

सत्यमेव जयते



Status Paper on Oilseeds



OILSEEDS DIVISION

Department of Agriculture & Cooperation
Ministry of Agriculture
Govt. of India
Krishi Bhawan, New Delhi
www.nmoop.gov.in



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December 2014

संयुक्त सचिव
भारत सरकार
कृषि मंत्रालय
(कृषि एवं सहकारिता विभाग)
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Dated: 22nd December, 2014

FOREWORD



Edible oil constitutes an important part of our daily diet. Domestic consumption of edible oils has increased substantially over the years and has touched the level of 19.82 million tonnes during 2012-13. However, the growth in production of domestic edible oils (9.22 million tonnes in 2012-13) has not been able to keep pace with the growth in consumption and the gap between production and consumption is being met through imports with huge drain of foreign exchequer.

Indian vegetable oil economy is world's fourth largest after USA, China and Brazil. Oilseed cultivation is undertaken across the country over an area of more than 26 million ha, largely under rainfed areas (72%) with high risk of investment. As per fourth advance estimates for 2013-14, an highest ever production of 328.77 lakh tonnes of oilseeds with a productivity of 1153 kg/ha has been recorded. It is a matter of great satisfaction that the productivity of oilseeds has increased from 481 kg/ha in 1950-51 to 1153 kg/ha during 2013-14. Oil Palm, highest vegetable oil yielding crop per unit area, undertaken for cultivation during late 70s, have also shown good impact with an area coverage of 2.69 lakh ha and productivity of fresh fruit bunches of 5000 kg/ha in the country.

Basic information about crop description, climatic requirement, national/international scenario, potential districts/areas, improved varieties/technologies, yield gap between the improved practices v/s farmer practices, best practices, nutritive values and market demand etc. brought out in this document would be of great help to all the concerned stakeholders in formulation and implementation of development programme of oilseeds and oil palm.

I am grateful to Dr. J.S. Sandhu, Agriculture Commissioner for his valuable guidance in bringing out this publication. I thanks to Dr. Anupam Barik, Addl. Commissioner (OS), Sh. Karanjit Singh Ngangbam, Dy. Director (OS), Sh. Ranvir Singh, Asstt. Director (OP), Sh. Jitendra Kumar, Asstt. Director (OS), of Oil Seeds Division and officials of Directorate of Oilseeds Development (DoD), Hyderabad including Shri R.P. Singh, Ex-Director for providing their input in bringing out this publication.

I congratulate Dr. J.P. Singh, National Consultant (OS) and his associates Mr. Rajeev Kumar Mishra, Technical Assistants & Miss Shabnam Parveen, DEO for their un-tiring efforts in bringing out this publication in a time bound manner.


(Sanjay Lohiya)



CONTENTS

Chapter 1:	An Overview of Oilseeds Sector	1
Chapter 2:	Soybean	11
Chapter 3:	Groundnut	23
Chapter 4:	Rapeseed & Mustard	43
Chapter 5:	Sesamum	55
Chapter 6:	Sunflower	69
Chapter 7:	Safflower	85
Chapter 8:	Niger	93
Chapter 9:	Linseed	103
Chapter 10:	Castor	115

ANNEXURES

Annex I:	Potential Districts of Soybean	125
Annex II:	Details of Soybean Varieties	129
Annex III:	Potential Districts of Groundnut	134
Annex IV:	Details of Groundnut Varieties	137
Annex V:	Potential Districts of R&M	145
Annex VI:	Details of R&M Varieties	148
Annex VII:	Potential Districts of Sesamum	157
Annex VIII:	Details of Sesamum Varieties	160
Annex IX:	Potential Districts of Sunflower	165
Annex X:	Details of Sunflower Varieties	167

Annex XI:	Potential Districts of Safflower	169
Annex XII:	Details of Safflower Varieties	170
Annex XIII:	Potential Districts of Niger	172
Annex XIV:	Details of Niger Varieties	173
Annex XV:	Potential Districts of Linseed	175
Annex XVI:	Details of Linseed Varieties	176
Annex XVII:	Potential Districts of Castor	179
Annex XVIII:	Details of Castor Varieties	180
Abbreviations		181



CHAPTER 1

AN OVERVIEW OF OILSEEDS SECTOR



► 1.1 Economic Importance of Oilseeds Sector

Edible oil constitutes an important part of our daily diet, being source of energy, essential fatty acids like linoleic and oleic acids, amino acids like lysine, leusine, histidine, tryptophan etc., which are vital for our growth. Domestic consumption of edible oils has increased substantially over the years and has touched the level of 19.82 million tonnes in 2012-13 (Nov-Oct) and is likely to increase further with enhancement in income and population. The growth in production of domestic edible oils (9.22 million tonnes in 2012-13) has not been able to keep pace with the growth in consumption and the gap between production and consumption is being met through imports. The cost of import of edible oil with a huge drain of the exchequer has touched to approximately ₹ 60,000 crores during 2012-13.

Indian Vegetable oil economy is world's fourth largest after USA, China and Brazil. Oilseed cultivation is undertaken across the country in about 260 lakh ha, largely under rainfed areas (72%) with risk in investment. The Oilseeds account for 13% of the Gross cropped area, 3% of the Gross National Product (GNP) and 10% value of all the agricultural commodities. The annual growth rates of area (2.44%), production (5.4%) and yield (2.96%) of Oilseed crops during 1999-2009 have declined as compared to that of 1986-98 (Area: 3.05%, Production: 6.36% and Yield: 3.73%). As per fourth advance estimates an ever highest production of 328.77 lakh tonnes of oilseeds with a productivity level of 1153 kg/ha has been recorded during 2013-14 due to favourable weather conditions coupled with support from the Government to the Oilseeds production programmes and policies.

► 1.2 Source of Vegetable Oils

The sources of vegetable oils could be categorised into primary sources like oilseed and oil palm and secondary sources. The primary sources includes crops like Groundnut, Rapeseed-Mustard, Soybean, Sunflower, Sesame, Safflower, Niger, Linseed and Castor, which are primarily grown

as oilseeds and oil palm a perennial crop introduced as an oilseed during 70s in India. The secondary sources includes crops like Paddy, Maize and Cotton, which are grown as cereals/ fibre crop but contain sizeable amount of vegetable oils in their seeds. There are other sources of vegetable oils like coconut and many other seeds/nuts of tree/crop species like Sal, Mahua, Mango, Cheura, Kokum, Dhupa, Simarouba, Rubber, Neem, Karanj, Pilu or Khakan, Palash, Nahor, Undi, Pisa, Wild-apricot, Rattan-jyot, Maroti, Jojoba, Mesta, Tobacco, Water melon etc. The commodity wise average yield, oil recovery and oil yield per unit area are given in **Table 1**.

TABLE 1: AVERAGE YIELD, OIL RECOVERY AND OIL YIELD PER UNIT AREA

Oilseeds	National Average Yield (11 th Plan)	Average Oil Recovery (%)	Oil Yield (kg/ha)
Groundnut	1274	40	510
Soybean	1166	17	198
Mustard	1128	33	372
Sunflower	535	35	187
Safflower	636	30	191
Sesame	387	45	174
Niger	278	30	83
Linseed	413	43	178
Castor	1451	45	653
Oil Palm (FFB)	5713	18	1028
Sal kernel	-	15	-
Mahua	-	35	-
Mango kernel	-	9-12	-
Cheura	-	50	-
Kokum	-	50	-
Simarouba (K)	-	60	-
Neem	-	20	-
Karnaja	-	30	-
Jatropha	-	30	-
Tung	-	20	-

1.2.1 Oilseeds

Nine oilseeds are the major source of vegetable oil in the country. Among 09 oilseeds soybean (39%), groundnut (26%), Rapeseed & Mustard (24%) contributes >88% of total oilseeds production in the country. However, in terms of vegetable oil production mustard, soybean and groundnut contributes >31%, 26% and 25% respectively. The plan wise average area,

production and productivity and crop and year wise area, production and productivity are given in Table 2 & 3 respectively. The crop-wise National and global scenario is described under the crop specific chapters.

TABLE 2: THE PLAN WISE AREA, PRODUCTION AND PRODUCTIVITY OF 09 OILSEED CROPS

Plan	Year	Area (lakh ha)	Production (lakh Tonnes)	Yield (kg/ha)	% Change in Production Over Previous Plan
First Plan	1951-56	67.65	19.18	284	-
Second Plan	1956-61	69.53	19.84	285	(+) 3.44
Third Plan	1961-66	81.53	22.80	280	(+) 14.92
Annual Plan	1966-69	87.15	24.37	280	(+) 6.89
Fourth Plan	1969-74	136.06	63.95	470	(+) 162.41
Fifth Plan	1974-79	171.15	95.90	560	(+) 49.97
Annual Plan	1979-80	170.42	87.39	513	(-) 8.87
Sixth Plan	1980-85	183.76	114.17	621	(+) 30.64
Seventh Plan	1985-90	204.95	139.39	680	(+) 22.09
Annual Plan	1990-91	250.17	186.05	744	(+) 33.47
Eighth Plan	1992-97	259.47	218.86	843	(+) 17.63
Ninth Plan	1997-02	244.09	211.79	868	(-) 3.23
Tenth Plan	2002-07	254.10	233.29	918	(+) 10.15
Eleventh Plan	2007-12	267.48	289.27	1082	(+) 24.00

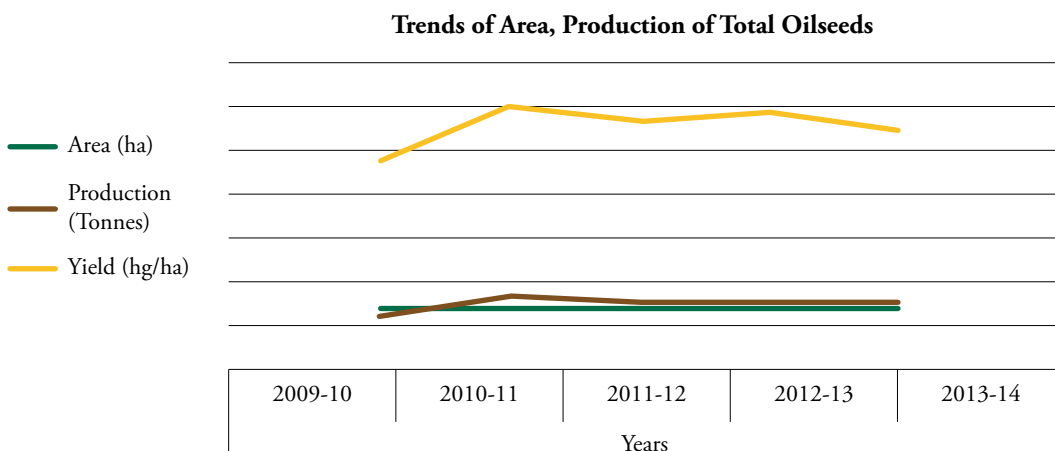
TABLE 3: CROP WISE AREA, PRODUCTION AND YIELD OF MAJOR OIL SEED CROPS DURING 11TH PLAN

(Area: lakh ha, Production: lakh tonnes, Yield: kg/ha)

Crop		Year					Average
		2009-10	2010-11	2011-12	2012-13	2013-14*	
Groundnut	A	54.78	58.56	52.64	47.66	55.27	53.78
	P	54.29	82.65	69.64	46.95	96.72	70.05
	Y	991	1411	1323	985	1750	1302
Soybean	A	97.35	96.01	101.09	108.43	122.00	104.98
	P	99.65	127.36	122.14	146.66	119.89	123.14
	Y	1024	1327	1208	1353	983	1173
Rapeseed-Mustard	A	55.88	69.01	58.94	63.39	67.01	62.84
	P	66.08	81.79	66.04	80.29	79.60	74.76
	Y	1183	1185	1120	1267	1188	1190

Crop		Year					Average
		2009-10	2010-11	2011-12	2012-13	2013-14*	
Sunflower	A	14.77	9.29	7.32	8.23	6.91	9.30
	P	8.51	6.51	5.17	5.44	5.47	6.22
	Y	576	701	706	661	791	669
Safflower	A	2.88	2.44	2.50	1.70	1.78	2.26
	P	1.79	1.51	1.45	1.09	1.14	1.39
	Y	621	617	580	641	641	618
Castor	A	7.35	8.80	14.71	13.17	10.00	10.80
	P	10.09	13.50	22.95	19.64	16.89	16.61
	Y	1373	1534	1560	1491	1689	1537
Sesame	A	19.42	20.83	19.01	16.73	16.67	18.53
	P	5.89	8.93	8.10	6.85	6.75	7.30
	Y	303	429	426	409	405	394
Linseed	A	3.42	3.59	3.23	2.96	2.87	3.21
	P	1.54	1.47	1.53	1.49	1.43	1.49
	Y	449	408	473	503	498	464
Niger	A	3.76	3.71	3.64	3.01	2.77	3.38
	P	1.00	1.08	0.98	1.02	0.88	0.99
	Y	266	290	269	339	319	294
Total Oilseeds	A	259.59	272.24	263.08	265.27	285.25	269.09
	P	248.82	324.79	297.99	310.06	328.77	302.08
	Y	958	1193	1133	1169	1094	1123

* Fourth advance estimates of DES



1.2.2 Oil Palm (Genus: *Elaeis*)

Oil Palm is considered to be highest oil yielding source per ha and largely cultivated in Malaysia, Indonesia, Thailand, Costa Rica, Ivory Coast etc. Average oil yield of Oil Palm is 4-5 tonnes per ha in Malaysia has been recorded against the highest oil yield of 1.3 tonnes per ha of rapeseed in Germany. Oil Palm was introduced in India in early 70s for plantation in Kerala, Andman Nicobar and Goa. It has now been well acclimatized and under commercial cultivation over an area of 2.69 lakh ha in the country during 2013-14.



Fresh Fruit Bunches of Oil Palm

Out of which 1.75 lakh ha is at fruiting stage and approximately 1.5 lakh tonnes of palm oil is being produced. The major oil palm growing States are Andhra Pradesh, Karnataka, Tamil Nadu, Mizoram, Kerala, Odisha, Gujarat, Goa, Maharashtra and Chhattisgarh.

1.2.3 Secondary Sources of Vegetable Oils

Almost 02 million tonnes of vegetable oils is being harnessed from cotton seeds and rice bran in the country. Coconut is also a major source of vegetable oil, which is mainly used for cooking in Kerala and largely used as hair oil. In addition to these sources seeds of plant/crop species like sal, mahua, mango kernel, karanja, neem, jatropha, water melon, mesta and tobacco are being collected and crushed. The year wise status of availability of oil from these sources is given in **Table 4**.

TABLE 4: AVAILABILITY OF VEGETABLE OIL FROM SECONDARY SOURCES

<i>(Quantity in lakh tonnes)</i>			
Commodity	2010-11	2011-12	2012-13
Cotton seed	10.89	11.62	11.16
Rice bran	7.20	7.50	7.80
Coconut	4.00	4.00	3.90
TBOs	1.20	1.20	1.20
SE oils	4.20	4.10	4.10
Total	27.49	28.42	28.16

► 1.3 Crop Development Programmes

Considering the importance of oilseeds various oilseeds development schemes like, Intensive Oilseed Development Programme (1974–84); National Oilseeds Development Project

(1984-90), Oilseeds Production Thrust Project (1987-91), Oilseeds Production Programme (1991-2004) and Oil Palm Development Programme (1991-2004) under Technology Mission on Oilseeds and Integrated Scheme of Oilseeds, Oil Palm and Maize (2004-2014), have been funded by the Government for the development of Oilseeds and Oil Palm in the country. Implementations of these schemes have given fillip in augmenting the availability of vegetable oil in the country. The impact of Integrated Scheme of Oilseeds, Oil Palm and Maize (ISOPOM) implemented during 2004-2014, on production of oilseeds and oil palm is summarized as under.

