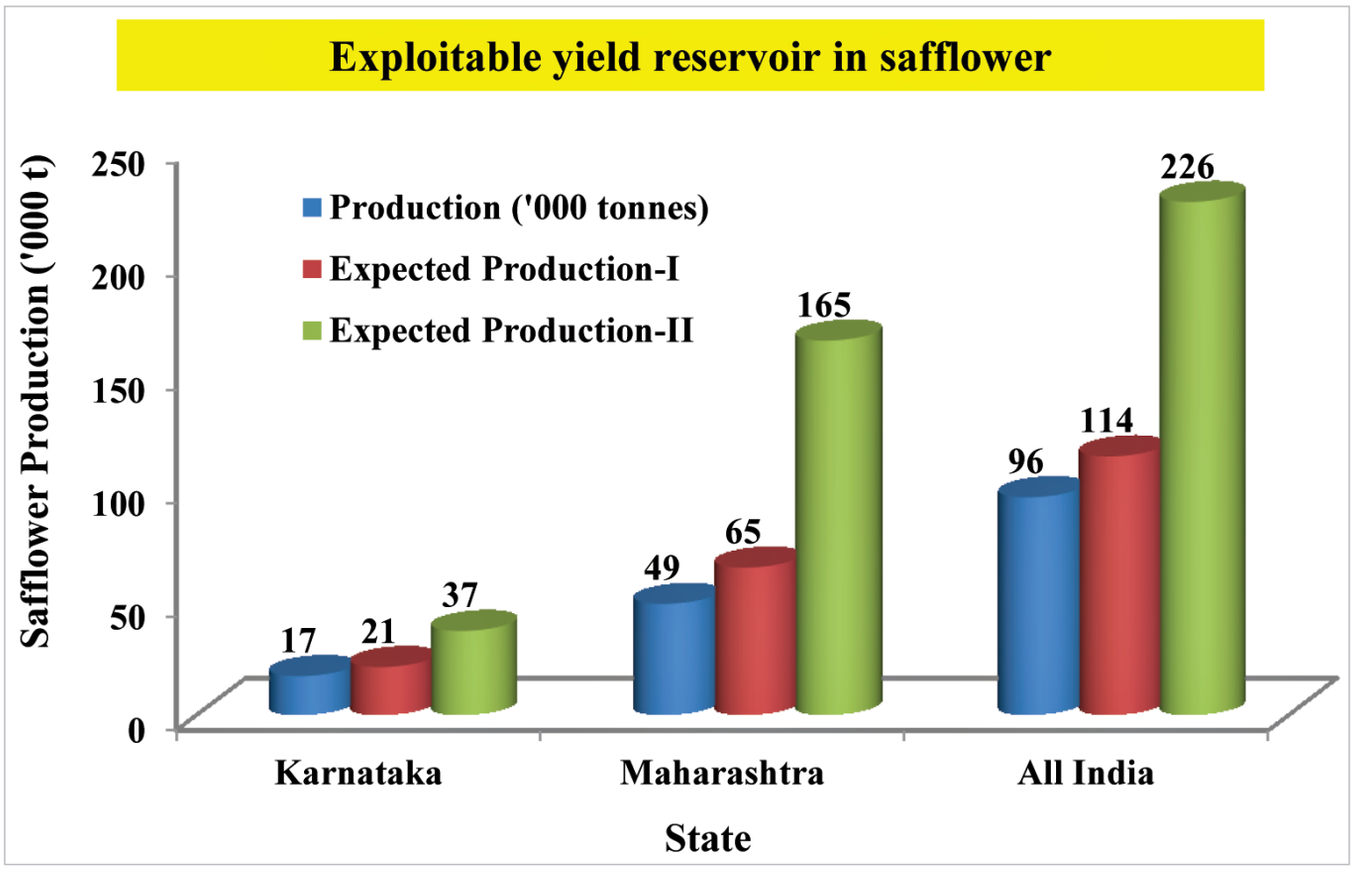
State	Centre	No. of demos	Technology		Mean Yield (kg/ha)		(%) increase in yield	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
			IT	FP	IT	FP		IT	FP	IT	FP		IT	FP
Recommended dose of fertilizer-rainfed														
Maharashtra	Solapur	15	SSF-708, RDF 50:25:0 in the form of Urea & SSP	SSF-708, Application of Urea & DAP	1067	902	18	17197	15850	30646	25899	3401	1.78	1.63
Need based plant protection-rainfed														
Maharashtra	Solapur	14	SSF-748 management of aphids by 3 sprays	SSF-748 management of aphids by 1 spray	1083	808	34	18543	15884	31346	23392	5295	1.69	1.47
Revised fertilizer recommendation-rainfed														
Maharashtra	Solapur	1	SSF-708, Revised RDF 60:30:0 NPK through Urea & SSP	SSF-708 RDF 50:25	1150	1075	7	21193	20238	32775	30638	1182	1.55	1.51

IT = Improved technology; FP = Farmers Practice ; B:C ratio = Benefit Cost ratio

Table 6. Exploitable yield reservoir in safflower

State	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Production ('000 t)	Expected production ('000 t)	
		IT	FP					EP-I	EP-II
Karnataka	185	1119	925	21	515	117	17	21	37
Maharashtra	118	1317	987	33	390	238	49	65	165
All India	513	1072	907	18	457	135	96	114	226

IT=Improved technology; FP=Farmers' practice; Yieldgap-I=Increase in IT over FP expressed in percentage; Yield gap-II=Increase in IT over state average yield expressed in percentage; EP-I=Expected production if Yield gap-I is bridged through complete adoption of improved practices; EP-II= Expected production if Yield gap-II is bridged through complete adoption of improved practices.



Visit to FLD plots by farmers, agricultural extension workers and scientists

FLD on whole package in Safflower

Field day on Safflower at Uravakonda, Ananthapur, Andhra Pradesh

FARMING SYSTEMS RESEARCH

N. Ravisankar

Project Coordinating Unit, Indian Institute of Farming Systems Research (ICAR-IIFSR), Modipuram, Meerut-250110, Uttar Pradesh

Frontline demonstrations were conducted during 2014-15, to show the productivity potentials and profitability of proven oilseed based cropping systems under real farm situation at selected centres of All India Coordinated Research Project on Farming Systems Research. Total number of demonstrations conducted was 88, of which 12 were in Arid, 32 were in Semi-arid, 24 were in Sub-himid and 10 each were in Humid and coastal ecosystems. The major cropping systems were mustard, soybean, castor, groundnut and gobhi sarson based systems (Table 1).

Table 1. Implementation of FLDS in farming system research

State	Centre	Agro Ecosystem	Crop/cropping system	FLDs no.
Gujarat	Jagudan	Arid	Hybrid castor	12
Andhra Pradesh	Seethampeta	Semi-Arid	Sunflower and Sesame	10
Punjab	Amritsar		Gobhi-Sarson	12
Uttar Pradesh	Kanpur Dehat		Mustard	10
Bihar	Purnea	Sub humid	Sunflower and Mustard	10
Himachal Pradesh	Kangra		Maize-Gobhi Sarson	6
Jharkhand	Pakur		Mustard	5
Uttarakhand	Jeolikote		Mustard	3
West Bengal	Kakdwip	Humid	Rice-Sunflower	10
Kerala	Thiruvalla	Coastal	Sesame	10
Total				88

Production potentials of demonstrations

Kharif 2014

At Dessa, the increase in seed equivalent yield was 22% with pearl millet-mustard system, 13% with castor + green gram and 4% with castor + cowpea systems, under arid conditions during *kharif*. At Aurangabad under semi-arid conditions, demonstrations on soybean based cropping systems recorded 27% higher seed equivalent yield with improved technology (IT) plots as compared to farmers' practice (FP). At Amritsar, gobhi sarson based cropping systems recorded 13% higher seed equivalent yield with IT plots as compared to FP plots. At Kangra under humid ecosystems maize based cropping systems gave 151% higher seed equivalent yield as compared to farmers' practice. At Raigad, rice based cropping systems increased seed yield by 89% with IT plots as compared to FP plots (Table 2).

Rabi 2014-15

The increase in seed equivalent yield was 9 and 22% with mustard based system at Sirsa and Deesa, respectively under arid conditions. Under semi-arid condition, 15% increase in seed equivalent yield was observed with chickpea system at Aurangabad, 20% with mustard based systems at Modipuram, 15% with mustard based systems at Kaushambi, 16% with raya based system at Amritsar and 53% with mustard based systems at Sant Kabirnagar. Under Sub-humid conditions, 20% increase in seed yield equivalent was observed at Sabour, 22% at Kawardha and 22% at Nainital in mustard based systems and 24% at Kendrapara with groundnut based cropping systems. Under humid ecosystem at Kangra, 139% increase in seed equivalent yield was observed in gobhi-sarson based system. At Raigad, 51% increase in seed equivalent yield was observed in groundnut based cropping systems.