1.3.1 Oilseeds

- Area, production and yield, which was 225.96 lakh ha, 202.29 lakh tonnes and 895 kg/ha respectively before the implementation of ISOPOM (TE: 2003-04), touched a record production of 328.77 lakh tonnes and yield of 1153 kg/ha respectively during 2013-14 with an increase of >63% in production and >29% in yield.
- Seed Replacement Rate (SRR) of oilseed crops, which was 12.6% before ISOPOM (2003-04) increased to 34.2% during 2011-12. The crop wise Seed Replacement Rate before and after ISOPOM is given in Table 5.

TABLE 5: CROP WISE SEED REPLACEMENT RATE (SRR) BEFORE AND AFTER ISOPOM

Crop	Seed Replacement Rate before (SRR) and after ISOPOM (%)		
	2011-12	2003-04	Difference
Groundnut	21.85	7.54	+14.31
Soybean	45.55	19.45	+26.10
Rapeseed-Mustard	84.50	33.53	+50.97
Sesamum	24.19	16.47	+7.72
Safflower	27.96	10.99	+16.97
Linseed	2.07	0.70	+1.37

- Disseminated improved crop production and protection technologies over an area of >7.20 lakh ha.
- Promoted mechanization by distributing 17.95 lakh farm implements.
- Demonstrated Integrated Pests Management (IPM) technologies over an area of 37.02 lakh ha and Integrated Nutrients Management (INM) over an area of 112. 52 lakh ha.
- Promoted newly released varieties of Soybean (JS-95-60, PS-1347); Groundnut (Kadiri-6,TPG-41, TG-37-A, GPBD-4, DH-86, TG-38, RG-382, ICGV-91114,

Narayani, Kadiri-9); Sunflower (KBSH-53); Sesame (GT-3); Castor (DCH-519, GCH-7); Rapeseed-Mustard (JD-6, JM-2, GM-3, CS-54, RGN-48, PM-21, CS-56, DMH-I, Ashirwad, RGN-73) and Linseed (Kartika).

1.3.2 Oil Palm

- Area under Oil Palm, which was 0.71 lakh ha prior to ISOPOM (2003-04), increased to 2.69 lakh ha during 2013-14.
- Increased Fresh Fruit Bunches (FFB) production from 1.68 lakh tonnes before ISOPOM to 8.97 lakh tonnes during 2012-13.
- Established 6 Oil Palm seed gardens with a capacity of 48.50 lakhs sprouts/year.
- Brought 55,538 ha of Oil Palm area under drip irrigation.
- Trained 4,48,700 Oil Palm growers.

► 1.4 National Mission on Oilseeds and Oil Palm (NMOOP)

The existing Centrally Sponsored Schemes of Integrated Scheme of Oilseeds, Oil Palm and Maize (ISOPOM), Tree Borne Oilseeds (TBOs) and Oil Palm Area Expansion (OPAE) programme have been restructured into National Mission on Oilseeds and Oil Palm (NMOOP), for implementation in the financial year 2014-15 with budgetary provision of ₹ 3507 crores for 12th Plan. The Mission aims to enhance production of oilseeds from 28.93 million tonnes (average of 11th Plan) to 35.51 million tonnes by 2016-17 and to bring additional area of 1.25 lakh ha under Oil Palm cultivation with increase in productivity of FFBs from 4927 kg/ha to 15000 kg/ha by end of 12th Plan. The strategy includes increasing irrigation coverage under oilseeds crops, improved varietal replacement, Area expansion under Oilseeds and Oil Palm, Improve mechanization and Strengthening procurement of Oilseeds and Tree Borne Oilseeds and processing of oil palm.

► 1.5 Status of Import and export in Oilseeds Sector

1.5.1 Import

More than 10 million tonnes of vegetable oil was imported with a total value of ₹ 61,106.43 crores during 2012-13, which include largest share of palm oil/palmolein (78%) followed by soybean (10%) and sunflower oil (9%). The details of imports of vegetable oil during last 5 years are given in Table 6.

TABLE 6: IMPORT OF VEGETABLE OIL DURING LAST FIVE YEARS

(Qty. in lakh tonnes)

Year (Nov-Oct)	Refined Oil	Crude Oil				Total
	RBD Palmolein	Palm Oil	Sunflower Oil	Soybean Oil	Others	
2008-09	12.40	51.87	5.90	8.90	1.76	81.83
2009-10	12.13	51.69	6.30	16.66	1.40	88.23
2010-11	10.82	53.74	8.04	10.07	0.99	83.71
2011-12	15.77	59.94	11.35	10.79	1.96	99.81
2012-13	22.23	58.89	9.73	10.91	2.07	103.85

1.5.2 Export

Export of oilseeds like HPS groundnut, white sesame, sunflower, mustard and niger seeds is allowed without any quantitative restrictions. Export restrictions have also been lifted in respect of castor oil, coconut oil and certain oils produced from the seeds of forest origin like sal, mahua, kokum, mango kenal etc. Besides, large quantity of De-Oiled Cakes (DOC) are also allowed for export. Soybean extraction has a largest (71%) share in export of cakes. In case of seeds HPS groundnut (59%) and sesame (33%) have largest share in export and castor oil (95%) in case of export of oils/fats. Exports of these commodities have earned a foreign exchange of ₹ 23,681/- crores during 2012-13. Details of export of these commodities during last 03 years are given in Table 7.

TABLE 7: EXPORT OF DOC, SEEDS AND OIL/FAT DURING LAST THREE YEARS

(Q = Quantity in lakh tonnes, V = Value in crores)

Commodities	2010-11		2011-12		2012-13	
	Q	V	Q	V	Q	V
De-Oiled Cakes (DOC)						
Soybean	38.38	7062.23	38.30	7009.75	34.40	10050.00
Others	13.43	1248.94	17.81	1437.98	14.16	1771.89
Seeds						
HPS Groundnut	4.34	2178.41	8.33	5246.45	5.36	4065.59
Sesame	3.98	2307.52	3.89	2641.66	3.00	2881.54
Others	0.42	133.99	0.86	324.93	0.63	310.02
Oils/Fats						
Castor oil	4.25	2982.92	4.93	4571.67	5.66	4314.78
Others	0.06	43.14	0.07	65.02	0.28	287.29
Grand total	64.86	15957.15	74.17	21297.46	63.48	23681.11

► 1.6 Awards and Recognition

NMOOP envisages provision for three awards for ₹ 50.00 lakh, ₹ 30.00 lakh and 20.00 lakh every year to the best performing states for increase in production/productivity of oilseeds, oil palm & TBOs, respectively. Eleven farmers will also be awarded every year in recognition of their contribution in enhancing production and productivity of oilseeds in the country. Award will be comprised of cash award of ₹ 1.00 lakh each farmer. Nine awards will be given for 9 oilseed crops one for oil palm and one for TBOs. Selection of farmers will be based on the recommendations of the State Governments implementing NMOOP.

► 1.7 Important Websites

- Indian Council of Agricultural Research, New Delhi.
(www.icar.org.in) – **Oilseed Research.**
- Directorate of Oilseeds Research
(<http://www.dor-icar.org.in>) – **Safflower, Sunflower, Linseed, Sesame, Niger, Castor.**
- APEDA (www.apeda.com) – **Oilseed export.**
- International Crops Research Institute for the Semi-Arid Tropics, Hyderabad
(<http://icrisat.org>) – **Groundnut.**
- Junagadh Agricultural University, Junagadh, Gujarat.
(<http://www.jau.in>) – **Groundnut, Sesame, Mustard, Castor.**
- National Peanut Research Laboratory, Dawson, GA, United States
(<http://www.ars.usda.gov>) – **Groundnut.**
- Seednet India Portal (<http://seednet.gov.in>) – **Varieties and seeds.**
- TNAU Agritech Portal, TNAU, Coimbatore.
(<http://agritech.tnau.ac.in>) – **Groundnut, Sesame.**
- USAID - Peanut Collaborative Research Support Program (CRSP)
(<http://peanutcrsp.org>) – **Groundnut.**
- SEA (<http://www.seaofindia.com>) – **Oil Industry and Trade.**
- IOPEA (<http://www.iopea.com>) – **Export.**
- SOPA, India (<http://www.sopa.org>) – **Soybean.**
- DAC, GoI (<http://agricoop.nic.in>) – **Development Schemes of GoI.**

- Sunflower (<http://www.helianthus.com>) – **Sunflower.**
- American Peanut Council, Washington (<http://www.peanutsusa.com>) – **Groundnut.**
- National Peanut Board, Atlanta, GA (<http://nationalpeanutboard.org>) – **Groundnut.**
- **National Seeds Corporation Limited**, New Delhi
(<http://www.indiaseeds.com>)– **Seeds.**
- Protection of Plant Varieties and Farmers' Rights Authority, Govt. of India
(<http://www.plantauthority.gov.in>) – **Farmers varieties.**
- The Peanut Institute, Albany, Georgia (<http://www.peanut-institute.org>) – **Groundnut.**
- NMOOP www.nmoop.gov.in - Oil Seeds development schemes/Guidelines/
Circulars etc.
- AGMARKNET <http://agmarknet.nic.in> - **Market arrivals and prices.**



CHAPTER 2

SOYBEAN



► 2.1 Crop Description

Soybean (*Glycine max-Linn.*) is a leguminous and self pollinated crop belongs to family Leguminoceae sub- family Papilionoideae (fabaceae). Crop cultivars generally reach a height of around 1 m (3.3 ft), and take 80–120 days from sowing to harvesting. Soybeans, like most legumes, perform nitrogen fixation by establishing a symbiotic relationship with the bacterium *Bradyrhizobium japonicum*. It is categorised as an oilseeds rather than a pulse, despite being rich source of protein and used as food and feed by the human as well as live stocks across the Globe because soybean cannot be cooked as a normal pulse. Parts of plants like leaves, stalks, petioles and stems are also used as dry fodder for the animals.

► 2.2 Centre of Origin

The first domestication of soybean has been traced to the eastern half of North China in the eleventh century B.C. or perhaps a bit earlier. Soybean has been one of the five



Soybean crop at maturity stage

main plant foods of China along with rice, wheat, barley and millet. According to early authors, soybean production was localized in China until after the Chinese-Japanese war of 1894-95. The first use of the word “soybean” in U.S. literature was in 1804. However, it is thought that soybean was first introduced into the American Colonies in 1765 as “Chinese vetches”. For many years, most of the references to this crop were by people working in eastern and southeastern United States where it was first popular. Most of the early U.S. soybeans were used as a forage crop rather than harvested for seed. Most of the early introductions planted in these areas were obtained from China, Japan, India, Manchuria, Korea, and Taiwan.

► 2.3 Climatic Requirement

Cultivation is successful in climates with hot summers, with optimum growing conditions with mean temperatures of 20 to 30 °C; temperatures of below 20 °C and over 40 °C stunt growth significantly. It can be grown under a wide range of soils, with optimum growth/yield under moist alluvial/vertisols with a good organic content.

► 2.4 Global Scenario

Soybean is cultivated across the continents except Europe and Australia over an area of >100 million ha. USA, Brazil, Argentina, India and China contribute about 90% of the total soybean production in the world. The status of area, production and productivity of important soybean growing countries is given in Table 8.

TABLE 8: COUNTRY-WISE AREA, PRODUCTION AND YIELD OF SOYBEAN

Sl. No.	Country	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
1	Argentina	187.46	175.77	194.19	488.79	401.00	493.06	2607	2281	2539
2	Bolivia	11.78	11.78	12.38	18.61	20.61	23.47	1580	1751	1896
3	Brazil	239.69	249.75	278.65	748.15	658.49	817.00	3121	2637	2932
4	Canada	15.42	16.79	18.20	42.46	50.86	51.98	2753	3029	2857
5	China	78.89	67.50	66.00	144.85	130.50	125.00	1836	1933	1894
6	India	101.80	108.40	122.00	122.14	146.66	119.48	1200	1353	979
7	Indonesia	6.21	5.68	5.51	8.44	8.43	7.80	1359	1485	1416
8	Nigeria	6.09	5.70	6.00	5.64	5.80	6.00	926	1018	1000

Sl. No.	Country	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
9	Paraguay	28.05	29.20	30.80	83.10	43.45	90.86	2962	1488	2950
10	Russian Fed.	11.87	13.75	12.03	17.56	18.06	16.36	1479	1313	1360
11	Ukraine	11.10	14.12	13.51	22.64	24.10	27.74	2039	1707	2054
12	USA	298.56	307.99	307.03	841.92	820.55	894.83	2820	2664	2915
13	Uruguay	8.62	9.50	12.00	18.30	30.00	32.00	2123	3158	2667
14	World+ (Total)	1038.06	1049.18	1112.73	2619.40	2411.42	2763.96	2523	2298	2484

► 2.5 National Scenario

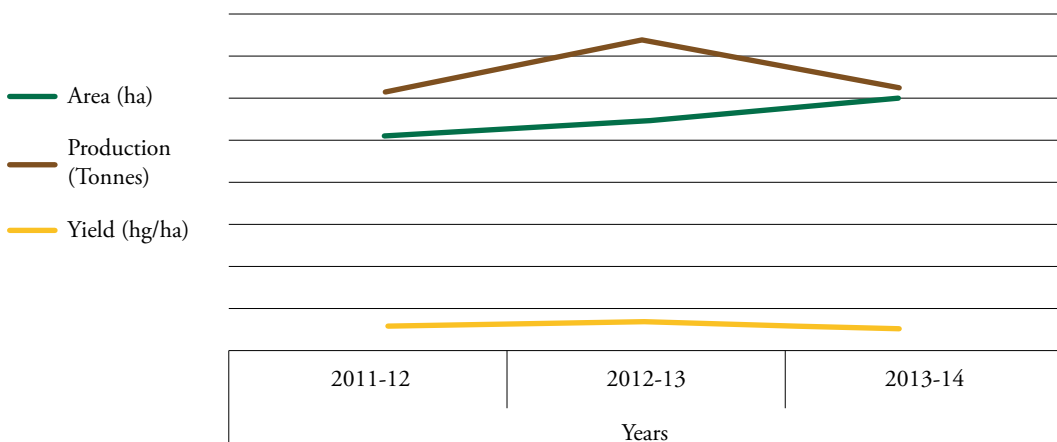
Soybean cultivation was in practice in Himalayan States including North-Eastern Region from ancient time. However, commercial cultivation of soybean as an oilseed crop was commenced in late 60s. It has been widely adopted as rainfed crop under Vertisols with an average rainfall of 750-900 mm in the country. Area under soybean is largely spread the states of Madhya Pradesh, Maharashtra, Rajasthan, Chhattisgarh, Andhra Pradesh and Karnataka. Area from millets, upland paddy and cotton has been diverted to soybean. State wise area, production and productivity of soybean growing States during last three years is given in Table 9.