Profitability of demonstrations

Among the oil seed crops evaluated at various locations, castor registered higher GMR of Rs. 97,630/ ha at Deesa with improved package of castor + cowpea intercropping system. On an average, Arid, Semi -arid

and Sub Humid systems recorded GMR of Rs. 82,292, 46,064 and 39,200/ha, respectively from mustard with improved package. Across the locations, the improvement in net returns with improved package of mustard was found to be 33%. At Palampur, gobhi sarson recorded an increase of 105 % in net returns while at Amritsar, it was found to be 18%. In groundnut, improved package led to 62 and 31 % increase in net returns at Raigad and Kendrapara respectively over FP. In castor and soybean, the increase was found to be 52 and 33 % respectively. In oilseeds, the net return increase in various ecosystems was found to be 35, 37, 26, 105 and 62 % in Arid, Semi -arid, Sub- humid, Humid and Coastal ecosystems respectively. Raya recorded 24 % increase in net returns at Amritsar. The other crops such as rice, maize and pearlmillet evaluated in the system gave 109, 203 and 33 % increase in net returns with improved package compared to FP.

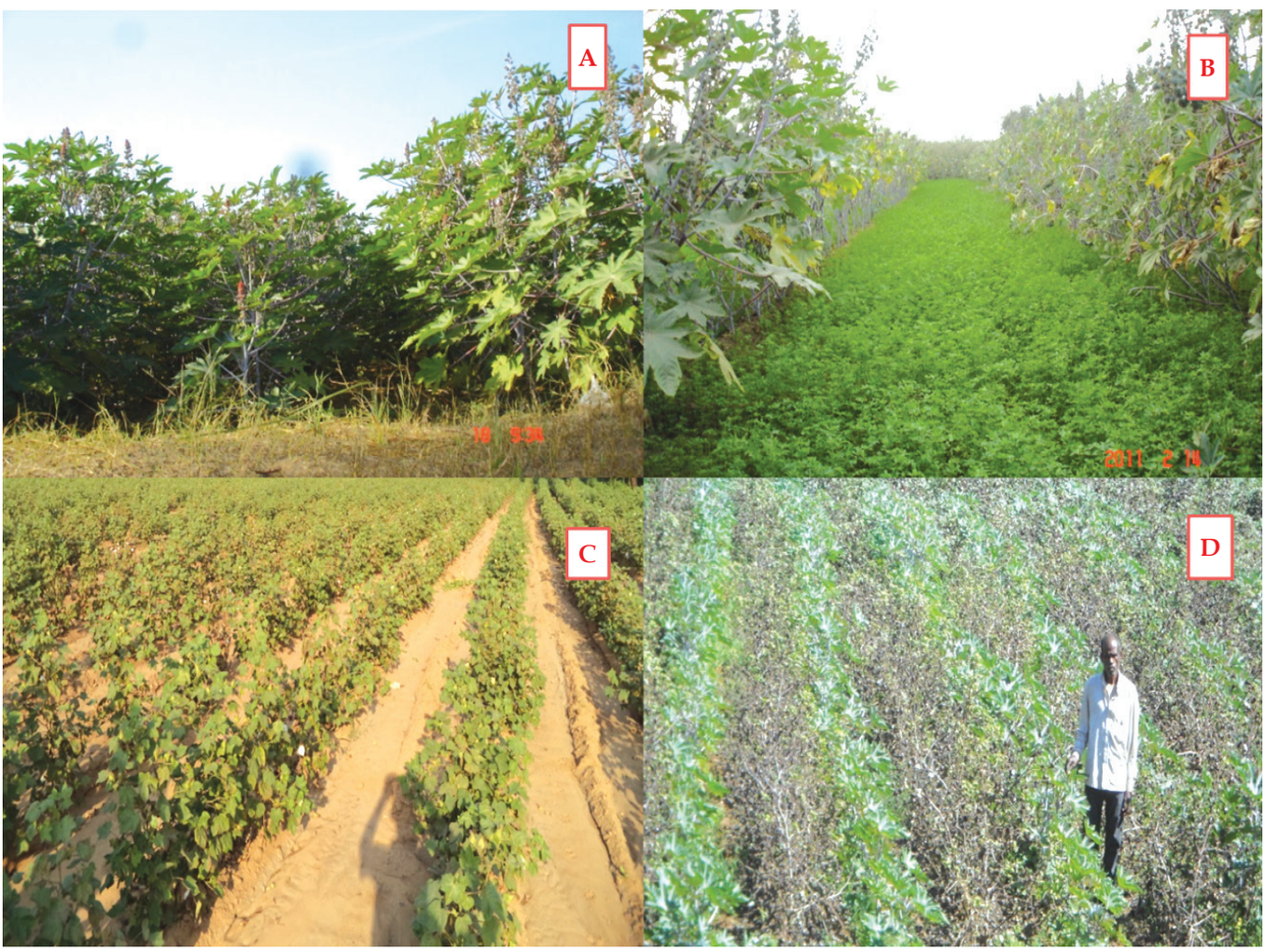
Plate 1: FLD at Jagudan (Gujarat) (A) Groundnut Sole (B) Relay Cropping of Groundnut+Castor (C) Castor after harvesting of groundnut (D) Hybrid Castor after harvesting of Groundnut

Table 2. Oilseed based technologies demonstrated during 2014-15

Agro Ecosystem (Centre)	Cropping system		Particulars of package	Farmer Practice		Improved Practice	
	Kharif	*Rabi*		*Kharif*	*Rabi*	*Kharif*	*Rabi*
Arid							
Jagudan (Gujarat)	Hy castor		Intercrop (IC)	Sole castor	-	Lucerne as IC	-
	Hy castor		Green manuring (GM)	Sole castor	-	GM by sunhamp	-
	Hy castor		Relay cropping (RC)	Sole castor	-	Groundnut relay cropped by hy castor (2:1)	-
	Hy castor		Relay cropping (RC)	Sole castor	-	Bt cotton relay cropped by hy castor (1:1)	-
Semi Arid							
Amritsar (Punjab)	-	Gobhi Sarson	Spacing	-	Broadcasting no thinning	-	45 X 10 maintain by thinning
Seethampeta (Andhra Pradesh)	-	Sunflower	Variety	Local	-	-	-
	Sesame	-	Variety	Local	-	YLM-66	-
Kanpur Dehat (Uttar Pradesh)	-	Mustard	Seed rate		7.5 kg/ha		5 kg/ha
Sub Humid							
Purenia (Bihar)	-	Mustard	Variety	-	Local	-	R-Sufalam
	Sunflower	-	Variety	Local	-	Leader(SF)	-
Jeolikote (Uttarakhand)	-	Mustard	Variety	-	Local	-	Rohini
			Spacing	-	20 x 15	-	30 x 15
			Weed control	-	Hand Weeding	-	Penda methylene
Kangra (Himachal Pradesh)	Maize	Gobhi Sarson	Variety	Local	Local	Kanchan Hybrid	HPN-3
Pakur, (Jharkhand)	-	Mustard	Variety	-	Local	-	Shivani
Humid							
Kakdwip (West Bengal)	Rice	Sunflower	Variety	Local	Local	Improved	KBSH-41 & KBSH-53
Coastal							
Thiruvalla (Kerala)	Sesame		Variety	Kayamkulam1	-	Tilak	-

Table 2b. Fertilizer management of crops in FLDs (2014-15)

Agro Ecosystem (Centre)	Cropping system		Farmer Practice		Improved Practice	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
Semi-Arid						
Jeolikote (Uttarakhand)	-	Mustard	-	NPK 100-40-40 Kg/ha	-	NPK 120-60-40 Kg/ha
Amritsar (Punjab)	-	Gobhi Sarson	-	NPK 100-30-0 (Through Urea and DAP)	-	NPK 100-30-0 (Through Urea and SSP)
Kanpur Dehat (Uttar Pradesh)	-	Mustard	-	NPK 30-22-0	-	NPK 48-24-24
Pakur, (Jharkhand)	-	Mustard	-	NPK 30-0-0	-	NPK 80-40-20
Kakdwip (West Bengal)	Rice	Sunflower	-	NPK only	-	Balanced application S & B



FLD at Jagudan (Gujarat) (A) Castor Sole (B) Inter Cropping of Castor+Lucerne (C) Sole Hybrid castor (D) relay Cropping Bt Cotton+Hybrid Castor