TABLE 9: STATE-WISE AREA, PRODUCTION AND YIELD OF SOYBEAN

Sl. No.	States	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
		2011-12	2012-13	2013-14*	2011-12	2012-13	2013-14*	2011-12	2012-13	2013-14
1	AP	1.30	1.59	2.45	2.10	2.89	3.94	1615	1818	1608
2	Chhattisgarh	1.00	1.06	1.07	0.76	1.28	0.94	753	1208	879
3	Karnataka	1.91	1.72	2.25	1.72	1.80	2.54	901	1047	1129
4	MP	56.69	60.32	63.80	62.81	78.00	53.69	1108	1293	842
5	Maharashtra	30.10	32.18	39.17	39.69	46.69	47.85	1319	1451	1222
6	Rajasthan	8.97	10.40	11.77	13.85	14.69	9.75	1544	1413	828
7	Others	1.12	1.16	1.49	1.20	1.44	1.18	1071	1241	792
All India		101.09	108.43	122.00	122.13	146.79	119.89	1208	1354	1034

**Fourth advance estimates of DES*

Trends of Area, Production and Yield of Soybean



► 2.6 Potential Districts

More than 97% production of soybean comes from 04 States namely MP (55%), Maharashtra (30%), Rajasthan (10%) and AP(2%). Details of 54 potential districts of MP (25) Maharashtra (21), Rajasthan (06) and AP (02) is given at Annexure I.

► 2.7 New/non Traditional Areas

Soybean introduced during late 60s has now been adopted on a large scale cultivation in MP, Maharashtra, Rajasthan and AP. Soybean cultivation can be profitably extended in other States like Bihar, Jharkhand, Eastern UP and Uttarakhand as a better substitute to upland rice with cluster approach and assured arrangement for buy-back of produce.

► 2.8 Yield Gap

Among the major soybean producing countries India has an average (2011-13) yield of 1168 kg/ha as against the world average 2436 kg/ha and highest average yield of 2894 kg/ha of Brazil, which indicates a large gap of 108% over world average. The higher yield in the countries like Brazil, USA, Argentina and China may be because of soils with high organic matter and longer crop duration. Yield gap calculated on the basis of the yields recorded under Front Line Demonstrations (FLD) of ICAR and average/highest yield recorded in the States is given below in Table 10.

TABLE 10: STATE WISE YIELD GAP IN SOYBEAN

(Yield in kg/ha)

State	Highest State Yield		Soybean			
			<i>Kharif-2012</i>			
			SAY	FLD	Yield gap (%)	
	Yield	Year			Over SAY	Over highest
AP	1966	2007-08	1818	2571	38	31
Karnataka	1166	2013-14	1046	1875	71	61
MP	1293	2012-13	1293	1732	34	34
Maharashtra	1582	2010-11	1268	2469	76	56
Rajasthan	1544	2011-12	1412	1912	32	24
Mean	1510		1367	2112	49	40

The above statement indicates an yield gap of 24-61% over highest and 32-76% over SAY, which could be minimized by adoption of improved technologies more effectively.

► 2.9 Cropping System

Soybean based cropping systems followed in major soybean growing States are listed as under:

- Soybean - Wheat/Mustard/Safflower – **MP**.
- Soybean - Jowar (*Rabi*)/Safflower/Linseed – **Maharashtra**.
- Soybean - Wheat/Mustard – **Rajasthan**.
- Soybean - Jowar/Groundnut – **AP**.

Besides, the above mentioned cropping system Soybean + arhar, soybean +cotton and soybean + sorghum/ragi/maize are the major inter cropping system followed by the major soybean growing States for better risk management.

► 2.10 Improved Varieties

All India Co-ordinated Research Project (AICRP) on Soybean was commenced in 1967, which was later on, upgraded to National Research Centre of Soybean/Directorate of Soybean Research at Indore an Institutions of ICAR. After inception of AICRP more than 100 varieties of soybean have been released for different agro-ecological situations. However, hardly half a dozen varieties like JS-335, JS 93-05, JS 95-60, JS 97-52, MAUS-71 and PS 1042 are more

popular in various soybean growing states. Variety JS 93-05 in AP, Chhattisgarh, Karnataka, MP, Rajasthan & UP; MAUS-71 in UP; MAUS-81 in Gujarat & Rajasthan; JS 95-60 in MP have shown significant yield gains under minikits programme of ISOPOM during 2007-12. In addition variety JS 93-05 in Karnataka, MP, Maharashtra and Rajasthan; variety JS 95-60 in MP, Rajasthan; MAUS-81 in Maharashtra have shown better performance FLD programme during 2012-13. Details of varieties alongwith their salient features are given in **Annexure II**.

► 2.11 Seed Scenario

Agricultural Statistics at a Glance- 2012 indicates SRR of 48.59% with supply of 36.84 lakh qtl certified seed as against the total requirement of 75.82 lakh qtls seed of soybean for a total area of 101.09 lakh ha sown during 2011-12. The State wise SRR in respect of soybean is given in **Table 11**.

TABLE 11: STATE WISE SRR OF SOYBEAN

State	2006	2007	2008	2009	2010	2011	Average
Andhra Pradesh	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chhattisgarh	26.00	37.62	46.90	62.13	57.92	64.44	49.17
Karnataka	48.00	51.00	69.00	84.25	87.52	89.06	71.47
Maharashtra	45.00	46.00	58.00	58.99	61.51	57.76	54.71
Rajasthan	10.99	13.30	18.19	21.24	30.47	28.33	20.42
Madhya Pradesh	15.84	14.77	19.43	23.78	23.88	30.26	21.33
All India		29.53	29.26	38.95	35.85	47.00	36.12

The seed supply position of last 03 years given below in **Table 12** indicates that variety JS-335 holds >80% share in supply of certified seeds of soybean.

TABLE 12 VARIETY WISE CERTIFIED SEED DISTRIBUTION OF SOYBEAN

<i>(Quantity in qtls)</i>					
State	Variety	Release Year	2009-10	2010-11	2011-12
AP	JS-335	1994	860	49353	39812
Gujarat	JS-335	1994	9075	10576	11808
	JS-93-05	2002	0	0	210
	Total		9075	10576	12018
Karnataka	JS-335	1994	205721	193116	120722
	JS-93-05	2002	0	3429	3764
	Total		205721	196545	124486

State	Variety	Release Year	2009-10	2010-11	2011-12
MP	JS-335	1994	89157	120885	105609
	JS-93-05	2002	48536	56635	68366
	JS-95-60	2006	10286	45337	71886
	JS-97-52	2008	2429	482	338
	NRC-7	1997	806	11	0
	NRC-37	2001	158	0	0
	MAUS-47		46	194	162
	Total		151418	223544	246361
Maharashtra	JS-335	1994	676807	633237	630925
	JS-93-05	2002	6726	13904	34342
	JS-95-60	2006	0	0	4390
	MAUS-71	2002	14760	15874	16576
	DS-228		363	141	0
	Total		698656	663156	686233
Rajasthan	JS-335	1994	5225	17423	28706
	JS-93-05	2002	642	4448	5988
	Total		5867	21871	34694
UP	JS-335	1994	2756	11388	0
	JS-93-05	2002	71	858	172
	PK-1042	1997	1905	3873	3323
	Total		4732	16119	3495
Variety wise total	JS-335	1994	989601	1035978	937582
	JS 93-05	2002	55975	79274	112842
	JS - 95-60	2006	10286	45337	76276
	JS-97-52	2008	2429	482	338
	MAUS-71	2002	14760	15874	16576
	PK-1042	1997	1905	3873	3323
	Others		1373	1373	1373
Grand Total			1076329	1181164	1147099

► 2.12 Best Practices

- Deep ploughing in summer for insect, pests, weed management and moisture conservation.
- Use of compost/organic manure 5-10 tonnes/ha.
- Recommended doses of fertilizers @ 20: 40: 40:30 kg N: P: K: S/ha.

- Optimum sowing time is mid of June subject to availability of moisture/rainfall.
- Optimum seed rate of 75 kg/ha for small seeded varieties and 100 kg/ha for bold seeded varieties with spacing (R×R=45 cm and P×P=10-15 cm) and plant population (2.25 lakh/ha).
- Use of quality seed with assured application of Rhizobium (400 gm per 65-75 kg seed) and Phosphorus Solubilizing Bacteria (PSB).
- Seed treatment with Carbendazim, Thiram, Thiamethoxam or Imidacloprid.
- Adoption of Varietal Cafeteria Approach for avoiding monoculture and risk management.
- Application of pre emergence weedicides followed by inter-culture operations.
- Adoption of Broad-Bed-Furrow/Ridge-Furrow System for effective water management.
- Inter cropping of arhar with soybean for risk management.

► 2.13 Important Diseases

Stem fly (*Melanagromyza sojae*), Tobacco Caterpillar (*Spodoptera litura*), Girdle Beetle (*Obereopsis brevis*), Green Semi-loopers (*Chrysodexis acuta* and *Diachrysia orichalcea*), Leafminer (*Aproaerema modicella*), White fly (*Bemisia tabaci*) and Podborer (*Helicoverpa armigera*, *Cydia ptychora*) are the major insects of soybean. Soybean Rust (*Phakopsora pachyrhizi*), Yellow Mosaic (Mungbean yellow mosaic virus), Bacterial Pustule (*Xanthomonas campestris* pv. *glycines*), Collarrot (*Sclerotium rolfsii*) and Leaf Spot (*Myrothecium roridum*) are the major diseases occurring in soybean.

Besides, deep summer ploughing and seed treatment with fungicides, use of resistant varieties like **Stem-fly** : JS 335, PK 262, NRC 12, MACS 124, **Defoliators**: NRC 7, NRC 37, JS 80-21, Pusa 16, Pusa 20, Pusa 24, PS 564, PK 472, **Girdle Beetle** : JS 71-05, **Soybean Rust** : JS 80-21, PK 1029, PK 1024, Indira Soya 9, **Collar-Rot**: PK 262, PK 416, PK 472, PK 1042, NRC 37, **Myrothecium Leaf Spot**: Bragg, JS 71-05, **Bacterial Pustule**: PK 416, PK 472, PS 564, Bragg, **Soybean Mosaic**: Ankur, PK 327, PK 416, PS 564 and **Yellow Mosaic** : PK 416, PK 472, PS 564, PK 1024, PK 1029, PS 1042, PS 1092, SL 295.

► 2.14 Insect-Pests Management

Regular field scouting and pest monitoring could facilitate mechanical removal of plant parts/plants infested with Girdle Beetle, or gregarious phases of Tobacco Caterpillar or Bihar Hair

Caterpillar or Yellow Mosaic Virus disease. This also helps in knowing the Economic Threshold Level (ETL) of pests load. The details of ETL for starting management of pests by Biological/Mechanical/Chemical are given in **Table 13**.

TABLE 13: ECONOMIC THRESHOLD LEVEL (ETL)

Insect pests	Crop stage	ETL
Blue Beetle	Seedling	4 beetle/m row
Green semiloopers	Flowering Podding	4 larvae/m row, 3 larvae/m row
Bihar Hairy Caterpillar	Pre-flowering	10 larvae/m row
Tobacco Caterpillar	Pre-flowering	10 larvae/m row
Pod borer	Podding	5 larvae/m row

Based on the ETLs, one foliar spray of any one of the insecticides Triazophos 40EC @ 0.8 l/ha, Chlorpyrifos 20EC @ 1.5 l/ha, Quinalphos 25EC @ 1.5 l/ha, Ethion 50EC @ 1.5 l/ha, Methomyl 12.5l @ 2.0 l/ha, Ethofenprox 10 EC @ 1.0 l/ha is to be given preferably at the time of flowering;

- One spray of any of the microbial pesticides: Dipel (*Bacillus thuringiensis*) @ 1 l/ha or Biobit (*Bacillus thuringiensis*) @ 1 kg/ha or Dispel (*Beauveria bassiana*) @ 1 l/ha should be given 15 days after the spray of chemical insecticide for the control of defoliators.
- In rust prone areas, prophylactic sprays of Hexaconazol, Propiconazol, Triadimefon @ 0.8 kg/ha is recommended.
- For the management of foliar diseases viz. *Myrothecium Cercospora* and *Altemaria* Leaf Spot diseases and *Rhizoctonia* Aerial Blight, two sprays of Carbendazim or Thiophenate methyl @ 0.5 kg/ha at 35 and 50 days after sowing may be given. For the control of Bacterial Pustule disease, crop may be sprayed with mixture of Copper Oxychloride (2 kg) + streptocyclin (200 g/ha) at the time of appearance of disease. For the control of yellow mosaic disease, spray of methyl dematon 25EC @ 0.8 l/ha or Thiomethoxam 25WG @ 100 g/ha is recommended for the control of vectors.
- In order to build up and conserve naturally occurring Biocontrol agents/fauna viz. Coccinellid Beetles, *Chrysoperla* etc., biodiversity should be created in the form of intercropping. In rainfed areas, intercropping soybean with maize, sorghum or short duration pigeonpea (in 4:2 row ratio) is beneficial.
- Yield of soybean are highly affected by weeds. A list of the common weedicides along with their doses is given in **Table 14**.

TABLE 14: WEEDICIDES FOR MANAGEMENT OF WEEDS

Chemical name	Mode of application	Dose kg ai/ha
Fluchloralin	PPI	1.00
Trifluralin	PPI	1.00
Alachlor	PE	2.00
Metolachlor	PE	1.00
Clomozone	PE	1.50
Pendimethalin	PE	1.00
Imazethapyr	POE	0.10

PPI: Pre-plant incorporation, PE: Pre-emergence, POE: Post emergence

► 2.15 Harvesting

Timely harvesting of the crop, when pods turn pale yellow, is recommended to avoid shattering. More mechanical damage is occurred with combine harvesting. Therefore, manual threshing may be used for retaining seed for sowing purpose.

► 2.16 Marketing Support

Soybean is covered under Minimum Support Price (MSP), which is announced well before the harvesting of crop. National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED) is the Nodal agency to undertake procurement of soybean under Price Support Scheme (PSS). Details of MSP and average market price during last five years given in **Table 15** indicates that the price of soybean never falls below MSP mainly because of large demand of raw material by Solvent Extraction Plant and global completion for export of soybean.

TABLE 15: MSP AND PROCUREMENT OF SOYBEAN

Year	MSP for FAQ (₹/qtls)		Avg. Market Price (₹/qtls)	Procured by NAFED	
	Black	Yellow		Quantity	Value ₹ In crore
2009-10	1350	1390	2411	NIL	NIL
2010-11	1400	1440	2260	NIL	NIL
2011-12	1650	1690	2162	NIL	NIL
2012-13	2200	2240	3063	NIL	NIL
2013-14	2500	2560	-	NIL	NIL

► 2.17 Nutritive Values

The unique chemical composition of soybean seed which includes about 20% oil and 40% protein, besides number of nutraceutical compounds such as isoflavons, tocopherol and lecithin has made it one of the most valuable agronomic crops in the world. Owing to its oil and protein profile, this crop has an important role in nutritional security. However, the food uses of soybean in the country are meager (5-6%). Currently, almost 100% of the oil extracted from soybean is consumed in the country rather a large quantity (10.79 lakh tonnes) of soybean oil is also imported. A variety of soya food products given below are being popularized and promoted:

- **Soyamilk:** Soybean milk can be used in the same way as dairy milk.
- **Tofu:** It is made by coagulating the hot soya milk and used as a substitute of dairy paneer.
- **Soya Nuggets:** These are protein rich (>50%) products made of soybean.
- **Bakery Products:** Soybean can be fortified with wheat flour for making bakery products.
- **Noodles:** Noodles and vermicelli are a form of pasta and popular in India.
- **Soya Flour:** Full fat soya flour obtained by grinding whole soybeans with heat treatment/ toasted to minimize enzyme action or defatted flour produced after complete removal of oil from soybeans.
- **Soya Protein:** The defatted soya flakes (after oil extraction) are the basis for different soybean products like soya flour, soya concentrate and soya protein highly digestible source of Amino Acids.
- **Substitute for Pulses:** Soybean is traditionally used as pulses in Uttarakhand and as fermented food in North-Eastern region.
- **Soya Lecithin:** Lecithin is obtained from degumming of soya oil.