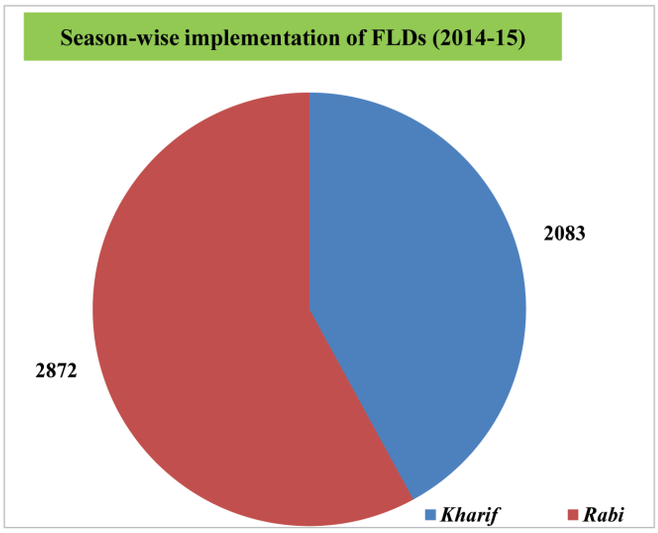
Table 3. Productivity potentials and profitability of improved technologies demonstrated during 2014-15

State	Centre	Technology	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ha)		Gross returns (Rs./ha)		Additional net returns (Rs./ha)	B:C Ratio	
				IT	FP		IT	FP	IT	FP		IT	FP
Kharif													
Arid													
Gujarat	Junagadh	Castor	5	3150	2652	19	92404	61464	142124	101468	9716	1.54	1.65
			2	2915	2470	18	72260	60175	110770	93860	4825	1.53	1.56
			2	4620	3160	46	130280	90120	195480	152350	2970	1.50	1.69
Semi Arid													
Andhra Pradesh	Seethampeta	Sesame	5	485	340	43	44046	28800	53350	37400	704	1.21	1.30
Sub Humid													
Bihar	Puenea	Sunflower	3	1220	850	44	-	-	-	-	-	-	-
Rabi													
Semi Arid													
Andhra Pradesh	Seethampeta	Sunflower	5	525	210	150	15980	3240	16500	6100	-2340	1.03	1.88
Punjab	Amritsar	Gobhi sarson	12	1252	1086	15	28337	22415	40080	34747	-589	1.41	1.55
Uttar Pradesh	Kanpur	Mustard	10	1227	1002	22	26129	19682	45329	36947	1935	1.73	1.88
Sub Humid													
Bihar	Puenea	Mustard	7	1030	680	51	-	-	-	-	-	-	-
Uttarakhand	Jeolikote	Mustard	3	2770	2500	11	53517	45658	89017	80525	633	1.66	1.76
Himachal Pradesh	Kangra	Maize-Gobhi sarson	6	1213	785	55	-	-	-	-	-	-	-
	Pakur	Mustard	5	674	277	143	-	-	-	-	-	-	-
Humid													
West Bengal	Kakdwip	Rice-Sunflower	45	1675	1540	9	25981	20760	66674	61297	156	2.57	2.95
Coastal													
Kerala	Thiruvalla	Sesame	10	519	385	35	44550	22386	95978	71206	2608	2.15	3.18

IT= Improved technology; FP= Farmers' practice; B:C ratio= Benefit cost ratio

SUMMARY

The summary of progress and impact of improved oilseed production technologies demonstrated through FLDs conducted by various AICRP oilseeds and voluntary centres during 2014-15 are presented in a nutsheel. The data were collected / compiled from nine oilseed crops as reported by various centres located across different agro-ecological and crop growing situations. A total of 4955 demonstrations were organized out of 5105 assigned, during 2014-15 across nine oilseed crops. Highest number of demonstrations (717) were conducted on groundnut followed by soybean (714), safflower (606), sunflower (600), rapeseed-mustard (523), castor (500), linseed (497), sesame (490), niger (220), and oilseed based cropping systems (88) (Table 1). During *rabi* 2014-15, 2083 FLDs were conducted, where as during *kharif* 2014, 2872 demonstrations were conducted as shown in the graph.



Productivity potentials and profitability of improved technologies

To show the productivity potential and profitability of improved technologies vis-a-vis farmers' practices FLDs were conducted in various states by AICRP centres of respective crops and voluntary centres. Highest number of FLDs were conducted in Andhra Pradesh (802), followed by Maharashtra (612), Madhya Pradesh (485), Karnataka (451), Rajasthan (406), Uttar Pradesh (383), and Gujarat (235). The details of other states are furnished in Table 2. The results are summarized in the following pages.

Table 1. Crop and Season-wise implementation of demonstrations during 2014-15

Crop	Season		Total
	Kharif	*Rabi*	
Groundnut	344	373	717
Rapeseed Mustard	-	523	523
Soybean	714	-	714
Castor	400	100	500
Linseed	-	497	497
Sunflower	65	535	600
Safflower	-	606	606
Sesame	340	150	490
Niger	220	-	220
Cropping system	-	88	88
Total	2083	2872	4955

Whole package demonstrations

Soybean

Under rainfed conditions, the whole package demonstrations in soybean resulted in 34% increase in seed yield with ANR of Rs. 9809/ha. The B:C ratio was 2.31 and 2.09 with IT and FP plots, respectively (Table 3).

Rapeseed-mustard

The overall seed yield increase as a result of whole package demonstrations in rapeseed-mustard was 23% with ANR of Rs. 7569/ha. The B:C ratio was 2.50 and 2.34 with IT and FP plots, respectively. Ghobi Sarson Under rainfed condition, the IT plots recorded 34% increase in seed yield as compared to FP plots with ANR of Rs. 5198/ha, respectively. The corresponding B:C ratio was 2.86 and 3.40 with IT and FP plots. In Indian mustard under irrigated condition, the IT plots recorded 32% increase in seed yield as compared to FP plots with ANR of Rs. 9515/ha, respectively. The corresponding B:C ratio was 2.49 and 2.30 with IT and FP plots. In Yellow Sarson under irrigated condition, the IT plots recorded 34% increase in seed yield as compared to FP plots with ANR of Rs. 10,362/ha, respectively. The corresponding B:C ratio was 2.42 and 2.19 with IT and FP plots. In Ghobi Sarson under irrigated condition, the IT plots recorded 8% increase in seed yield as compared to FP plots with ANR of Rs. 3397/ha, respectively. The corresponding B:C ratio was 2.30 and 2.19 with IT and FP plots. In Karan rai under irrigated condition, the IT plots recorded 12% increase in seed yield as compared to FP plots with ANR of Rs. 5783/ha, respectively. The corresponding B:C ratio was 2.56 and 2.37 with IT and FP plots, respectively (Table 3).

Groundnut

The whole package demonstrations in groundnut had shown 20% increase in pod yield as compared to farmers' practice plots with ANR of Rs. 14,116/ha. The B:C ratio was 2.73 and 2.40 with IT and FP plots, respectively. Under *rabi* and *kharif* conditions, the IT plots recorded 18 and 22% increase in pod yield as compared to FP plots with ANR of Rs. 13,131 and 15,258/ha, respectively. The corresponding B:C ratio was 2.77 and 2.68 with IT plots and 2.49 and 2.30 with FP plots (Table 3).

Sunflower

The overall seed yield increase as a result of whole package demonstrations in sunflower was 24% with ANR of Rs. 8453/ha. The B:C ratio was 2.02 and 1.78 with IT and FP plots, respectively. During *rabi* season, the IT plots recorded 24% increase in seed yield as compared to FP plots, with ANR of Rs. 8816/ha. The B:C ratio was 2.10 and 1.85 with IT and FP plots, respectively. During *kharif* season, the IT plots recorded 27% increase in seed yield as compared to FP plots, with ANR of Rs. 6478/ha. The B:C ratio was 1.59 and 1.40 with IT and FP plots, respectively (Table 3).

Sesame

The seed yield increase as a result of whole package demonstrations in sesame was 52% with ANR of Rs. 37,039/ha. The B:C ratio was 2.58 and 0.84 with IT and FP plots, respectively (Table 3).

Safflower

The overall seed yield increase as a result of whole package demonstrations in safflower was 25% with ANR of Rs. 6213/ha. The B:C ratio was 2.10 and 1.72 with IT and FP plots, respectively. Under irrigated and rainfed conditions, the IT plots recorded 33 and 23% increase in seed yield as compared to FP plots with ANR of Rs. 8412 and 5633/ha, respectively. The corresponding B:C ratio was 2.01 and 2.12 with IT plots and 1.66 and 1.72 with FP plots (Table 3).

Niger

The overall seed yield increase as a result of whole package demonstrations in niger was 90% with ANR of Rs. 6420/ha. The B:C ratio was 2.00 and 1.56 with IT and FP plots, respectively (Table 3).

Castor

The overall seed yield increase as a result of whole package demonstrations in castor was 28% with ANR of Rs. 19612/ha. The B:C ratio was 3.20 and 2.71 with IT and FP plots, respectively. Under *rabi* and *kharif* situation, the IT plots recorded 18 and 28% increase in seed yield as compared to FP plots with ANR of Rs. 10,055 and 20,366/ha, respectively. The corresponding B:C ratio was 2.93 and 3.22 with IT plots and 2.73 and 2.71 with FP plots (Table 3).

Linseed

The overall seed yield increase as a result of whole package demonstrations in linseed was 51% with ANR of Rs. 9019/ha. The B:C ratio was 2.61 and 2.17 with IT and FP plots, respectively. Under irrigated, rainfed and *utera* conditions, the IT plots recorded 71, 35 and 66% increase in seed yield as compared to FP plots with ANR of Rs. 12,438, 7562 and 5891/ha, respectively. The corresponding B:C ratio was 2.62, 2.63 and 2.39 with IT plots and 2.13, 2.23 and 1.98 with FP plots, respectively (Table 3).

Component Technology Demonstrations

Improved cultivars

The FLDs on improved cultivars under rainfed conditions showed that the seed yield increase was ranging from 7% each in toria and yellow sarson to 68% in niger, with corresponding additional net returns of Rs. 2371, 2699 and 6647/ha, respectively. The B:C ratio was 2.40, 2.13 and 2.11 with IT plots in toria, yellow sarson and niger, whereas, it was 2.29, 1.99 and 1.59 with FP plots in toria, yellow sarson and niger, respectively (Table 4).

Line sowing

Line sowing in niger gave 54% seed yield increase with IT plots as compared to FP plots. The corresponding ANR was Rs. 3689/ha. The B:C ratio was 1.90 and 1.56 with IT and FP plots, respectively (Table 4).

Micro nutrient management

Micro nutrient management in castor gave 24% seed yield increase in IT plots as compared to FP plots. The corresponding ANR was Rs. 18,163/ha. The B:C ratio was 3.07 and 2.43 with IT and FP plots, respectively (Table 4).

Fertilizer management

Application of recommended dose of fertilizers gave seed yield increase of 18% in safflower and 86% in niger with corresponding ANR of Rs. 3400 and 5087/ ha, respectively. The B:C ratio was 1.78 and 1.66 with IT plots and 1.63 and 1.27 with FP plots in safflower and niger, respectively (Table 4).

Revised fertilizer recommendation

Under revised fertilizer recommendation, the seed yield increase was seven per cent in safflower with corresponding ANR of Rs. 1182/ha. The B:C ratio was 1.55 and 1.51 with IT and FP plots, respectively (Table 4).

Plant protection

FLDs on plant protection gave seed yield increase of 21% in sesame, 207% in niger in IT plots as compared to FP plots with ANR of Rs. 5742 and 10,415/ha, respectively. The corresponding B:C ratio was 2.55 and 2.66 with IT plots and 2.48 and 1.55 with FP plots, respectively (Table 4).

Need based Plant protection

FLDs on need based plant protection gave seed yield increase of 34% in safflower in IT plots as compared to FP plots with ANR of Rs. 5295/ha. The corresponding B:C ratio was 1.69 with IT plots and 1.47 with FP plots, respectively (Table 4).

Site specific nutrient management

FLDs on site specific nutrient management gave seed yield increase of 19% in sunflower in IT plot as compared to FP plots with ANR of Rs. 13,000/ha. The corresponding B:C ratio was 2.86 and 2.24 with IT and FP plots, respectively (Table 4).

Spray of Boron

FLDs on spray of boran gave seed yield increase of 12% in sunflower in IT plot as compared to FP plots with ANR of Rs. 4812/ha. The corresponding B:C ratio was 2.13 and 1.98 in IT and FP plots, respectively (Table 4).

Soil application of Sulphur

Application of recommended dose of sulphur gave seed yield increase of 13% in sunflower with IT plot as compared to FP plots with ANR of Rs. 6063/ha. The corresponding B:C ratio was 2.49 and 2.24 with IT and FP plots, respectively (Table 4).

Application of Sulphur

Demonstrations on recommended dose of sulphur application in linseed resulted in 11% higher seed yield in IT plots as compared to FP plots. The corresponding ANR was Rs. 1457/ha. The B:C ratio was 1.85 and 1.77 with IT and FP plots, respectively (Table 4).

Weed management

Demonstrations on weed management in sesame gave 54% increase in seed yield in IT plot as compared to FP plot with ANR of Rs. 17,357/ha. The B:C ratio was 2.10 and 1.37 with IT and FP plots, respectively (Table 4).

Integrated pest and disease management (IPDM)

Demonstrations on IPDM resulted in seed yield increase of 21% in linseed in IT plots as compared to FP plots. The corresponding ANR was Rs. 4339/ha. The B:C ratio was 2.43 and 2.19 in IT and FP plots, respectively (Table 4).

Demonstration of integrated pest and disease management in groundnut during *rabi* season gave 21% seed yield increase with IT plots as compared to FP plots, with ANR of Rs. 16,653/ha. The B:C ratio was 3.00 and 2.66 with IT and FP plots, respectively (Table 4).

Integrated pest management

Demonstration of integrated pest management in groundnut during *kharif* gave 20% seed yield increase in IT plots as compared to FP plots, with ANR of Rs. 11,380/ha. The B:C ratio was 2.45 and 2.16 with IT and FP plots, respectively (Table 4).

Integrated disease management

Demonstration of integrated disease management in groundnut during *kharif* gave 21% seed yield increase in IT plots as compared to FP plots, with ANR of Rs. 5860/ ha. The B:C ratio was 2.15 and 2.17 with IT and FP plots, respectively (Table 4).

Integrated nutrient management (INM)

Demonstrations on INM in groundnut during *rabi* resulted in 40% higher seed yield in IT plots as compared to FP plots with ANR of Rs. 28,510/ha. The B:C ratio was 2.86 and 2.26 with IT and FP plots, respectively. During *kharif* INM resulted in 27% higher seed yield in IT plots as compared to FP plots with ANR of Rs. 24,491/ha. The B:C ratio was 3.42 and 2.92 with IT and FP plots, respectively (Table 4).

Integrated weed management

Demonstrations on integrated weed management in groundnut during *rabi* gave 18% seed yield increase in IT plots as compared to FP plots, with ANR of Rs. 12,777/ ha. The B:C ratio was 1.85 and 1.66 with IT and FP plots, respectively (Table 4).

Plant growth promoting rhizobacteria (PGPR)

Demonstrations on plant growth promoting rhizobacteria application in groundnut during *rabi* resulted in six percent higher seed yield in IT plots as compared to FP plots with ANR of Rs. 5316/ha. The B:C ratio was 3.10 and 3.01 with IT and FP plots, respectively. During *kharif* PGPR resulted in nine per cent higher seed yield in IT plots as compared to FP plots with ANR of Rs. 6412/ha. The B:C ratio was 3.13 and 2.95 with IT and FP plots, respectively (Table 4).

Plant protection

FLDs on plant protection gave seed yield increase of nine percent in Indian mustard in IT plots as compared to FP plots with ANR of Rs. 13,839/ha, respectively. The

corresponding B:C ratio was 3.04 and 1.74 with IT and FP plots, respectively (Table 4).

Painted bug management

Timely management of painted bug resulted in 22% seed yield increase in IT plots as compared to FP plots with ANR of Rs. 32,282/ha in Indian mustard. The B:C ratio was 8.08 and 1.60 with IT and FP plots, respectively (Table 4).

Application of Sulphur

Demonstrations on recommended dose of sulphur application in Indian mustard resulted in 10% higher seed yield in IT plots as compared to FP plots. The corresponding ANR was Rs. 5413/ha. The B:C ratio was 2.16 and 2.01 with IT and FP plots, respectively (Table 4).

Timely sowning

Demonstrations on timely sowning in Indian mustard resulted in 25% higher seed yield in IT plots as compared to FP plots. The corresponding ANR was of Rs. 11, 680/ha. The B:C ratio was 2.21 and 1.78 with IT and FP plots, respectively (Table 4).

Thinning

Adoption of thinning to maintain optimum plant population gave 16% higher seed yield in Indian mustard. With ANR of Rs. 6240 /ha. The B:C ratio was 1.96 and 1.88 with IT and FP plots, respectively (Table 4).

Two irrigations

Providing irrigation at critical stages in Indian mustard gave 14% higher seed yield as compared to farmers' practice with ANR of Rs. 6930/ha. The B:C ratio was 1.93 and 1.79 with IT and FP plots, respectively (Table 4).

Weed control

Demonstrations on effective weed control resulted in 27% higher seed yield in IT plots as compared to FP plots with ANR of Rs. 7858 /ha in Indian mustard. The corresponding B:C ratio was 1.75 and 1.60 with IT and FP plots, respectively (Table 4).