► 2.18 Export Demand

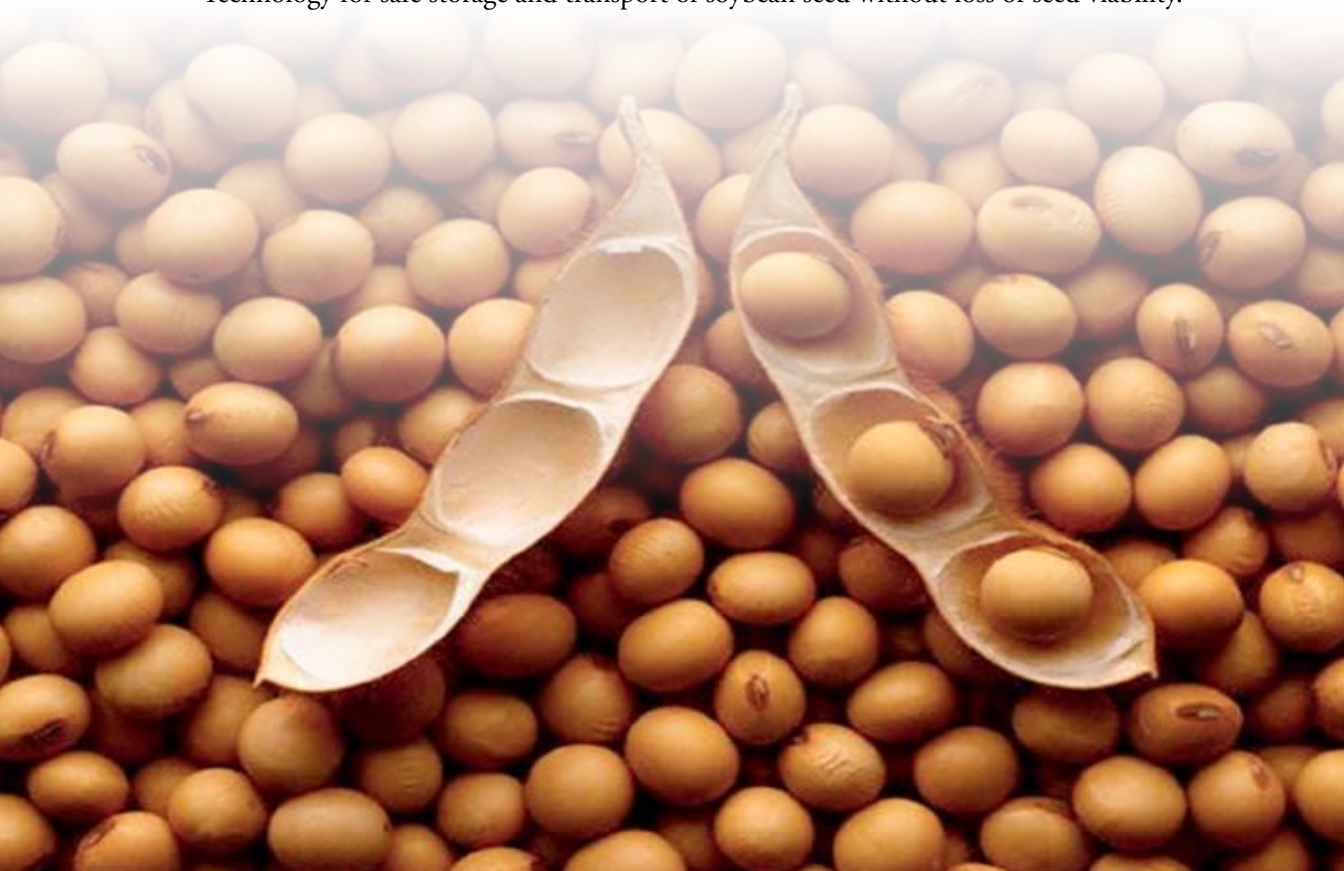
The market prices of soybean had always been much higher than the minimum support price of soybean largely because of the demand of raw material by the huge soybean processing industry and demand of DoC in the international market. Soybean DoC is a major source of foreign exchequer in oilseed sector, which contributes almost 50% of total export value of DoC, seeds and oils/fats. Details of soybean DoC exported during last 05 years is given in Table 16.

TABLE 16: DETAILS OF SOYBEAN DOC EXPORT DURING LAST 05 YEARS

Years	Quantity (lakh tonnes)	Value (₹ in crores)
2008-09	417.73	7238.00
2009-10	211.44	4136.88
2010-11	383.84	7062.23
2011-12	382.95	7009.75
2012-13	343.98	10050.00

► 2.19 Researchable Issues

- Varieties with low linolenic fatty-acid to improve the shelf life of soybean oil.
- Varieties with less beany flavours and Lipoxygenase (enzyme) lacking varieties (Kyushu-III-Japan) for increasing domestic consumption of Protein Rich Soya Foods.
- Varieties with bold pods/seeds for use as vegetable.
- Rust resistance varieties.
- Short duration varieties for dry land areas.
- Technology for safe storage and transport of soybean seed without loss of seed viability.



GROUNDNUT



► 3.1 Crop Description

Groundnut belongs to family Leguminoceae (Fabaceae) sub-family Papilionoideae. The genus *Arachis* is morphologically well defined and clearly delineated from its closest relatives by the presence of geocarpic peg. The genus *Arachis* is placed with its relatives *Stylosanthes*, *Chapmannia*, *Arthrocarpum* and



Groundnut crop sown with Broad Bed-Furrow System

Pachecoa in the sub-tribe *Stylosanthinae* of the tribe *Aeschynumeneae* on the basis of the shared morphological characters of a staminal tube with alternately attached basal and dorsal anthers, flowers in terminal or axillary spikes or small heads (which are sometimes raceme-like), pinnate leaves, and leaflets without stipules. The flowers are borne on axils of leaves on primary or secondary branches. The pollen matures 6-8 hours before anthesis. The self-pollination occurs because the stigma and anthers are enclosed by the keel. However, cross pollination (ranging from 0 to 6%) also occurs through bees. After fertilization, the elongated gynophores develop into a peg like structure and becomes subterranean, which are converted into pods. Groundnut pods are elongated with varying degrees of reticulation on the surface. They contain two to five seeds. Seed size ranges from 0.15 to more than 1.3 g/seed while the seeds of the wild species weigh as low as 0.047 g/seed.

Groundnut has been classified on the basis of growth habit, branching pattern, inflorescence, pod and seed characters, seed dormancy etc. The details of most widely adopted classification of groundnut, is shown in **Table 17**.

TABLE 17: CLASSIFICATION OF GROUNDNUT

Botanical Type	Subspecies	Cultivar	Branching pattern	Growth habit	Seed/Pod
Virginia	Hypogaea	Hypogaea	Alternate	Prostrate to semi erect	2-3
Runner		Hirsuta	Alternate	Prostrate	2-4
Valencia	Fastigiata	Fastigiata	Sequential	Erect	3-5
Spanish		Vulgaris	Sequential	Erect	2

► 3.2 Centres of Origin

Species of the genus *Arachis* are native of South America. About 100 species have been reported which are distributed between the river Amazon in the north, Rio de la Plato in the south, the Andes to the west and the Atlantic to the east. Krapovickas (1969) postulated that the cultivated groundnut, *Arachis hypogaea* is believed to have originated in northern Argentina and south Bolivia and the centre of diversity of the genus *Arachis* to be the Mato Grasso, Brazil in which majority of the species are found. Bolivia has the second largest number of species followed by Paraguay, Argentina and Uruguay.

► 3.3 Climatic Requirement

Warm and moist conditions are highly congenial for groundnut cultivation. Temperature, light intensity, rainfall and humidity significantly influence the groundnut production. Cool and wet climate delay the germination and seedling emergence and thus enhance the risk of seed rot and seedling diseases. Optimum temperature of 25-35 °C is required for good germination, flowering and pod formation.

► 3.4 Global Scenario

Groundnut is cultivated in tropical, sub-tropical and warm temperate regions between 40°N and 40°S latitudes. The production is largely confined to Asian and African countries. Asia accounts for about 50% of area and 60% of world production of groundnut with largest share of India (>20%) in the groundnut coverage, followed by China (>18%). However, China accounts for highest share (37%) in the total production of groundnut in the World. Area, production and yield of major growing countries during last three years is given in Table 18.

TABLE 18: AREA, PRODUCTION AND YIELD OF GROUNDNUT MAJOR COUNTRIES

Sl. No.	Country	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
1	Cameroon	5.05	4.22	4.63	5.64	6.34	6.36	1116	1500	1373
2	China	46.04	47.19	46.82	161.14	168.57	169.19	3500	3572	3614
3	India	53.10	47.70	52.50	69.64	46.95	94.72	1312	984	1804
4	Indonesia	5.39	5.60	5.19	12.13	12.51	11.50	2250	2236	2216
5	Myanmar	8.87	8.80	8.90	14.00	13.72	13.75	1578	1559	1545
6	Niger	6.91	7.41	7.20	3.96	2.92	2.80	573	394	389
7	Nigeria	23.43	24.20	23.60	29.63	30.71	30.00	1265	1269	1271
8	Senegal	8.66	7.09	7.70	5.28	6.73	7.10	609	949	922
9	Sudan	16.98	16.20	21.62	11.85	10.32	17.67	698	637	817
10	USA	4.37	6.51	4.21	16.60	30.58	18.93	3795	4699	4496
	World	247.40	245.91	254.60	405.74	404.75	453.08	1640	1646	1780

► 3.5 National Scenario

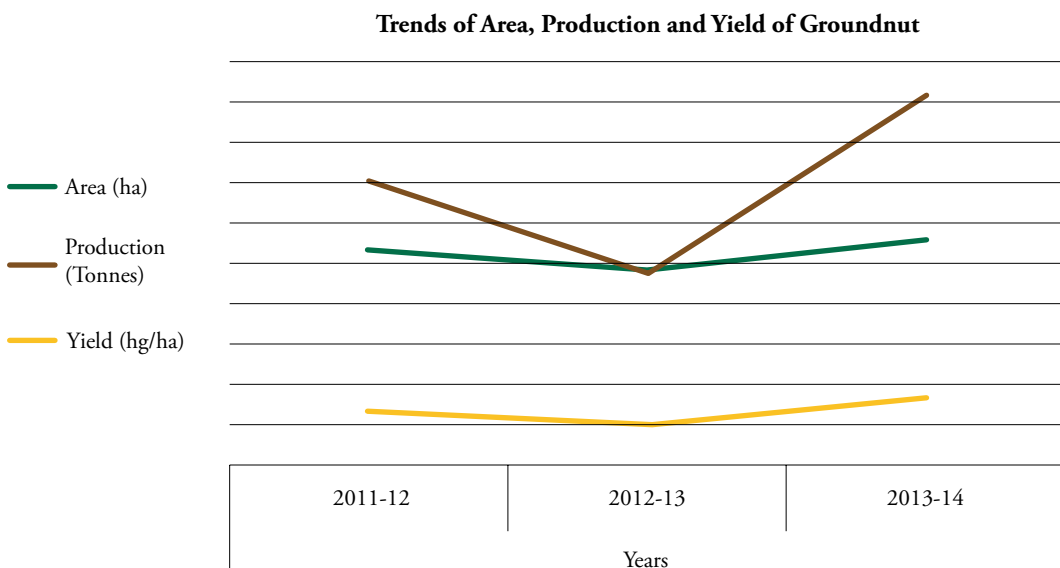
In India, groundnut is cultivated largely in *Kharif* season (June to October) under rainfed conditions with low input use and high pressure of insect-pests and diseases including weeds, hence, the productivity is low. In *Rabi* season (October to March), the crop is grown on residual moisture in rice fallows with protective irrigation or in river bed areas. Summer groundnut (Feb-May) grown under assured irrigation is generally practiced with high input application with low pressure of insect-pests, diseases and weeds hence, the productivity is quite high. Six States namely Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Rajasthan and Tamil Nadu account for about 90% of the total groundnut area of the country. AP and Gujarat contribute >55% of the total area and production of groundnut. State wise area, production and yield of groundnut are given in Table 19.

TABLE 19: STATE WISE AREA, PRODUCTION AND YIELD OF GROUNDNUT

Sl. No.	States	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
1	AP	13.07	13.45	13.86	8.44	11.09	12.34	646	825	890
2	Gujarat	16.86	12.94	18.42	27.17	7.58	49.18	1612	586	2670

Sl. No.	States	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
3	Karnataka	6.77	6.48	7.25	4.85	4.12	6.58	716	636	908
4	MP	2.13	2.06	2.00	3.45	3.12	1.98	1620	1515	990
5	Maharashtra	3.03	2.24	2.67	3.51	2.46	3.25	1158	1098	1217
6	Odisha	0.66	0.66	0.58	0.79	0.81	0.8	1197	1227	1379
7	Rajasthan	4.18	4.02	4.66	8.05	6.22	9.06	1926	1547	1944
8	Tamil Nadu	3.86	3.86	3.42	10.61	8.64	9.62	2749	2238	2813
9	UP	0.92	0.94	0.96	0.92	0.94	0.86	1000	1000	896
10	West Bengal	0.54	0.68	0.79	1.06	1.71	2.02	1963	2515	2557
Others		0.62	0.33	0.66	0.79	0.80	1.04	1274	2424	1576
All India		52.64	47.66	55.27	69.64	47.49	96.73	1323	996	1750

Groundnut is most sensitive crop to moisture stress. Distribution of rainfall plays a greater role than the quantum of rains received during the crop season. Longer dry spell at the time of peg formation/penetration and grain filling is most injurious to the quantity and quality of groundnut produced. Large variation in yield from 996 to 1642 kg/ha as shown in the above table is also supportive of the statement.



3.5.1 Potential Districts

More than 85% production of groundnut comes from 05 States namely Gujarat (38%), AP (16%), Tamil Nadu (14%), Rajasthan (9%) and Karnataka (8%). Details of 45 potential districts of AP (10), Gujarat (10), Karnataka (11), Maharashtra (2), Rajasthan (5) and Tamil Nadu (7) is given at *Annexure-III*.

3.5.2 New/Non-Traditional Areas

Productivity and the quality of *Rabi*/summer groundnut is much better than the *Kharif* season. Area under *Rabi*/summer groundnut, may be enhanced with the use of micro irrigation appliances like sprinkler/drip in the States like AP, Assam, Gujarat, Karnataka, Maharashtra, UP and West Bengal. Cotton/potato fields, which are normally vacated around mid of January, could be utilized more profitably for groundnut cultivation with replenishment of soil health. River bed areas in eastern and north eastern region also provides better scope for groundnut cultivation.

► 3.6 Yield Gap

Among the major Groundnut producing countries India has an average (2011-13) yield of 1245 kg/ha as against the world average 1689 kg/ha and highest average yield of 4699 kg/ha of USA, which indicates a large gap of 36% over world average and 277% over highest yield of USA. The State average yield of 3751kg/ha of Tamil Nadu is much higher (122%) than world average yield and also comparable with the with the yield of China and USA. It is mainly because of the reason that groundnut is largely grown under sandy loam soils in Tamil Nadu, which are porous in structure and rich in organic matter. Yield gaps calculated on the basis of the yields recorded under Front Line Demonstrations (FLD) of ICAR and average/highest yield recorded in the States is given below in **Table 20**.