Weed control

Demonstrations of weed control (application of pendimethalin 1 kg a.i. at 0-3 DAS) in Indian mustard resulted in seed yield increase of 14% in IT plots as compared to FP plots with ANR of Rs. 7770/ha. The B:C ratio was 2.62 and 2.51 with IT and FP plots, respectively (Table 4).

Seed treatment

Demonstrations on recommended seed treatment in Indian mustard resulted in 16% higher seed yield in IT plots as compared to FP plots with ANR of Rs. 4240/ha due to effective control of *sclerotia rot*. The B:C ratio was 1.43 and 1.33 with IT and FP plots, respectively (Table 4).

Aphid management

Timely management of aphid (one spray of Oxidemeton methyl/ Dimethioate) resulted in 43% seed yield increase in IT plots as compared to FP plots with ANR of Rs. 10,732/ha in Indian mustard. The B:C ratio was 1.97 and 1.73 with IT and FP plots, respectively (Table 4).

Zero tillage

Demonstrations of zero tillage in Indian mustard resulted in seed yield increase of 20% with IT plots as compared to FP plots with ANR of Rs. 5932/ha. The B:C ratio was 3.27 and 3.23 with IT and FP plots, respectively (Table 4).

Zero drill line sowing

Demonstrations of zero drill line sowing in Indian mustard resulted in seed yield increase of 13% in IT plots as compared to FP plots (broad casting) with ANR of Rs. 7230/ha. The B:C ratio was 2.66 and 2.52 with IT plots and FP plots, respectively (Table 4).

Zero tillage

Demonstrations of zero tillage in Toria resulted in seed yield increase of 25% in IT plots as compared to FP plots with ANR of Rs. 3772/ha. The B:C ratio was 2.08 and 1.99 with IT plots and FP plots, respectively (Table 4).

Sowing method and seed rate

Adoption of recommended method of sowing and seed rate resulted in increasing the seed yield by 40% in yellow sarson with ANR of Rs. 10, 494/ha. The B:C ratio was 2.67 and 2.13 with IT and FP plots, respectively (Table 4).

White rust management

Timely management of white rust resulted in 43% increase in seed yield in IT plots as compared to FP plots with ANR of Rs. 13,520/ha in Indian mustard. The B:C ratio was 2.56 and 1.98 with IT and FP plots, respectively (Table 4).

Club root management

Demonstrations on timely management of club root (using tolerant variety kalyan) in gobhi sarson gave 55% higher seed yield in IT plot as compared to FP plots with ANR of Rs. 12,732/ha. The B:C ratio was 2.61 and 2.31 with IT and FP plots, respectively (Table 4).

Recommended dose of fertilizers and improved variety

The seed yield increase was 20% in *taramira* with ANR of Rs. 4340/ha. The B:C ratio was 5.10 and 4.96 with IT and FP plots, respectively (Table 4).

Plant protection and improved variety

The seed yield increase was 21% in *taramira* with ANR of Rs. 4499/ha. The B:C ratio was 5.01 and 4.80 with IT and FP plots, respectively (Table 4).

Cropping system demonstrations

In order to attain sustainable profit and minimize the risk of crop failure under monocropping system, viable and remunerative oilseeds based intercropping systems were identified by the AICRP network on oilseeds. Among the systems, the most promising have been evaluated under real farm conditions through demonstrations at different agro-ecological conditions during 2014-15. The promising such systems are presented in Table 5.

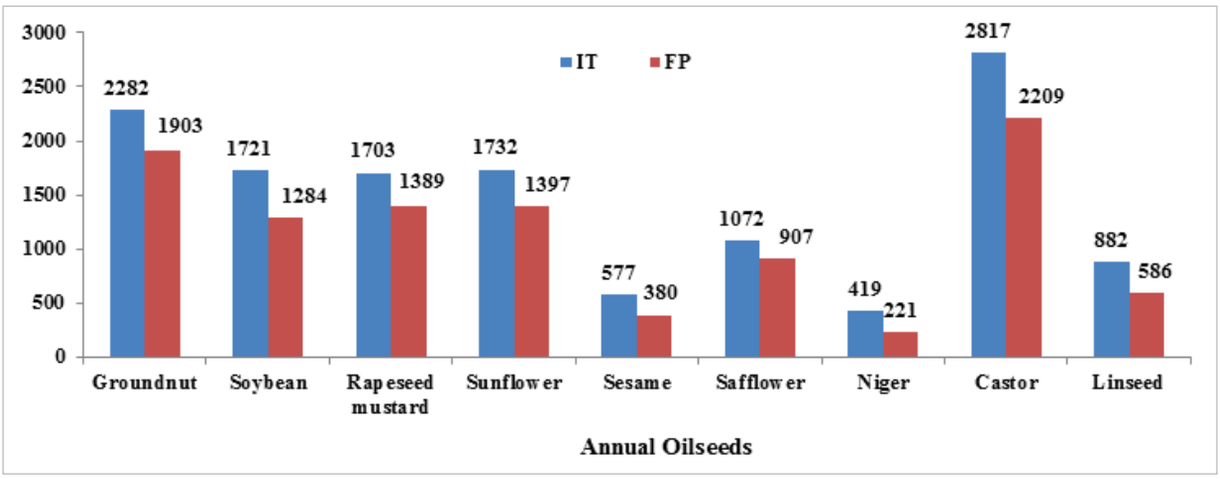
Table 2. State-wise implementation of frontline demonstrations in oilseeds (2014-15)

State	Groundnut	Rapeseed mustard	Soybean	Castor	Linseed	Sunflower	Sesame	Safflower	Niger	PDFSR	Total
Andhra Pradesh	151	-	10	110	-	206	-	315	-	10	802
Assam	-	-	-	-	30	-	-	-	-	-	30
Bihar	-	15	-	-	64	13	15	-	25	10	142
Chhattisgarh	-	-	10	-	40	-	-	30	-	-	80
Gujarat	45	20	15	85	-	-	13	25	20	12	235
Haryana	-	40	-	55	-	20	-	-	-	-	115
Himachal Pradesh	-	35	17	-	10	-	-	-	-	6	68
Jammu & Kashmir	-	36	-	-	-	-	-	-	-	-	36
Jharkhand	-	-	20	-	24	-	12	-	70	5	131
Karnataka	80	-	95	50	20	75	86	25	20	-	451
Kerala	-	-	-	-	-	-	20	-	-	10	30
Madhya Pradesh	30	20	360	20	10	-	-	20	25	-	485
Maharashtra	155	20	60	-	60	71	46	155	45	-	612
Manipur	10	40	10	-	-	-	-	-	-	-	60
Nagaland	-	-	-	-	36	-	-	-	-	-	36
Odisha	60	-	-	20	15	-	20	-	-	-	115
Punjab	10	50	10	-	-	50	25	-	-	12	157
Rajasthan	40	145	85	90	28	-	18	-	-	-	406
Tamil Nadu	60	-	10	50	-	25	30	-	-	-	175
Uttarakhand	-	20	12	-	-	30	-	-	-	3	65
Uttar Pradesh	-	62	-	20	160	40	55	36	-	10	383
West Bengal	76	20	-	-	-	70	-	-	15	10	191
Total	717	523	714	500	497	600	490	606	220	88	4955

Table 3. Impact of whole package technologies on seed yield and income of oilseed growers (2014-15)

State	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Mean cost of cultivation (Rs./ha)		Mean gross returns (Rs./ha)		Mean ANR (Rs./ha)	B:C Ratio	
		IT	FP		IT	FP	IT	FP		IT	FP
Groundnut-*rabi*	58	2353	1992	18	35628	33555	98679	83475	13131	2.77	2.49
Groundnut-*kharif*	50	2200	1800	22	34648	32996	92918	76008	15258	2.68	2.30
	108	2282	1903	20	35174	33296	96012	80018	14116	2.73	2.40
Soybean	714	1721	1284	34	23097	18796	53462	39352	9809	2.31	2.09
Rapeseed mustard Gobhi sarson-rainfed	12	1334	992	34	14447	9043	41354	30752	5198	2.86	3.40
Indian mustard-irrigated	59	1664	1263	32	22658	18592	56368	42787	9515	2.49	2.30
Yellow sarson-irrigated	13	1630	1220	34	23610	19364	57083	42475	10362	2.42	2.19
Gobhi sarson-irrigated	14	1761	1638	8	24900	24300	57232	53235	3397	2.30	2.19
Karan rai-irrigated	36	1894	1693	12	24000	23250	61555	55022	5783	2.56	2.37
	134	1703	1389	23	22610	19660	56577	46058	7569	2.50	2.34
Sunflower-*rabi*	354	1767	1430	24	27241	24928	57235	46106	8816	2.10	1.85
Sunflower-*kharif*	65	1542	1216	27	28474	25639	45241	35928	6478	1.59	1.40
	419	1732	1397	24	27432	25038	55374	44527	8453	2.02	1.78
Sesame	195	577	380	52	19610	38438	50572	32361	37039	2.58	0.84
Safflower-irrigated	107	1240	931	33	18756	15969	37676	26477	8412	2.01	1.66
Safflower-rainfed	406	1084	884	23	15430	15804	32776	2757	5633	2.12	1.74
	513	1117	894	25	16124	15838	33798	27300	6213	2.10	1.72
Niger	97	419	221	90	10494	7352	20997	11435	6420	2.00	1.56
Castor-*Rabi*	15	2444	2077	18	28801	26445	84474	72063	10055	2.93	2.73
Castor-*kharif*	190	2846	2219	28	31382	28798	101099	78149	20366	3.22	2.71
	205	2817	2209	28	31193	28626	99883	77704	19612	3.20	2.71
Linseed-irrigated	127	1105	646	71	15853	11773	41548	25030	12438	2.62	2.13
Linseed-rainfed	197	810	602	35	12713	10753	33458	23936	7562	2.63	2.23
Linseed-utera	47	585	353	66	9056	6795	21626	13474	5891	2.39	1.98
	371	882	586	51	13325	10601	34728	22985	9019	2.61	2.17

IT= Improved technology; FP= Farmers' practice; ANR= Additional net returns; BC ratio= Benefit cost ratio;I= Irrigated; R= Rainfed U= *Utera*



Productivity potentials of oilseeds crops during 2014-15

Table 4. Impact of component technologies on yield and income of oilseed growers

State	Crop	No. of demos	Mean seed yield (kg/ha)		Increase in yield (%)	Cost of cultivation (Rs./ ha)		Gross returns (Rs./ ha)		Additional net returns (Rs./ ha)	B:C Ratio	
			IT	FP		IT	FP	IT	FP		IT	FP
Improved cultivars	Indian Mustard-rainfed	23	792	658	20	12923	12837	24037	19972	3979	1.86	1.56
	Indian Mustard-irrigated	179	1779	1580	13	23635	23263	58190	51737	6081	2.46	2.22
	Gobhi sarson	23	1364	1183	15	14065	10645	42284	36673	2191	3.01	3.45
	Brown sarson	10	1141	982	16	19542	19542	70804	60884	9920	3.62	3.12
	Toria	3	1187	1107	7	16464	16129	39565	36859	2371	2.40	2.29
	Yellow sarson	13	1309	1223	7	19395	19381	41297	38584	2699	2.13	1.99
	Groundnut -*rabi*	219	1865	1529	22	35731	32787	80432	64641	12847	2.25	1.97
	Groundnut -*kharif*	276	2628	2145	23	41274	38410	110008	85906	21238	2.67	2.24
	Sunflower	15	3277	2699	21	34914	33090	98320	81090	15406	2.82	2.45
	Sesame	60	492	393	25	18743	17990	47874	37568	9553	2.55	2.09
	Niger	36	458	272	68	10321	8255	21821	13108	6647	2.11	1.59
	Linseed	19	1193	830	44	20324	17484	12061	5114	4107	0.59	0.29
Fertilizer management	Sesame	48	456	331	38	18854	16896	43711	31220	10533	2.32	1.85
	Niger	34	406	218	86	11073	8461	18425	10726	5087	1.66	1.27
	Safflower	15	1067	902	18	17197	15850	30646	25899	3400	1.78	1.63
Revised fertilizer recommendation	Safflower	1	1150	1075	7	21193	20238	32775	30638	1182	1.55	1.51
Plant protection	Sesame	12	517	426	21	19636	16768	50119	41509	5742	2.55	2.48
	Niger	5	455	148	207	7700	4300	20475	6660	10415	2.66	1.55

Need based plant protection	Safflower	14	1083	808	34	18543	15884	31346	23392	5295	1.69	1.47
Site Specific nutrient management	Sunflower	5	1850	1550	19	24250	26000	69375	58125	13000	2.86	2.24
Spray of boron	Sunflower	5	1450	1295	12	25500	24500	54375	48563	4812	2.13	1.98
Soil application of sulphur	Sunflower	5	1475	1300	13	22250	21750	55313	48750	6063	2.49	2.24
Sulphur	Linseed	7	891	806	11	11551	10951	21394	19337	1457	1.85	1.77
Weed management	Sesame	2	828	538	54	23612	23569	49650	32250	17357	2.10	1.37
Line sowing	Niger	28	281	182	54	8263	6616	15678	10342	3689	1.90	1.56
Micro nutrient management	Castor	1	2625	2125	24	29945	30608	91875	74375	18163	3.07	2.43
Integrated pest and disease management	Linseed	5	510	422	21	9432	7721	22950	16900	4339	2.43	2.19
Integrated pest disease management	Groundnut-*rabi*	5	1915	1585	21	36122	33515	108450	89190	16653	3.00	2.66
Integrated Pest Management	Groundnut -*kharif*	14	2038	1693	20	34899	33822	85629	73172	11380	2.45	2.16
Integrated Disease Management	Groundnut -*kharif*	5	1840	1516	21	30600	25000	65670	54210	5860	2.15	2.17
Integrated Nutrient Management	Groundnut -*rabi*	14	2361	1681	40	38001	33489	108577	75555	28510	2.86	2.26
	Groundnut -*kharif*	45	2249	1766	27	35332	31806	120750	92733	24491	3.42	2.92
Integrated Weed Management	Groundnut -*rabi*	5	2198	1855	18	53297	48834	98485	81245	12777	1.85	1.66
Plant growth promoting rhizobacteria	Groundnut -*rabi*	15	3194	3014	6	36015	35015	111792	105476	5316	3.10	3.01
	Groundnut -*kharif*	5	2276	2087	9	27658	26858	86503	79291	6412	3.13	2.95
Plant protection	Indian Mustard	4	1636	1498	9	16161	25860	49080	44940	13839	3.04	1.74
Painted bug management	Indian Mustard	4	1888	1550	22	7008	29150	56640	46500	32282	8.08	1.60
Sulphur fertilization	Indian Mustard	32	1944	1775	10	31460	30958	68040	62125	5413	2.16	2.01
Timely sowning	Indian Mustard	5	1994	1600	25	27032	26892	59820	48000	11680	2.21	1.78

Thinning	Indian Mustard	3	2416	2083	16	37000	33250	72480	62490	6240	1.96	1.88
Two irrigation v/s one irrigation	Indian Mustard	3	2384	2083	14	37000	34900	71520	62490	6930	1.93	1.79
Weed control	Indian Mustard	12	1892	1494	27	34027	29243	59404	46762	7858	1.75	1.60
Sclerotinia rot management	Indian Mustard	4	1355	1165	16	33675	31170	48102	41357	4240	1.43	1.33
Aphid management	Indian Mustard	9	1482	1038	43	27595	21930	54346	37949	10732	1.97	1.73
Zero tillage by using zero till seed dril	Indian Mustard	12	1160	970	20	14738	12300	48140	39770	5932	3.27	3.23
Zero drill Line sowing	Indian Mustard	2	2266	2002	13	29810	27800	79310	70070	7230	2.66	2.52
Weed control	Indian Mustard	5	2483	2181	14	33180	30380	86905	76335	7770	2.62	2.51
Zero tillage by using zero till seed dril	Toria	18	682	544	25	14738	12300	30690	24480	3772	2.08	1.99
Sowing method and seed rate	Yellow sarson	3	1068	764	40	16000	14334	42720	30560	10494	2.67	2.13
White rust management	Yellow sarson	2	1280	892	43	20000	18000	51200	35680	13520	2.56	1.98
Club root management	Gobhi sarson	5	1360	880	55	19573	14305	51000	33000	12732	2.61	2.31
RDF + improved variety	Taramira	8	1100	920	20	6261	5381	31900	26680	4340	5.10	4.96
Plant Protection + improved variety	Taramira	7	1061	877	21	6137	5300	30769	25433	4499	5.01	4.80

IT= Improved technology; FP= Farmers' practice; BC ratio= Benefit cost ratio; I= Irrigated; R= Rainfed

Table 5. Remunerative intercropping systems demonstrated in oilseeds during 2014-15

Crop	State	Intercropping system
Castor	Gujarat (Junagadh)	Castor + groundnut (1 :2 / 1 :3)
	Uttar Pradesh (Kanpur)	Castor + chilli (1:8)
Linseed	Bihar (Dholi)	S+L (1:3)
	Bihar (Dholi)	S+L (1:3)
	Chhattisgarh (Raipur)	L+G (4:2)
	Karnataka (Raichur)	L+G (4:2)
	Madhya Pradesh (Sagar)	L+G (4:2)
	Maharashtra (Nagpur)	L+G (4:2)
	Uttar Pradesh (Kanpur)	L+G (4:2)
	Uttar Pradesh (Mouranipur)	L+G (4:2)

L= Linseed; S= Sugarcane; G=Gram

Exploitable yield reservoir in oilseeds

During 2014-15, a total of 4955 demonstrations were conducted in nine oilseed crops in different agro-ecological conditions. The comparative yield data with farmers' practice is used for quantification of the additional yield that is possible with the new technology. The additional yield projected can be realized without bringing any additional area under these crops, if all the farmers adopt the improved technologies in the existing cropped area.