TABLE 20: STATE WISE YIELD GAP IN GROUNDNUT

State	Groundnut					
	<i>Rabi-2011-12</i>			<i>Kharif-2012</i>		
	SAY	FLD	Yield Gap (%)	SAY	FLD	Yield Gap (%)
AP	1848	2947	70	533	1698	74
Gujarat	1914	2216	19	790	1446	42
Karnataka	917	2498	101	564	1694	72
Maharashtra	1446	2176	46	1037	2379	85

(Yield in kg/ha)

State	Groundnut					
	<i>Rabi-2011-12</i>			<i>Kharif-2012</i>		
	SAY	FLD	Yield Gap (%)	SAY	FLD	Yield Gap (%)
Odisha	0	0	0	1041	2424	88
Rajasthan	0	0	0	1549	3033	94
TN	3751	2027	-110	1928	1870	-4
West Bengal	1969	2962	63	0	0	0
Mean	1974	2471	32	1063	2078	65

The above statement indicates an average yields gap of 65% for *Kharif* and 32% for *Rabi* summer groundnut over state average yield. However, yield gaps are higher in the states of Karnataka (72-101%) and Rajasthan (94%), due to lack of organic content in the soil. In case of Tamil Nadu, state average yield are much higher than the yield recorded under FLD both in *Kharif* and *Rabi* season.

► 3.7 Cropping System

About 60% of the total groundnut cultivated area is under mono-cropping during *Kharif* season. Major cropping system followed by various groundnut growing States are given in Table 21.

TABLE 21: MAJOR CROPPING SYSTEM OF VARIOUS GROUNDNUT GROWING STATES

State	Rainfed	Residual Moisture	Irrigated
Andhra Pradesh	Groundnut-Sorghum	Groundnut-Bengal gram	Groundnut-Maize
	Groundnut-Millet	Groundnut-Safflower	Groundnut-Wheat
	Groundnut-Tobacco	Groundnut-Sesame	Groundnut-Onion
Gujarat	Groundnut-Sesame	Groundnut-Fodder Sorghum	Groundnut-Mustard-Green gram
		Groundnut-Mustard	Groundnut-Wheat-Green gram
Karnataka	Groundnut-Sorghum	Groundnut-Safflower	Groundnut-Wheat
			Groundnut-Maize
			Groundnut-Sunflower
Maharashtra	Groundnut-Sorghum	Groundnut-Safflower	Rice-Potato-Groundnut
		Groundnut-Fodder Maize	Groundnut- <i>Rabi</i> Sorghum
			Groundnut-Safflower

State	Rainfed	Residual Moisture	Irrigated
Tamil Nadu	Groundnut-Sesame	Groundnut-Sesame	Rice-rice- Groundnut
	Groundnut-Cotton		Groundnut-Rice-Green gram
			Groundnut-Maize
Rajasthan	Groundnut-Pearlmillet	Groundnut-Barley	Groundnut-Wheat-Green gram
		Groundnut-Mustard	Groundnut-Wheat
MP	Groundnut-Sorghum	Groundnut-Safflower	Groundnut-Wheat/Mustard
Odisha	Groundnut-Sorghum/ Pearl millet	Groundnut-Bengal gram	Groundnut-Rice/Ragi
		Groundnut-Sesame	Groundnut-Coriander/Cumin

Groundnut crop suites well under inter-cropping with coarse cereals, pulses, cotton and also with other oilseeds. The major inter-cropping system of are given in Table 22.

TABLE 22: MAJOR INTERCROPPING SYSTEMS OF GROUNDNUT

Intercropping system	Ratio	States
Groundnut + Red gram	6:1 or 8:1 or 10:2	AP, Gujarat, Karnataka and MP
Groundnut + Cotton	3:1 or 5 : 1	Karnataka and Tamil Nadu
Groundnut + Sorghum/Ragi	6:1	Karnataka and Maharashtra
Groundnut + Pearl Millet	3:1 or 4:1	AP and Rajasthan
Groundnut + Cowpea/Blackgram/ Greengram	6:1	AP and Tamil Nadu
Groundnut + Castor	5:1 or 7:1	AP, Gujarat and Tamil Nadu
Groundnut + Sesame/Sunflower	4:1 or 6:1	Gujarat, MP, Tamil Nadu and Rajasthan
Groundnut + Soybean	4:1 or 6:1	MP

► 3.8 Improved Varieties

All India Co-ordinate Research Project (AICRP) on Groundnut later on upgraded into National Research Centre of Groundnut has now been converted into Directorate of Groundnut Research (DGR) and located in GAU Campus, Junagarh. DGR is entrusted with development of new varieties and improved production technologies. After inception of AICRP >150 varieties of groundnut have been released for different agro-ecological situations, however, only a few age old varieties like TMV-2, TMV-7, GG-11, Chitra Kaushal, SV-xi, JL-24 and AK-12-24, K-6, CO-2, Polachi-1, GAUG-10, and new varieties like TG37-A, GBPD-4, Narayani, ICGV-91114, TPG-41, TG-38, VRI-6 are popular among the farmers for large scale

cultivation. Variety GPBD-4 in Karnataka, Rajasthan & TN; TG 37A in AP, Chhattisgarh, Gujarat & Karnataka, MP, Odisha; TPG-41 in AP, Chhattisgarh, Karnataka, TN; Kadri-6 & Narayani in AP; have shown significant yield gains over local varieties under minikits programme of ISOPOM during 2007-12. In addition, variety K-6 & Narayani in AP; TG-37A in Gujarat & Rajasthan; AK-159 in Maharashtra; TPG-41 in Gujarat, Maharashtra; GPBD-4 in Karnataka has also shown significant yield gains under FLD during *Rabi*-2011-12 and *Kharif*-2012-13. A list of improved varieties of groundnut released after 2001 along with their salient features is given at *Annexure-IV*.

► 3.9 Seed Scenario

As against the total requirement of about 84 lakh qtls certified seed for the total coverage of 52.64 lakh ha only 17.83 lakh qtls of certified seed was used by farmers in country, which indicate SRR of 21% at National Level. The details of state wise SRR in respect of groundnut crop is given in **Table 23**.

TABLE 23: STATE WISE SRR OF GROUNDNUT

State	2006	2007	2008	2009	2010	2011	Average
Andhra Pradesh	25.0	36.0	50.0	60.85	62.99	62.18	49.50
Karnataka	13.0	12.0	10.0	25.41	22.06	28.82	18.55
Tamil Nadu	3.2	5.0	6.1	8.73	8.91	12.05	7.33
Kerala	10.0	10.0	10.0	-	-	-	10.0
Gujarat	1.9	1.9	2.3	3.04	3.50	4.07	2.79
Maharashtra	3.0	5.0	5.0	4.22	5.76	2.69	4.28
Rajasthan	2.2	11.2	4.4	8.93	13.33	6.05	7.69
Madhya Pradesh	0.3	0.2	0.5	0.66	0.40	0.97	0.51
Uttar Pradesh	4.4	4.4	3.4	4.38	12.49	18.54	7.94
Odisha	22.0	23.6	22.9	31.28	29.70	32.41	26.98
West Bengal	35.0	36.0	37.0	38.0	39.51	40.38	37.65
Chhattisgarh	2.0	1.7	3.1	3.90	2.42	3.37	2.75
All India	9.8	14.3	17.0	22.95	24.50	21.00	18.26

The seed supply position of 03 years given in **Table 24** indicates that variety TMV-2 released during 1975 still holds largest share (>30%) in supply of certified seeds of groundnut in the country, which is an area of concern.

TABLE 24: VARIETY WISE CERTIFIED SEED DISTRIBUTION OF GROUNDNUT DURING 2009-10 TO 2011-12

Sl. No.	State	Variety	Year of Release	(Quantity in qtl)		
				2009-10	2010-11	2011-12
1	AP	GPBD-4	2004	0	0	70
		K-6	2005	32153	69512	107928
		TAG-24	1992	5869	14248	16963
		TG-37- A	2004	0	943	144
		TMV-2	1976	114798	116156	60107
		JL-24	1984	72869	54317	21747
		Polachi	1999	810	13916	0
		Narayani	2002	44542	49523	23415
		ICGV-91114	2007	575	0	0
		TPG-41	2004	91	0	0
		Total		271707	318615	230374
2	Gujarat	GG-20	1992	25401	41914	34903
		TAG-24	1992	446	280	1297
		TG-37-A	2004	1581	186	194
		TG-38	2006	61	174	626
		TPG-41	2004	32	186	165
		GG-2		1830	1856	2390
		GG-5		1413	651	731
		GG-11		5470	5819	3843
		GAUG-10		4164	2828	980
		Total		583812	691124	505877
3	Karnataka	GPBD-4	2004	9490	26713	11806
		K-6	2005	0	0	4906
		TAG-24	1992	767	6126	631
		TG-37-A	2004	390	0	3206
		TMV-2	1976	263471	231042	214846
		JL-24	1984	666	965	327
		ICGV-91114	2007	208	1912	521
		TPG-41	2004	0	0	499
		Total		274992	266758	236742

Sl. No.	State	Variety	Year of Release	2009-10	2010-11	2011-12
4	Maharashtra	K-6	2005	0	0	6230
		TAG-24	1992	3635	1871	5890
		TG-37-A	2004	200	0	896
		TMV-2	1976	15385	24730	945
		JL-24	1984	2391	648	1527
		GG-20	1992	610	115	326
		Total		22221	27364	15814
5	Rajasthan	GG-20	1992	30	0	0
		GPBD-4	2004	0	0	1443
		TAG-24	1992	573	14	0
		TG-37-A	2004	0	80	163
		TMV-2	1976	160	0	0
		Total		763	94	1606
6	Tamil Nadu	TG-37-A	2004	800	0	210
		K-6	2005	9420	11900	14154
		TAG-24	1992	1350	3611	173
		GPBD-4	2004	0	841	382
		TMV-2	1976	19313	22882	24050
		JL-24	1984	2720	3000	2780
		TMV-7	1985	12470	13600	13840
		VRI-2	1989	3110	3400	3380
		VRI-3	1991	2820	2420	2390
		CO (GN)-4	2001	1680	2000	2070
Total		53683	63654	63429		
7	West Bengal	GPBD-4	2004	0	0	1073
		K-6	2005	0	0	8117
		TAG-24	1992	15	120	2423
		TG-37-A	2004	300	0	0
		TMV-2	1976	10090	3976	33903
		Total		10405	4096	45516
Grand Total				1217583	1371705	1099358
TMV-2				423217	398786	333851
% of TMV-2				35	29	30

► 3.10 Best Practices

3.10.1 Sowing Time

- *Kharif* groundnut: June to July subject to onset of monsoon.
- *Rabi* groundnut: November.
- *Summer* groundnut: February-March.

3.10.2 Methods of Sowing

- Broad Bed and Furrow System.
- Ridge and Furrow System.

3.10.3 Seed Rate, Spacing and Plant Population

- Bunch type groundnut varieties- 100-110 kg/ha.
- Spreading and semi-spreading varieties - 95-100 kg/ha.
- Spacing for bunch type varieties - 30 x 10 cm with plant population of 3.33 lakh/ha.
- Runner type varieties - 45 x 10 cm or 30 x 10 cm with plant population of 2.22 lakh/ha.

3.10.4 Manures and Fertilizers

- For every one tonne of pod yield and two tonne of haulm yield, groundnut crop removes 63 kg N, 11 kg P₂O₅, 46 kg K₂O, 27 kg CaO and 14 kg MgO from the soil.
- To obtain higher yield well decomposed farm yard manure @ 10 t/ha should be applied at least 21 days before sowing of crop.
- State wise recommended doses of NPK fertilizers under rainfed and irrigated situation and correction of micronutrient deficiencies are given in Table 25 & Table 26.

TABLE 25: RECOMMENDED DOSES OF NPK FOR DIFFERENT STATES

State	Situation	N-P-K (kg/ha)
Andhra Pradesh	Rainfed	20 - 40 - 20
	Irrigated	30 - 60 - 45
Gujarat	Rainfed	12.5 - 25 - 0
	Irrigated	25 - 50 - 0

State	Situation	N-P-K (kg/ha)
Karnataka	Rainfed	15 - 30 - 25
	Irrigated	25 - 75 - 25
Madhya Pradesh	Rainfed	20 - 40 - 20
Punjab	Irrigated	15 - 40 - 25
Rajasthan	Rainfed	20 - 60 - 0
	Irrigated	20 - 60 - 0
Maharashtra	Irrigated	20 - 40 - 0
Uttar Pradesh	Rainfed	15 - 30 - 45
West Bengal	Irrigated	15 - 30 - 45
Tamil Nadu	Rainfed	11 - 22 - 33
	Irrigated	22 - 44 - 66

TABLE 26: CORRECTION OF MICRONUTRIENT DEFICIENCIES

Micronutrient	Form and rate of application to soil	Spray schedule
Boron	Borax 5-20 kg/ha	0.2% Borax
Copper	Copper Sulphate 5-10 kg/ha	0.1% Copper Sulphate + 0.05% lime
Manganese	Manganese Sulphate 10-50 kg/ha	0.6% Manganese Sulphate + 0.3% lime
Zinc	Zinc Sulphate 10-50 kg/ha	0.5% Zinc Sulphate + 0.2% Lime
Molybdenum	Sodium or Ammonium Molybdate 0.5-1.0 kg/ha	0.07-0.1% Ammonium Molybdate
Iron	Ferrous Sulphate 10 kg/ha	0.5% Ferrous Sulphate + 0.02% Citric Acid

3.10.5 Water Management

Groundnut crop is mostly cultivated during *Kharif* under rainfed conditions (80%).

- Crop could with stand up to 25 days of emergence without irrigation/rainfall.
- Rainfall/protective irrigation is necessary at flowering (20-40 DAS), pod formation (40-70 DAS) and pod filling (70-100 DAS).
- Eight irrigations are adequate for optimal yield i.e. pre – sowing irrigation followed by an irrigation at 25 DAS, 4 irrigations at 10 days interval and final two irrigations at 15 days interval.

- Sprinkler irrigation is ideal for the crop grown under sandy soils.
- Drip irrigation is becoming popular among groundnut growers as it increases crop yield by 25-40% besides improving seed quality and saves up to 40-50% irrigation water compared to flood irrigation.

3.10.6 Weed Management

The average yield loss due to weeds is about 45%. Important weed flora in the groundnut crop are: *Amaranthus viridis* (Jangli Chaulai), *Boerhaavia diffusa* (Vishakhapra), *Cyperus rotundus* (Motha), *Cyperus esculentus* (Yellow nut sedge), *Cynodon dactylon* (Doob grass), *Digera arvensis* (Laksha), *Convolvulus arvensis* (Hiran khuri), *Argemone maxicana* (Satyanashi), *Anagallis arvensis* (Krishna neel), *Desmodium trifolium* (Tinpatia), *Commelina benghalensis* (Kankawa), *Celosia argentea* (White cock's comb) and *Portulaca oleracea* (Pig weed). Some of the weed management practices are given below.

- Adopting right spacing between rows and within the row.
- Mulching the soil surface in between rows with crop residue material like straw etc may prevent the germination of weed seeds.
- Adoption of crop rotation and intercropping.
- Two hand weeding, first around 20 days after sowing and 2nd at about 35 days after sowing.
- Inter-cultivation usually starts around 10 days after emergence and continues up to 35 DAS at 7-10 days interval till pegging begins.
- Use of herbicides is given in Table 27.

TABLE 27: HERBICIDES RECOMMENDED FOR USE IN GROUNDNUT

Herbicide	Rate of application (kg ai/ha)	Time of application
Pendimethalin	1.0-2.0	Pre-emergence
Oxyfluorfen	0.25-0.50	-do-
Quizalofop ethyl	0.050	Post-emergence
Imazethapyr	0.050	-do-

3.10.7 Important Insects/Pests

The details of major insects, disease and nematode are given in Table 28.

TABLE 28: IMPORTANT INSECTS/PESTS OF GROUNDNUT CROP

Name pests	Scientific name	Possible yield loss (%)	Period of Occurrence
Leaf Miner	<i>Aproaerema modicella</i> (Deventer)	16-92	Mar-Oct
Tobacco Caterpillar	<i>Spodoptera litura</i> (Fab.)	15-30	Mar-Oct
Hairy Caterpillars	<i>Amsacta albistriga</i> (Walker), <i>A. moorei</i> (Butler) and <i>Spilosoma obliqua</i> (Walker)	26-100	June-Oct
Thrips	<i>Caliothrips indicus</i> Bagnell, <i>Frankliniella schultzei</i> Trybom, <i>Thrips palmi</i> Karny and <i>Scirtothrips dorsalis</i> Hood	15-28	Mar-Oct
Aphids	<i>Aphis craccivora</i> Koch	Up to 40	July-Sept
Leafhoppers/Jassids	<i>Empoasca kerri</i> Pruthi, <i>Balclutha hortensis</i> Lindb.	9-22	Mar-Oct
White grub	<i>Holotrichia consanguinea</i> Blanch and <i>H. serrata</i> (Fab.)	20-100	Aug-Oct
Termites	<i>Odontotermes obesus</i> (Rambur) and <i>Microtermes obesi</i> (Holgren)	5-46	Sept-Oct
Bruchid	<i>Caryedon serratus</i> (Olivier)	Varied	Throughout the year
Collar rot	<i>Aspergillus niger</i> van Tieghem.	28-47	-
Stem rot	<i>Sclerotium rolfsii</i> Sacc. Teleomorph: <i>Athelia rolfsii</i> (Curzi) Tu & Kimbrough	27	-
Early Leaf Spot	<i>Cercospora arachidicola</i> S. Hori. Teleomorph: <i>Mycosphaella arachidis</i> Deighton	Up to 60	-
Rust	<i>Puccinia arachidis</i> Speg	10-52	-
Alternaria Leaf Blight & Leaf Spot	<i>Alternaria alternata</i> , <i>A. tenuissima</i> and <i>A. Arachis</i>	up-to 22	Summer
Peanut Bud Necrosis Disease	Peanut Bud Necrosis Virus (Tospovirus)	30-90	-
Root knot	<i>Meloidogyne arenaria</i> , <i>M. hapla</i> and <i>M. Javanica</i>	21.6	-
Kalahasti Malady	<i>Tylenchorhynchus Brevelineatus</i>	40-50, Endemic in Chittoor and Nellore district of AP	-

3.10.8 The Integrated Pests Management Practices in Groundnut are

- Deep ploughing during April-May to expose pupae to sunlight and predatory birds.
- Clean cultivation by rouging out weed hosts and self-sown plants.
- Growing of resistant varieties like, BR 2, ICGV 87160, ICGV 86031, ICGV 86699 (Leaf Miner), ICGV 86590 (*Spodoptera*), BG 2, Girnar 1 (aphids), Girnar 1, Co-1, Dh-3-30, ICGS 11, MH 1, POL 2, S 206 (Leafhoppers) and Girnar 1 (Thrips).
- Early sowing escapes the damage caused by Leaf Miner and White Grubs.
- Intercropping with Soybean (Leaf Miner), Castor (*Spodoptera*), Cowpea (Hairy Caterpillars, Aphid and Leafhopper) and Pearl millet (Thrips).
- Set up the petromax light traps @ 1-2/ha to attract and kill the moths during June-August.
- Install pheromone traps @ 10 traps/ha for *Spodoptera* and *Helicoverpa* and 25 traps/ha for leaf miner.
- Spray neem oil @ 5ml/ltr water along with suitable surfactant like soap powder @ 1g/ltr or NSKE 5% as it acts as oviposition deterrent.
- Erect bird perches @ 10-12/ha.
- Conserve the natural enemies like, Coccinellids, Spiders, Hymenopteran and Dipteran Parasitoids.
- Release *Trichogramma chilonis* @ 50000/ha, two times at 7-10 days interval followed by release of *Bracon hebetor* @ 5000/ha two times at 7-10 days against Leaf Miner and Defoliators.
- Spray commercial formulation of Nuclear Polyhedrosis Virus (NPV) for the management of *Spodoptera* and *Helicoverpa* @ 250 LE (6x10⁹/LE/ha) and @ 200 LE for Hairy Caterpillars.
- Spray *Bacillus thuringiensis* @ 1-1.5 kg/ha against Hairy Caterpillars, *Spodoptera* and *Helicoverpa*.
- Spray entomo-pathogenic fungus like, *Nomuraea rileyi* and *Beauveria bassiana* @ 2g/ltr of water for lepidopteran Caterpillars and *Verticillium lecanii* for sucking pests.

3.10.9 The Integrated Disease Management Practices in Groundnut are

- Deep burial of surface organic matter and crop debris.
- Use good quality seeds of resistant/tolerant varieties.
- Seed treatment with commercial formulation of *Trichoderma harzianum* or *T. viride* or *Pseudomonas fluorescens* @ 10g/kg seed or Thiram or Carbendazim or Captan or Mancozeb @ 3-4g/kg seed or Tebuconazole (Raxil 2% DS) @ 1.25g/kg.
- Avoidance of deep sowing and injury to the seedling.
- Crop rotation with wheat and gram, mixed cropping with mothbean.
- Soil application of neem cake or castor cake @ 500kg/ha or neem seed kernel powder @ 3-5%.
- Foliar application of Carbendazim (0.025%) + Mancozeb (0.2%) at 2-3 weeks interval, 2 or 3 alternate spray of Mancozeb (0.2%), Carbendazim (0.02%) and Mancozeb (0.2%) or three sprays of Chlorothalonil (0.2%) or Hexaconazole (0.005%) or Difenconazole 25% EC @ 2ml/l at 30, 50 and 70 DAS effectively reduces the early leaf spot and late leaf spot severity.
- Spray Mancozeb (0.2%) or Copper Oxychloride (0.2%) and destroy the collateral weeds and self-sown plants.

3.10.10 The Integrated Nematode Management Practices in Groundnut are

- Crop rotation with poor or immune host crops like cereals.
- Deep summer ploughing.
- Soil solarization by a transparent polythene sheet (25-50 µm) for 15 days during summer also helps to control nematodes. Soil amendments such as neem cake or castor cakes @ 1 tonnes/ha preferably seven days prior to sowing has been found to reduce nematode population. Their combination with seed treatment, with Carbosulfan (25 DS) @ 3% ai (W/W) further improves efficacy in reducing the nematode population and enhancing yield significantly.
- Use resistant varieties like Tirupathi-2 and 3 for the management of Kalahasti malady disease.

- Farmers of south Saurashtra region of Gujarat may use groundnut with castor as an intercrop (row ratio 2:1) along with soil application of Carbofuron @ 1kg ai/ha to reduce the population of root-knot nematodes.

3.10.11 *Harvesting, Threshing and Storage*

Select five to ten plants randomly and break and open each pod. Pods with prominent veins, dark coloured inside of the shells and the kernels are the indicatives maturity of crop.

Harvesting

- Bunch type of groundnut is mostly harvested by pulling out the plants.
- The bullock-drawn groundnut digger can harvest groundnut crops over an area of 0.75 ha in 8 hours.
- The spreading or semi -spreading type of groundnut is harvested either manually or by using a blade harrow. The soil should be sufficiently moist for easy harvesting without losing pods in the soil.
- Set the blade of the digger at right depth to avoid injury to mature pods. Do not use *Khurfi*/spade to harvest groundnut crop.
- Do not detach the pods immediately after uprooting the plants. Allow them to dry first alongwith vines.
- Dry the produce until the pod moisture is below 8%.

Threshing

- Strip or thresh the pod immediately after drying. Avoid stacking.
- When using Mechanical Threshers, use appropriate sieves based on pod size so that immature pods are blown off.
- Remove mechanical and insect damaged pods.
- Remove all immature pods attached to the haulms.
- Large quantities of bunch type of groundnuts can be stripped using groundnut strippers.
- In some areas in India, the pods are first lifted out of the soil, dried in the field and then the pods of the plants are knocked against a crossbar to dislodge the pods.

- In this process some pods will be damaged although this method of stripping is cheaper.
- In the case of runner types, the plants are first allowed to dry, then are beaten with flails and the pods are separated from the beaten mass by winowing.

Storage

- Post-harvest losses in groundnut are mainly inflicted by the bruchids and Aflatoxin contamination, which severely affect the nutritional qualities and export of groundnut.
- Best storage conditions for groundnuts is about 8.0% kernel moisture content at 10°C and 65% relative humidity.
- Groundnuts always should be stored as pods rather than as kernels.
- Smallholder farmers store groundnut as pods, in earthen pots, mud bins, bamboo baskets.
- Such containers are often plastered with mud and cow dung with little or no use of pesticides.
- For long-term storage the containers are sealed with mud after the addition of ashes, dried neem leaves or other local herbs to control storage pests.
- Use new/clean gunny bags to store the produce.
- Stack the pod-filled gunny bags on wooden planks keeping a metre gap from the walls and store them in well aerated, waterproof storage.
- Spray Malathion 1.25% or Deltamethrin 0.04% on the walls, floor and roof of the Warehouses or Godowns before storage and use Aluminium Phosphide @ 3-5 tablets/tonnes of pods for the management of bruchids.
- Prevent insect damage to the pods in storage by fumigating with phosphine (use 3-5 Aluminium Phosphide tablets for every 100 kg of pods for 7-8 days).
- Do not open the doors of the warehouse for at least a week after fumigation.

► 3.11 Marketing Support

Groundnut is covered under Minimum Support Price (MSP), which is announced well before the harvesting of crop. National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED) is the Nodal agency to undertake procurement of groundnut under Price Support Scheme (PSS). Year wise details of MSP and **Average Market Price of groundnut** during last

five years given in **Table 29** indicates that the price of groundnut falls below MSP many times mainly because of poor quality of produce brought to the market by the farmers.

TABLE 29: MSP V/S AVERAGE MARKET PRICE (AMP) OF GROUNDNUT

Year	Groundnut	
	MSP	AMP
2008-09	2100	1985
2009-10	2100	2582
2010-11	2300	2186
2011-12	2700	2784
2012-13	3700	3611

► 3.12 Nutritive Values

About 75% of groundnut is used for oil extraction. It is known as Indian almond and eaten as roasted/boiled groundnut. A variety of value added products like Peanut Butter, Groundnut Chikki, Groundnut Milk, Groundnut Burfi, Groundnut bhujia, Groundnut Biscuits. The groundnut shell used in various industry as fuel, filler in fertilizers and cattle feeds, preparation of particle boards/papers. Use of groundnut shell in oil extraction of mustard facilitate better recovery and low energy consumption. De-oiled groundnut cakes is used in animal and poultry feeds.

► 3.13 Export Demand

Among oilseeds groundnut has highest share in export. Groundnut kernels of Hand Picked Selection (HPS) varieties are exported in bulk quantities for table purposes. Out of total quantity of 9 lakh tonnes of oilseeds exported during 2012-13 includes >5 lakh tonnes of HPS groundnut. Year wise quantity and value of export is given in **Table 30**.

TABLE 30: EXPORT OF HPS GROUNDNUT

Year	Quantity in lakh tonnes	Value ₹ in crores
2008-09	2.98	1239.00
2009-10	3.40	1424.55
2010-11	4.34	2178.41
2011-12	8.33	5246.45
2012-13	5.36	4065.59

► 3.15 Researchable Issues

- Resistance variety/technology for control of Peanut Bud/Stem Necrosis (AP, Karnataka, Maharashtra, Tamil Nadu, Rajasthan and UP).
- Resistant variety/technology for control for clump virus disease (Rajasthan and UP).
- Resistant varieties/technology for control of aflatoxin.
- There are some very old varieties like TMV-2 and Pollachi red, which are popular in Southern states because of their better performance and adaptability under adverse weather conditions and their acceptability in the market. Some bio-technological studies may be undertaken to transfer cytoplasm/gene from such varieties to other high yielding varieties.
- Bio-control measures for white Grub and Termites in Rajasthan.





► 4.1 Crop Description

Rapeseed-mustard is a group of crops comprising rapeseed (toria, brown sarson and yellow sarson) cultivar of *Brassica campestris*; Indian Mustard (*Brassica juncea*); black mustard (*Brassica nigra*) and taramira (*Eruca sativa*). Some exotic species of Brassicas like gobhi sarson (*B. napus*), Ethiopian mustard or karan rai (*B. carinata*) and white mustard (*Sinapis alba*) have been brought into cultivation in India. The crops of rapeseed group are largely cross pollinated where as Indian mustard is largely self pollinated. Out of these cultivars Indian mustard fits well in cropping system of rainfed areas and accounts for >75% of the total area under rapeseed-mustard cultivation in India. Other cultivars like brown sarson and yellow sarson are under cultivation over a limited areas in the Eastern part of the country including North-Easter States. Toria, a short duration crop is largely grown as a catch crop in tarai part of UP, Haryana, Assam and Odisha. Gobhi sarson is under cultivation over a limited areas in HP, J&K and Punjab under Irrigated ecologies.



Indian Mustard (B. juncea) at flowering stage

► 4.2 Centre of Origin

The genus *Brassica* is one of 51 genera of Brassicaceae belonging to the crucifer family. *Brassica juncea* (n = 18) is an amphidiploid species derived from inter specific crosses between *B. nigra* (n = 9) and *B. rapa* (n = 10). Wild forms of *B. juncea* have been found in the Near East, southern Iran and in India indicates about its centre of origin. It is also grown as a leafy vegetable in China. However, China cannot be considered as a centre of origin for *B. juncea* because the two parent species, *B. nigra* and *B. rapa*, were never found as wild species in that country. The Chinese *B. juncea* forms are yellow-seeded, in contrast to the brown-seeded Indian types which also have a larger seed size. The yellow-seeded *B. juncea* types are grown as an oilseed in the Ukraine. Indian oilseed types contain primarily 3-butenyl glucosinolate in their seeds and vegetative tissue, while *B. juncea* from China contains only 2-propenyl (allyl) glucosinolate, and only trace amounts of 3-butenyl glucosinolate.

► 4.3 Climatic Requirement

Brassicas grow well under low temperature and average (day and night) temperature of 25°C is required at the time of sowing for optimum germination. These crops are grown in almost all part of the country. However, best yield potential exist in North-West and North-East Region.

► 4.4 Global Scenario

Rapeseed & Mustard is widely grown in majority of Continents with largest area of 8 million ha in Canada followed by 7.5 million ha in China and >6 million ha in India. However, the productivity of India is the lowest among the major rapeseed mustard growing countries. As against the World average of 1994 kg/ha, highest productivity of 3947 kg/ha of Germany, the Indian average yield was only 1233 kg/ha during 2012-13. Longer crop duration and high carbon content in the soil are the major factors attributing to high productivity of rapeseed in Western part of the World. The area, production and productivity of the important countries during last 2 years is given in Table 31.