The exploitable yield reservoir is estimated by using the formula as follows:

Let demonstrations be conducted at 'A' places with IT_1, IT_2, …, IT_A, as means of improved technology and FP_1, FP_2, …, FP_A, as means of farmers' practice with n_1, n_2, …, n_A, demonstrations at each of the 'A' places. The weighted average of IT and FP are

$$WIT = \frac{n_1 IT_1 + n_2 IT_2 + \ldots + n_A IT_A}{n_1 + n_2 + \ldots + n_A}$$

$$WFP = \frac{n_1 FP_1 + n_2 FP_2 + \ldots + n_A FP_A}{n_1 + n_2 + \ldots + n_A}$$

$$\text{Percentage increase of IT over FP} = \frac{WIT \times 100}{WFP}$$

If AVG is the average production of a particular crop at state or national level, then

$$\text{"AVG x} = \frac{WIT \times 100}{WFP}\text{" is the exploitable yield gap}$$

(or)

$$\text{"AVG + AVG x} = \frac{WIT \times 100}{WFP}\text{" is the exploitable yield reservoir}$$

Table 6. Exploitable yield reservoir in oilseeds (2014-15)

Crop	No. of FLDs	FLD average yield (kg/ha)		Yield gap-I (%)	Average yield (kg/ha)	Yield gap-II (%)	Average production ('000 tonnes)	Expected production ('000 tonnes)	
		IT	FP					EP-I	EP-II
Groundnut *rabi*	136	2353	1992	18	1977	19	1482	1750	1763
Groundnut *kharif*	104	2200	1800	22	1290	71	5075	6203	8656
Soybean	714	1721	1284	34	950	81	10528	14111	19072
Rapeseed Mustard	134	1703	1389	23	1089	56	6309	7735	9866
Sunflower *rabi*	354	1767	1430	24	877	101	309	382	623
Sunflower *kharif*	65	1542	1216	27	532	190	106	134	307
Sesame	195	577	380	52	456	27	811	1231	1026
Safflower	513	1072	907	18	457	135	96	114	226
Niger	97	425	237	79	310	37	73	130	100
Castor	205	2816	2208	28	1568	80	1733	2211	3113
Linseed	371	867	574	51	539	61	153	231	246
Total/Mean	2888	1501	1168	29	1037	45	26675	34280	38610

IT= Improved technology; FP= Farmers' practice; Yield Gap-I= Increase in IT over FP expressed in percentage; Yield Gap-II= Increase in IT over state average yield expressed in percentage; EP-I= Expected production if Yield gap-I is bridged through complete adoption of improved practices; EP-II= Expected production if Yield gap-II is bridged through complete adoption of improved practices.

Untapped Yield Potential

It is evident from Table 6 that there exists a tremendous potential for enhancing the yields of all the nine oilseed crops by adopting the package of recommended technologies. The gap between IT and FP (gap-I) was ranging from 18% each in groundnut during *rabi* and sesame to 79% in niger. It was found that by bridging this gap, the national oilseed production could be increased from 26.67 m t to 34.28 m t.

The yield gap-II between IT and state average yield was ranging from 19% in groundnut during *rabi* to 190% in *kharif* sunflower. By bridging the yield gap-II, the national oilseed production could be increased from 26.67 to 38.61 m t. Thus, there exists a huge exploitable yield reservoir in all the oilseed crops, which could be narrowed down through adoption of improved oilseed production technologies.

Feedback

It is imperative to draw valid conclusions from the various experiences across different agro-ecological situations for betterment of implementation, which ultimately leads to higher efficiency. The feed back obtained based on the implementation of demonstrations during the current year is given as follows.

Constraints encountered

Technological constraints

- It is a very complex situation for clear-cut difference between improved technology and local/farmers' practice, more so in whole package demonstrations, since the farmers are either partial or complete adopters in traditional areas.
- Lack of an organized seed-chain mechanism hinders the adoption and popularization of promising cultivars.
- Poor resource-base of the farmers affects the adoption of the technology.
- Non-availability of critical agricultural inputs is a major factor for non-adoption of the recommended technology by the farmers, although the farmers are fully convinced of the potential benefits of the improved technology.
- The perpetual nature of the marginal and scattered size of holdings is a hindrance for obtaining reliable data for quantifying the worthiness of local practices/farmers' practices with precision.

Operational constraints

- The conduct and/or involvement in field experiments by the scientists are a limiting factor to pay frequent visits to the demonstrations in the farmers' fields.
- Difficulties in appropriate sampling of the farmers
- Non-availability of data on biotic and abiotic stresses during the demonstrations.
- Lack of access to weather data especially rainfall, for providing situation-specific guidance to farmers
- Lack of appropriate feedback from the farmers on the constraints in implementation of the recommended technologies.
- Poor or no transport facilities at the centres for effective monitoring of the demonstrations during the crop growth period.
- Delay in submission of reports by the centres and in sufficient information defining the farmers practice.
- Non-release or untimely release of funds to the centres at the University level.
- Considerable delay in submitting 'Audit Utilization Certificates' (AUCs) by the centres, which in turn delays release of funds by DOR.
- Poor involvement and interaction by the personnel from the state department of agriculture.
- Non-conduct of field days by some centres results in limited spread of the technology.

Strategies for making the FLDs more effective tool for transfer of oilseed technologies to farmers

1. Crop – ecological zoning and mapping of potential district for each crop has to be done on priority.
2. District – wise good agricultural practices (GAPs) are to be defined and demonstrated in each crop.
3. Cluster area approach in transfer of oilseed technologies, organizing FLDs cluster in one or two villages for making the demonstrations more effective.
4. Use of ICTs particularly mobile phones for dissemination of knowledge on oilseed production technologies to farmers.
5. Organizing field days on FLD plots to enhance the visibility of the demonstrations.
6. More popularization/replication of success stories under real farm situations and use of mass media *viz*, video programmes, print media, radio or television for popularizing these success stories.

7. Importance for cropping system demonstrations *viz*, relay, sequential and intercropping systems.
8. Financial supports for conducting farmers day/ field day may be provided in order to make the demonstrations effective in out-reach of the improved technologies to farmers.
9. Organizing workshop with farmers and scientists involved in conducting the FLDs on oilseed crops.
10. Contractual staff has to be provided, at least one each at all the Directorates under the project for compilation of FLD data and preparation of half yearly, annual, three yearly and five yearly reports.
11. It is well understood that every crop is grown under a variety of farming situations and oilseeds are no exception to it. While some problems need to be addressed commonly, there are other problems that are location-specific and/or agroecology-specific. It is thus imperative for the demonstrations to be located under each major farming situation, so that the relevance of the technology could be properly assessed. Such an approach shall also help in comprehensive understanding of the farming situations and thus facilitate proper refining of the package for different situations.
12. The critical input gaps affecting the productivity are to be identified and only such components are to be demonstrated.
13. For the technologies demanding community action *viz*., integrated pest management, seed production, soil and water management *etc*., special attention has to be given while formulating the demonstrations. Only then, the demonstrations would be relevant and the technology(s) advocated shall be successful.
14. Appropriate/proven technologies that are economically viable and socially acceptable are to be focused upon and demonstrated.
15. Demonstrations ought to be conducted for educating rather than distribution of free input incentives.
16. Protection/compensation to farmers against loss of revenue due to new technologies may be thought of for encouraging effective participation.
17. The data about the details of farmers' practice should be included in addition to yield and economics for zeroing down to the critical gaps.
18. The inconsistency in the yardstick for choosing the local check for comparison with the improved technology should be removed. Usually, the yield under local checks collected from any one of the following sources:

- Adjoining area of the same farmer where farmer used his practice.
- Nearby fields of other farmers within the same village.
- District/state level data from the bureau of economics and statistics.

Out of the above, the first or second options are to be used.