TABLE 31: AREA, PRODUCTION AND YIELD OF R&M OF IMPORTANT COUNTRIES

Country	Area (Lakh ha)		Production (Lakh tonnes)		Yield (kg/ha)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Australia	23.59	32.72	34.27	41.42	1453	1266
Canada	83.80	80.07	154.10	179.35	1839	2240
China	73.00	75.00	140.00	144.00	1918	1920

Country	Area (Lakh ha)		Production (Lakh tonnes)		Yield (kg/ha)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
France	16.07	14.38	54.63	43.70	3399	3040
Germany	13.06	14.66	48.21	57.84	3691	3947
India	58.90	63.40	66.00	78.20	1121	1233
Poland	7.20	9.21	18.66	26.78	2590	2908
Russia	9.76	11.20	10.35	13.93	1061	1244
Ukraine	5.47	9.96	12.04	23.52	2202	2361
UK	7.56	7.15	25.57	21.28	3382	2976
USA	7.01	6.85	11.12	8.80	1588	1285
WORLD	341.02	363.74	645.64	725.33	1893	1994

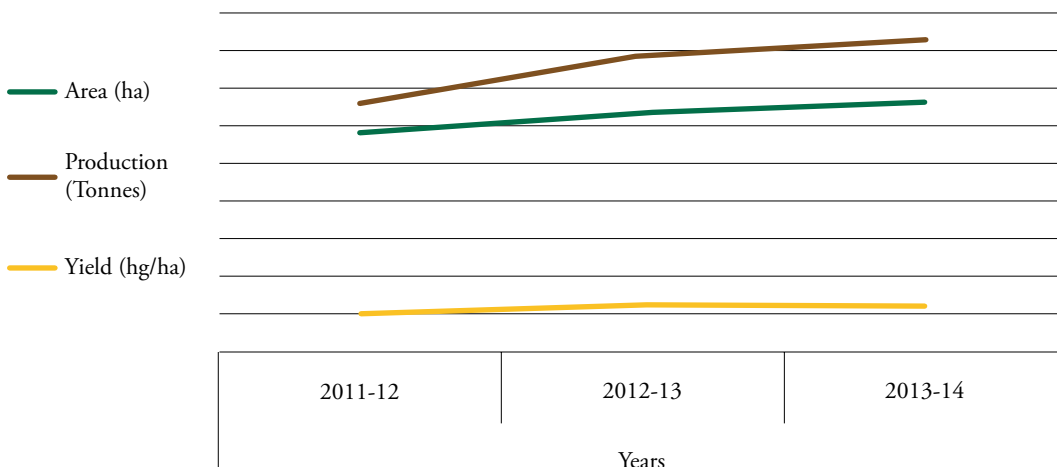
► 4.5 National Scenario

Rapeseed-mustard is grown across the country, pre-dominantly in North, North-Western and North-Eastern Region of the country over an area of >6 million ha. The area coverage under mustard is largely dependent on the late *Kharif* rains. Rajasthan, MP, Haryana and UP contributes >77% of area and about 82% of production of mustard in India. West Bengal, Gujarat and Assam also contribute significantly in mustard production. The State wise area, production and yield of mustard during last 3 year is given in Table 32.

TABLE 32: STATE WISE AREA, PRODUCTION AND YIELD OF MUSTARD DURING LAST 3 YEAR

States	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
Rajasthan	25.02	28.35	30.79	29.76	36.45	38.28	1189	1286	1243
MP	7.85	7.85	8.14	8.70	9.19	9.02	1108	1171	1108
Haryana	5.35	5.59	5.37	7.47	9.62	8.8	1396	1721	1639
UP	6.39	6.62	6.63	7.26	8.36	7.7	1136	1263	1161
WB	4.20	4.67	4.55	3.81	4.58	4.9	908	981	1077
Gujarat	2.08	2.14	2.82	3.27	3.37	4.46	1572	1575	1582
Assam	2.41	2.47	2.57	1.35	1.58	1.45	560	640	564
Jharkhand	1.75	1.71	2.1	1.17	1.36	1.45	670	795	690
Bihar	0.90	0.91	0.9	0.93	1.11	1.02	1029	1220	1133
J&K	0.60	0.60	0.61	0.51	0.51	0.49	851	850	803
Chhattisgarh	0.50	0.50	0.47	0.22	0.26	0.26	436	520	553
Others	1.67	1.98	2.06	1.59	1.81	1.77	952	914	859
All India	58.94	63.39	67.01	66.04	78.20	79.6	1121	1234	1188

Trends of Area, Production and Yield of Mustard



4.5.1 Potential Districts

More than 90% production of Rapeseed-mustard comes from 6 States namely Rajasthan (48%), MP (12%), Haryana (12%), UP (10%), West Bengal (6%) and Gujarat (5). Fifty eight districts of Rajasthan (26), MP (8), Haryana (7), UP (6), West Bengal (8) and Gujarat (3) contributes >80% of total production of R&M in the country. State wise detail of APY of the potential districts is given at *Annexure-V*.

4.5.2 New/Non-Traditional Areas

Approximately an area of about 12 million ha remain fallow during *Rabi* season in the country, out of which >78% area is spread in Eastern States like Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, West Bengal and Eastern Uttar Pradesh, mainly after harvest of paddy. Such rice fallow land could be more profitably utilized for cultivation of rapeseed & mustard with low cost of seeds and other inputs with utera and zero-tillage cultivation.

► 4.6 Yield Gap

Among the major rapeseed & mustard producing countries India has an average (2011-13) yield of 1206 kg/ha as against the world average 1916 kg/ha and highest average yield of 3947 kg/ha of Germany, which indicates a large gap of 59% over world average and 227% over highest yield of Germany. However, the yield gap are much lower in case of

States like Haryana and Gujarat, who has recorded highest yield of 1869 kg/ha (Haryana) and 1579 kg/ha (Gujarat). Yield gaps calculated on the basis of the yields recorded under Front Line Demonstrations (FLD) of mustard conducted by ICAR and average/highest yield recorded in the States is given below in **Table 33**.

TABLE 33: STATE WISE YIELD GAP IN MUSTARD

State	<i>(Yield in kg/ha)</i>		
	Mustard		
	Rabi 2012-13		
	SAY	FLD	Yield Gap (%)
Bihar	1219	2600	113
Jharkhand	794	980	23
Odisha	274	1088	297
Punjab	1265	1741	38
Rajasthan	1286	2148	67
UP	1263	2150	70
Uttarakhand	947	1993	110
Mean	1007	1814	80

The above statement indicates an average yields gap of 80% for mustard over state average yield. However, it is relevant to add that the result of FLD pertains to irrigated condition, whereas, State Average Yield both irrigated and rainfed areas. The higher yield gap in case of Odisha are mainly because of cultivation of M-27 of toria in the State. These yield gaps could be minimized by promotion of short duration mustard varieties. Similarly, in case of Rajasthan, yield gap could be minimized by providing protective irrigation.

► 4.7 Cropping System

There has been a massive change in mustard cultivation during post green revolution period. Intercropping/mix cropping with early sown wheat/gram (October), which was in practice has been changed to pure crop of mustard. Delayed sown mustard also faces more disease and pest problems. Therefore, early sowing of mustard as a pure crop has been adopted over large area. Normally fallow-mustard, fodder crop-mustard, toria-wheat and paddy-mustard crop sequences are more prevalent in Haryana, Punjab, Rajasthan and UP. Traditionally Taramira is grown under low moisture areas of Haryana, Rajasthan, Uttar Pradesh. Rapeseed-Mustard is also grown as an inter/mix crop with wheat, gram, lentil, potato and also with sugarcane.

► 4.8 Improved Varieties

All India Co-ordinate Research Project (AICRP) on Rapeseed & Mustard (R&M) later on upgraded into National Research Centre of R&M has now been converted into Directorate of Rapeseed & Mustard Research (DRMR) located at Bharatpur, Rajasthan is entrusted with development of new varieties and improved production technologies of R&M. After inception of AICRP >120 varieties of R&M have been released for different agro-ecological situations. Variety Aravali Mustard in Chhattisgarh, Rajasthan & UP; Sawarn Jyoti in Odisha, Rajasthan & UP; Pusa Agrani in Chhattisgarh, MP, Odisha, Rajasthan & UP; Pusa Mehak in Bihar, Chhattisgarh, MP, Odisha, UP & WB; JM-2 in Chhattisgarh & MP; Vasundhara in Chhattisgarh, MP & UP; Ashirwad in MP, Rajasthan & UP; RGN-48 in Rajasthan & UP; GUJ-3 in Gujarat; CS-54 in Gujarat, Rajasthan & UP have shown significant yield gains over local varieties under minikits programme of ISOPOM during 2007-12. In addition variety JD-6 and Pusa Agrani in Odisha, Ashirwad in UP; RGN-48 in Rajasthan have also shown better performance under FLD programme during *Rabi*-2012-13. Details of varieties alongwith their salient features are given in *Annexure-VI*.

► 4.9 Seed Scenario

In view of low seed rate and choice of varieties farmers preferred to buy quality/certified seed every year, resulting good Seed Multiplication Ratio (53-80%). The seed supply position of last 3 years is given in Table 34.

TABLE 34: VARIETY WISE CERTIFIED SEED DISTRIBUTION OF R&M DURING 2009-10 TO 2011-12

State	Variety	Year of release	2009-10	2010-11	2011-12
Bihar	B-9	1982	136	0	150
	Pusa Jai Kisan	1994	3646	406	439
	Pusa Bold	1984	2525	551	1484
	Total		6307	957	2073
Haryana	Swarn Jyoti	2003	250	500	200
	RH-30	1983	2353	1216	1512
	Varuna	1975	372	205	385
	Laxmi	1995	1201	487	738
	RNG-48	2006	86	17	0
	CS-52	1996	470	0	0
	Kranti	1983	55	0	0
	T-9	1982	80	30	37
	PT-303	1985	33	2433	0
	Total		4900	4888	2872

State	Variety	Year of release	2009-10	2010-11	2011-12
Gujarat	Pusa Jai Kisan	1994	729	0	60
	GUJ-1	1990	500	515	429
	GUJ-2	1997	638	509	474
	GUJ-3	2006	115	448	259
	Total		1982	1472	1222
MP	Pusa Jai Kisan	1994	600	316	0
	Pusa Bold	1984	173	236	167
	Swarn Jyoti	2003	605	500	450
	Pusa Bold	1984	623	452	0
	JM-2	2005	5	74	462
	Vasundhra	2003	1	128	174
	Varuna	1975	0	0	2
	Aashirwad	2005	0	0	15
	Total		2007	1706	1270
Rajasthan	Pusa Jai Kisan	1994	1372	2906	4323
	Pusa Bold	1984	2476	3658	4475
	Swarn Jyoti	2003	300	1200	672
	Total		3848	6564	8798
UP	B-9	1982	2750	900	0
	Pusa Jai Kisan	1994	1158	2015	848
	Pusa Bold	1984	323	150	0
	Swarn Jyoti	2003	180	200	0
	PT-303	1985	50	0	0
	Total		4461	3265	848
WB	B-9	1982	409	547	399
	Pusa Bold	1984	137	100	100
	Total		546	647	499
Grand Total			24051	19499	17582

The above statement indicates that old varieties like Varuna(1975), B-9 (1982), RS-30 (1983) Pusa Bold (1984) and Pusa Jai Kisan (1994) are still predominant under mustard cultivation in the country.

► 4.10 Best Practices

- Line sowing with row-to-row distance of 30 cm and plant-to-plant distance of 10-15 cm.
- An average day and night temperature of 25°C is considered optimum. From August end to first half of September is best for sowing of toria, 25th September to 15th October for sarson, 30th September to 15th October for mustard.
- Seed treatment with Apron SD 35 @ 6 g/kg of seed is advised for White Rust and Downy Mildew endemic areas. For other seedling diseases, seed treatment with Carbendazim, Thiram or Captan @ 2 g/kg of seed is recommended.
- Use of ridge & furrow technique is most beneficial in saline area and for moisture conservation.
- Thinning is necessary after three weeks of sowing for maintain optimum plant population.
- Protective irrigation at flowering and pod formation.
- Integrated nutrient management with 40 kg N per ha for rainfed situations and 40-80 kg of N per ha under irrigated situations is recommended.
- Harvesting as soon as the crop begins to turn yellow, threshing mechanically and storing at the moisture content of less than 8% is suggested.
- Integrated Pest Management: Rapeseed mustard crop is affected by a number of pests which reduces the yield of rapeseed mustard. The major pests and diseases are given in Table 35.

TABLE 35: INSECTS/PEST OF RAPESEED-MUSTARD

Pests	Crop stage attacked	Period of activity
1. Insect – pest		
i. Mustard Aphid (<i>Lipaphis erysimi</i>)	Vegetative/flowering and pod formation	December-March
ii. Painted Bug (<i>Bagrada hilaris</i>)	Leaves	August-October
iii. Tobacco Caterpillar (<i>Spodoptera litura</i>)	i. Seedling ii Maturity stage	i. October-November ii. March-April
iv. Mustard Sawfly (<i>Athalia proxima</i>)	Vegetative	October-December

Pests	Crop stage attacked	Period of activity
v. Leafminer (<i>Chromatomyia horticola</i>)	Reproductive	February-March
2. Diseases		
i. White rust (<i>Albugo candida</i>)	i. Vegetative ii. Reproductive	i. November ii February-March
ii. Alternaria Leaf Spot (<i>Alternaria brassicae</i>)	Throughout crop growth	February-March
iii. Powdery Mildew (<i>Erysiphe cruciferarum</i>)	Reproductive	February-March
iv. Sclerotinia rot (<i>Sclerotinia sclerotiarum</i>)	i. Vegetative ii. Reproductive	i. October-November ii. February-March

► 4.11 Management of Pest and Diseases

- Deep ploughing during peak summer months.
- Clean cultivation with regular weeding.
- Treat the seeds with Carbedazim 0.1% or Thiophanate Methyl against seedling diseases and Imidacloprid @ 5g/kg of seeds.
- Arrange for drainage of excess water from the field for painted bug.
- If the white rust mean disease severity is more than 3%, apply ridomil MZ 72 WP @ 3g/l.
- If the alternaria blight mean disease severity is more than 3%, spraying of Mancozeb 50 WP @ 2g/l needs to be taken up at 50 and 70 days after sowing. Disease affected plants should be uprooted and destroyed.
- If Powdery Mildew disease is observed, dusting of Sulphur @ 1.5 kg/ha or spraying of Sulfex 2 g/l may be used.
- Wherever the ETL level of Mustard Aphid (per plant) has been crossed, spray of systemic insecticides viz. Monocrotophos, Oxydemeton Methyl etc., may be done at recommended doses. If population of the beneficial insects in aphid infested field is sufficient, insecticide sprays may be avoided.

► 4.12 Marketing Support

National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED) is the Nodal agency to undertake procurement of rapeseed & mustard under Price Support Scheme (PSS). Purchases under PSS are undertaken when the prices fall below the declared support prices for a particular year. A comparison of Minimum Support Price (MSP) and Average Market Price (AMP) of mustard of last 05 years given in Table 36 indicates that mustard price has invariably been much higher (28-42%) than MSP, which is a positive feature for encouraging rapeseed & mustard cultivation in the country.

TABLE 36: MSP AND AMP OF MUSTARD

Year	Mustard	
	MSP	AMP
2008-09	1800	2402
2009-10	1830	2428
2010-11	1830	2345
2011-12	1850	2626
2012-13	2500	3469

► 4.13 Nutritive Values

Mustard oil is extracted at a low pressure & low temperature (40-60°C). It contains 0.30-0.35% essential oil (Allyl-Iso-Thiocynate) which acts as preservative. The Kachchi Ghani Oil is nutritious oil commonly used in Eastern, North & North-Eastern region of the country. Mustard oil is a good source of Omega-3 (MUFA) and other fatty acids like linoleic and alpha lenolic acid respectively in good proportion close to 10:1, rarely found any other oil.

Unlike canola type of varieties with <2% erusic acid of rapeseed, recently a number of varieties of Indian mustard like Pusa Karishma, Pusa Mustard-21, Pusa Mustard-22, Pusa Mustard -24, RLC-1, LET-36 and LET-43 with low erusic acid (<2%) and varieties/hybrids of Gobhi sarson like Hyola-401, GSC-5, TERI-Uttam Jawahar, NUDB-26-11, GSC-101 with 0-2% erusic acid have also been developed.