19. At each centre, impact of demonstrations has to be studied. After assessing the situation of temporal and spatial variations in adoption of the improved technologies, the constraints in spread of technologies have to be worked out to give an effective feedback to the scientists for fine-tuning/refining the technologies.
20. Frequent visits by multi-disciplinary teams to the demonstration enable practical understanding of the SWOT of technology(s) demonstrated thereby facilitating rapid fine-tuning and refining of the technology(s).
21. Pro-active role of the extension agencies is warranted for forecasting rapid spread of the technology.
22. The development personnel (public and private) should facilitate with the public sector financial institutions for arrangement of credit on a tie up basis to ease the burden of the farmers' from the clutches of the unorganized financial sources.

Annexure I

FEATURES/NORMS OF ORGANIZING FLDs ON OILSEEDS

- Planning, implementation including release of funds to cooperating centres, monitoring, reviewing and evaluation of the project is done by the Directorate of Oilseeds Research (DOR), Hyderabad.
- The project now covers nine annual oilseed crops of the AICRP *viz*., groundnut, sesame, sunflower, niger, castor, rapeseed-mustard, linseed, safflower and soybean and oilseeds-based cropping systems.
- The selected AICRP and voluntary centres conduct the demonstrations. The number and type of demonstrations to be conducted by each of the selected centre is decided in the respective crop-wise 'Annual Oilseeds Research Worker's Group Meetings' organized prior to the beginning of the crop season.
- The number of demonstrations assigned to the centres varies depending upon the scientific and technical manpower availability and appropriate improved technologies available at the centre and extent of the need for demonstrations in the concerned area/locality.
- Most of the times senior scientist/in-charge of the centre is responsible for conducting of demonstrations. He/she is the nodal person as far as execution of the programme at the centre is concerned.
- The existing staff at the cooperating centre is utilized for conducting the demonstrations and no separate staff, either scientific or technical, is provided for this purpose.
- The demonstrations are to be laid out on a cluster approach preferably in watersheds, wherever located within a radius of 30 to 50 km from the concerned oilseed research centres.
- The location of the village and the site of demonstrations shall be easily approachable, preferably on national or state high ways in order to enable the organizers to conduct "Field Days" training activities, ghostis, farmers and scientists interface meetings *etc.*, effectively.
- The size of the plot is invariably 0.4 ha each for demonstration plot (with improved technology) and control plot (with farmers/ local practices) and both the plots are as far as possible agro-ecologically identical.
- Against improved technology demonstration plot, sometimes the adjoining plot of the same farmer with prevailing cultivation practices serves as check/farmers' practice plot. In case of demonstrations pertaining to specific inter/ sequential cropping systems involving oilseed crops, the currently existing popular cropping systems in the specific region form the check for the purpose of comparison of their economic feasibility. Whereas, in component technology oriented demonstrations, all the components of a technology package except the component under evaluation/demonstration are held constant between the demonstration plots and the control plots so as to assess the contribution of the component technology to the yield enhancement and profitability.
- Only released varieties, hybrids preparably less than 10 years and recommended technologies are used in the demonstrations.
- The expenditure on all major inputs such as seed, fertilizer, plant protection chemicals *etc.* in respect of demonstration (improved technological plot) is completely borne from the funds available in the project, whereas expenditure on cultural operations including harvesting, other operations involving labour on the demonstration plot and the entire cost of cultivation in respect of control plot are borne by the farmer himself.
- A set of literature describing the production technology in easily understandable local language is made available to the farmers along with seed. All the operations are carried out as per the directions of subject matter specialist (SMS) of the research centre.
- A team of scientists comprising of plant breeder, agronomist, entomologist and plant pathologist visits these demonstrations two to three times, even more if necessary during the crop season to assess the overall impact of improved technology and to critically examine the qualitative and quantitative constraints to use them as feedback for further refinement of the technology.
- In case of sudden out-break of disease or insect pest, the concerned SMS immediately visits and guides for corrective measures.
- These demonstrations are utilized as channels for rapid out-reach of the technology. In order to

achieve this objective "Field Days", "Farmers' rallies" are organized by the cooperating centres. On the occasion of Kisan Melas/Rythu Sadassus organized by the respective university / institute / centre, these demonstrations are used for field visits too.

- Sign-boards in local languages are also kept at the roadside demonstrations in order to attract the passer by farmers to know about technology.
- Maximum publicity is accorded to these demonstrations by way of making available the postal address of the farmers and location of the demonstrations to the concerned Agriculture Officer, the Department of Agriculture of the district and Director of Extension of the university concerned.
- Concerned in-charge scientist of demonstrations and the associated team of scientists maintain demonstration record.
- Demonstration records (Annexure 1 to 6) are maintained in quadruplicate, one each with the farmer, organizing centre, Project Coordinator/ Project Director of the crop concerned and ICAR-IIOR, Hyderabad and DAC & FW, New Delhi.
- The cooperating centre should submit preliminary, mid-season, follow up action and final technical reports to the IIOR, Hyderabad periodically in the specified proformae designed and supplied to the centres by the Directorate.
- The data obtained from the centres shall be compiled and submitted by the Institute to ICAR and DAC, New Delhi.
- The coordinating centre can utilize 10% of the allocated budjet for monitoring, printing of reports, organizing kisan melas and exhibitions.

Annexure II

Pattern of Assistance for Transfer Technology component under Mini Mission-I (Oilseeds) of NMOOP during XII Plan

S. No.	Components	Pattern of funding	Rate of Assistance	
1	(a) Frontline demonstrations	100%	By ICAR and ICRISAT for mandated crop groundnut.	
			Crop	Rate of Assistance (Rs./ha)
			Groundnut	8500
			Soybean	6000
			R & M	6000
			Sunflower	6000
			Sesame/Safflower/niger/castor/linseed	5000
	(b) Frontline demonstrations on Polythene Mulch Technology in Groundnut		Poly-mulch on groundnut by ICAR.	12500
			Maximum of one demonstration will be allowed to one farmer an area of one hectare under each crop. The size of the FLD plot will be of one ha but not less than 0.4 ha. The assistance will be on Pro-rata basis with the reduction of size of demonstration plot.	
2	Farmers Training	75:25	Rs. 24000/- per training for a batch of 30 farmers for 2 days (@ 400/- per participant per day)	
3	Officers/Extension workers training (input dealers included)	75:25	Rs. 36000/- per training for a batch of 20 officers for 2 days. (@900/- per participant per day)	

Training of Extension officers/Workers/input dealers

Components	Rate	Amount (Rs.)
Training material/stationery/venue cost/Audio-visual aids *etc*	Rs. 5000/- per training	5000.00
Lodging/Travel/Transport/Visits *etc*	Rs. 15000/- per training	15000.00
Honorarium to Trainer/Scientist	Rs. 500/lecture x 8 Lectures in two days	4000.00
2 Meals/Refreshment for officers/extension workers	@ Rs. 300/day x 20 officers/ extension workers x 2 days	12000.00
Total		36000.00

Annexure III

Annual Action Plan for FLDs, Trainings of Extension Officers/Workers/ Input Dealers and related activities implemented by Indian Institute of Oilseeds Research (IIOR)

Season	Crops	Technologies to be demonstrated	No. of FLDs (acre)	Allocation (Rs./acre)	Total allocation (Rs.)
I.	**Frontline Demonstrations in Annual Oilseed Crops by ICAR**				
***Kharif*-2015 (crop-wise)**	Castor	Whole package	300	2000	600000
	Sunflower	Whole package	50	2400	120000
	Sesame	Whole package	500	2000	1000000
Niger		Whole package	200	2000	400000
	Groundnut	Whole package	375	3400	1275000
	Groundnut	Poly-mulch technology	52	5000	260000
	Soybean	Whole package	1100	2400	2640000
	Farming Systems	Groundnut based farming systems	25	3400	85000
	Total		**2602**		**6380000**
***Rabi* 2015 summer-2015-16 (Crop-wise)**	Castor	Whole package	100	2000	200000
	Sunflower	Whole package	400	2400	960000
	Safflower	Whole package	568	2000	1136000
	Linseed	Whole package	500	2000	1000000
	Rapeseed & Mustard	Whole package	500	2400	1200000
	Groundnut	Whole package	300	3400	1020000
	Farming Systems	Soybean/sunflower/ rapeseed-mustard based farming systems	75	2400	180000
	Total		**2443**		**5696000**
	Grand total for FLDs		**5045**		**12076000**
II.	**Training of Extension Officers/ Workers/ Input Dealers**				
Training of extension officers/ workers/ input dealers	IIOR, Hyderabad		20	36000	720000
	DGR, Junagadh		20	36000	720000
	DRMR, Bharatpur		5	36000	180000
	IISR, Indore		5	36000	180000
	IIFSR		4	36000	144000
	AICRP Linseed		5	36000	180000
	Total		**59**		**2124000**
III.	**Regional Mela**		**2**	**400000**	**800000**
Grand total from items I to III					**15000000**