► 4.14 Export Demand

Both the seeds and the oil of Indian mustard is in demand in various countries primarily to meet the requirement of Indian population. In addition, de-oiled meal of mustard is also

exported to a number of countries like Thailand, Vietnam, Taiwan, Indonesia, South-Korea and Europe in bulk quantities for use as manure. The quantities and values of these exports during the year 2012-13 is given in Table 37.

TABLE 37: QUANTITIES AND VALUES OF EXPORTS OF R&M

Sl. No	Commodity	Qty. (Lakh tonnes)	Value (₹ In crores)
1	Seed	0.31	129.40
2	Oil	0.024	21.51
3	Meal	10.60	1540.90*

* Estimated @ current price of ₹ 14533 per MT.

► 4.15 Researchable Issues

- Short duration varieties of mustard for Eastern Region particularly for rice fallows.
- High yielding and thermo-insensitive varieties/hybrids both for pure crop and inter-cropping.
- Technology for control of broomrape (Orobanche) emerging as a major parasitic weed.
- Development of canola type of high yielding varieties of Indian mustard.



CHAPTER 5

SESAMUM



► 5.1 Crop Description

Sesamum is a genus of approximately 20 species of family Pedaliaceae. The plants are annual or perennial herbs with edible seeds. Sesame has a taproot system. The stem is erect, normally square in section with distinct longitudinal furrows and is glabrous or pubescent. Lower leaves tend to be broad, sometimes lobed, margins often outwardly toothed, intermediate leaves are entire, lanceolate and sometimes serrate, upper leaves are more narrow and lanceolate. Tubular



Sesamum crop at flowering stage

flowers arise in the leaf axis on the upper part of stems and branches. The fruit is a capsule, normally pubescent, rectangular in section and deeply grooved with a short triangular beak.

► 5.2 Centre of Origin

The origin of *Sesamum indicum* is uncertain as it is widely cultivated and naturalized in tropical regions. The species are primarily African, with some species occurring in India, Sri Lanka, and China. The genus is closely related to the strictly African genus *Ceratotheca* and is itself probably African in origin.

► 5.3 Climatic Requirement

The crop requires well drained, fertile soil with medium texture and neutral pH. Sesame is largely cultivated as a *Kharif* crop in arid and semi-arid tropics and as a *Rabi*/Summer crop in the cooler areas. However, it is frost-susceptible. The minimum temperature of 12°C. Is required for germination thereafter, temperature of 25-35°C encourages rapid growth and flower formation.

► 5.4 Global Scenario

Sesame is cultivated over an area of more than 7 million ha in world with an annual production of 4 million tonnes and yield of 535 kg/ha. India, Myanmar, Sudan, China are the major sesamum growing countries. India has largest coverage but China has highest yield of sesamum. Average area, production and yield of sesamum of 5 years (2007-12) of major sesamum growing countries is given in Table 38.

TABLE 38: AVERAGE AREA, PRODUCTION AND YIELD OF MAJOR SESAME GROWING COUNTRIES (2007-12)

(Area: lakh ha, Production: lakh tonnes, Yield: kg/ha)			
Countries	Area	Production	Yield
Myanmar	15.167	8.433	556
India	19.070	7.378	387
China	4.797	5.921	1234
Sudan	12.774	2.895	227
Uganda	2.842	1.724	607
World	74.058	39.592	535

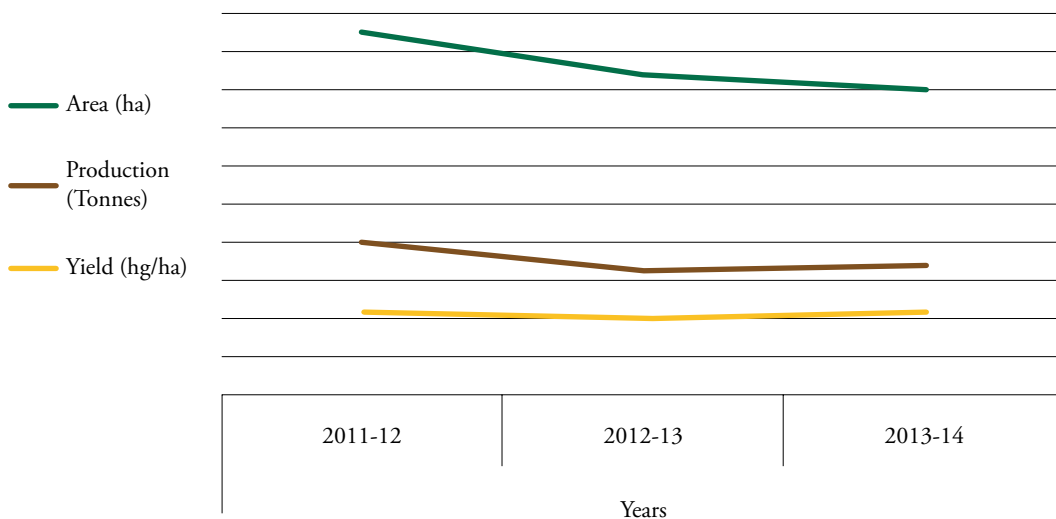
► 5.5 National Scenario

Sesame grown throughout the year in one or the other part of the country and in more than one season in a region. Sesame in India is cultivated over an avg. area of >17 lakh ha with a production of >7 lakh tonnes and productivity of 413 kg/ha during last 3 years. However, productivity and quality of sesamum seed produced during *Rabi*/summer season is much better than *Kharif* season. The State wise area, production and productivity of sesamum of last three years is given in Table 39.

TABLE 39: STATE WISE AREA, PRODUCTION AND PRODUCTIVITY OF SESAMUM OF LAST THREE YEARS

State	Area in lakh ha			Production in lakh tonnes			Yield kg/ha		
	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
AP	0.72	0.67	0.85	0.20	0.22	0.26	278	328	306
Assam	0.12	0.12	0.11	0.07	0.07	0.08	583	583	727
Chhattisgarh	0.20	0.19	0.18	0.08	0.06	0.05	400	316	278
Gujarat	2.47	1.33	2.36	1.17	0.34	1.24	474	256	525
Karnataka	0.62	0.40	0.38	0.31	0.13	0.21	500	325	553
MP	2.95	3.15	2.56	1.55	1.57	1.07	525	498	418
Maharashtra	0.46	0.31	0.25	0.15	0.09	0.07	326	290	280
Odisha	0.27	0.23	0.23	0.05	0.04	0.05	185	174	217
Rajasthan	5.13	4.15	3.61	1.66	1.22	0.72	324	294	199
TN	0.43	0.48	0.64	0.26	0.21	0.28	605	438	438
UP	3.45	3.45	2.93	0.75	0.64	0.43	217	186	147
WB	1.82	1.88	2.24	1.67	1.77	2.15	918	941	960
Others	0.38	0.37	0.33	0.18	0.18	0.14	474	486	424
All India	19.02	16.73	16.67	8.10	6.54	6.75	426	391	405

Trends of Area, Production and Yield of Sesamum



► 5.6 Potential Districts

More than 85% production of Sesame comes from WB, MP, Rajasthan, UP, Gujarat and AP. A list of 47 potential districts along with area, production and productivity of sesame is given at *Annexure-VII*.

► 5.7 Yield Gap

Though the National Average Yield of 413 kg/ha of sesame in India is lower than the World Average Yield of 535 kg/ha, however, State Average Yield 939 kg/ha of West Bengal, who is the largest producer of sesame is much higher than the World average but lower than the highest yield of 1234 kg/ha of China. FLDs of sesame organised during *Kharif/Rabi/Summer* – 2012-13 indicates an average yield gap of 84% over National Average Yield and 58-209% over State Average Yield (SAY) of Sesame as given below in **Table 40**.

TABLE 40: STATE AVERAGE YIELD (SAY) OF SESAME

State	<i>Kharif/Rabi/Summer</i> – 2012-13 (Yield kg/ha)		
	SAY	FLD	Yield Gap (%)
Karnataka	325	515	58
Maharashtra	290	709	144
Rajasthan	294	451	53
Tamil Nadu	186	564	203
UP	438	1353	209
All India	391	718	84

► 5.8 Cropping System

5.8.1 Cropping Sequence

Sesame is a short duration crop and fits well into a number of multiple cropping systems either as a catch crop or a sequence crop. The details of common sequences followed in different regions are given in **Table 41**.

TABLE 41: SEQUENCE CROPPING WITH SESAME

States	Crop sequence
Andhra Pradesh	Rice-Groundnut-Sesame, Sesame-Horsegram, Ragi/Sorghum/Horsegram (Early)-Sesame, Sesame- Upland Rice.
Bihar	Early Rice -Potato-Summer Sesame/Moongbean, <i>Kharif</i> Sesame-Maize/ Pigeonpea/ <i>Rabi</i> gram, Wheat-Summer Sesame/Moongbean

States	Crop sequence
Gujarat	Sesame-Wheat/Mustard
Karnataka	Sesame-Horsegram/Chickpea
Madhya Pradesh	Cotton-Sesame-Wheat, Rice - Summer Sesame, Sesame-Wheat
Maharashtra	Sesame (Early)- <i>Rabi</i> Sorghum/Safflower, Cotton-Sesame-Wheat
Odisha	Rice/Potato-Sesame, <i>Kharif</i> Sesame-Maize/Pigeonpea/ <i>Rabi</i> Gram
Rajasthan	Sesame-Wheat/Moongbean/Barley
Tamil Nadu	Rice/Groundnut-Sesame, Sesame-Urdbean, Sesame- <i>Rabi</i> , Sorghum, Sesame-Moongbean, Cowpea-Sesame.
Uttar Pradesh	Sesame (Early)-Gram/Rapeseed-Mustard/Lentil/Pea
West Bengal	Potato-Sesame (Late Jan./Early Feb), Rice – Sesame

5.8.2 Inter Cropping

Intercropping systems recommended for different states are given in Table 42.

TABLE 42: STATE WISE INTER CROPPING SYSTEMS

State	Intercropping system
Gujarat	Sesame+Groundnut/Urd bean (3:3), Sesame+Pearlmillet/Cotton (3:1)
Karnataka	Sesame+Groundnut (1:4)
Madhya Pradesh	Sesame+Moongbean/Urdbean (2:2 or 3:3), Sesame+Soybean (2:1 or 2:2)
Maharashtra	Sesame+Pearlmillet/Urdbean (3:1)
Odisha	Sesame+Summer Groundnut (2:3), Sesame+Moongbean/Urdbean (2:2)
Rajasthan	Sesame+Pearlmillet/Mothbean (1:1)
Tamil Nadu	Sesame+Moongbean/Urdbean (3:3), Sesame+Pigeonpea(3:1), Sesame+Groundnut (2:4)
Uttar Pradesh	Sesame+Moongbean (1:1), Sesame+Pigeonpea(3:1)
West Bengal	Sesame+Groundnut (1:3 or 2:2)

► 5.9 Varieties and Seed Scenario

A separate Project Coordinating Unit under DoR is entrusted with the crop improvement of sesame and located in JNKVV Campus, Jabalpur. Details of varieties of sesame released after

2001 are given in *Annexure-VIII*. However, State-wise farmers preferred varieties are given in Table 43.

TABLE 43: FARMERS PREFERRED VARIETIES OF SESAME

State	Varieties	Seed Colour
Gujarat	Guj-Til-1,2,3	White seed
	Guj-Til-10	Black seed
Madhya Pradesh	TKG-21, 22, 55, 306, 308 and JTS-8	White seed
	PKDS-11, 12	Dark brown seed
	PKDS-8	Bold black seeded
Rajasthan	RT-46, 103, 125, 127, 346, 351,	White seed
	RT-54	Light brown seed
Maharashtra	AKT-64, AKT-101, JLT-408, PKVNT-11	White seed
UP	T-78, Sekhar	White seed
Tamil Nadu	TSS-6	White seed
	Co-1, Paiyur-1, VRI-1, VRI-2, TMV-7	Black seed and Brown Seed
WB	Rama, Savitri	Brown seed
Odisha	Nirmala, Shubhra	White seed
	Prachi, Amrit	Brown/Black seed
	Smarak	Golden yellow and bold seed
Andhra Pradesh	Varaha, Gautama, Chandana	Brown seed
	Swetha til, Hima	White seed
Karnataka	DS-1	Dark brown seed
	DSS-9	White bold seed

Availability of quality seed is a major problem resulting into low SRR of about 20%.

► 5.10 Best Practices

5.10.1 Soils

Sesame can be grown on a wide range of soils but well drained light to medium textured soils are preferred. The optimum pH range is 5.5 to 8.0, acidic or alkaline soils are not suitable.

5.10.2 Seed Rate

A seed rate of 5 kg/ha is adequate to achieve the required plant population.

5.10.3 Sowing Method

In order to facilitate easy seeding and even distribution increase the bulk by mixing the seed with either sand or dry soil or well sieved farm yard manure in 1:20 ratio.

5.10.4 Optimum Time of Sowing and Spacing

The optimum time of sowing and spacing recommended for different state/regions are given in Table 44.

TABLE 44: STATE/REGION WISE OPTIMUM TIME OF SOWING AND SPACING

States	Season	Sowing time	Spacing (cm)
Andhra Pradesh	<i>Kharif</i>	Second fortnight of May	30 x 15
Coastal	Summer	Second fortnight of January	30 x 15
Telangana	<i>Kharif</i>	Second fortnight of July	30 x 10-15
Gujarat	<i>Kharif</i>	Last week of June to	45 x 10
	<i>Semi-Rabi</i>	second fortnight of July	
	Summer	Mid September	45 x 10
		January-February	45 x 15
Madhya Pradesh	<i>Kharif</i>	First week of July	30 x 10-15
/Chhattisgarh	<i>Semi-Rabi</i>	Late August-Early September	30 x 15
	Summer	Second to last week of February	30 x 15
Maharashtra	<i>Kharif</i>	Second fortnight of June to July	30 x 15
	<i>Semi-Rabi</i>	Early September	30 x 15
	Summer	February	45 x 15
Rajasthan	<i>Kharif</i>	Late June-Early July	30 x 15
Odisha	<i>Kharif</i>	June-July	30 x 15
	<i>Rabi</i>	September-October	30 x 15
	Summer	February	30 x 15
Uttar Pradesh/ Uttarakhand	<i>Kharif</i>	Second fortnight of July	30-45 x 15
Bihar/Jharkhand	<i>Kharif</i>	July	30 x 15
West Bengal	Summer	February-March	30 x 15
Tamil Nadu	<i>Kharif</i>	Second fortnight of May to Second fortnight of June	22.5 x 22.5
	<i>Rabi</i>	November-December	22.5 x 22.5
	Summer	Second fortnight of Jan. to March	30 x 10

States	Season	Sowing time	Spacing (cm)
Karnataka	<i>Kharif</i>	June-July	30 x 15
North South	Early <i>Kharif</i>	April-May	30 x 15
Assam	<i>Kharif</i>	July-August	30 x 10-15
Punjab/Haryana	<i>Kharif</i>	Second fortnight of July	30 x 10-15
Kerala	<i>Kharif</i>	August	30 x 10-15
	Summer	December	30 x 15

5.10.5 Seed Treatment

For the prevention of seed borne diseases, use seed treated with Bavistin 2 g/kg seed. Wherever bacterial leaf spot disease is a problem, soak the seed for 30 minutes in 0.025% solution of Agrimycin-100 prior to seeding.

5.10.6 Manures and Fertilizers

The optimum doses of N, P and K recommended for different regions/situations are given in Table 45.

TABLE 45: STATE WISE RECOMMENDED DOSES OF FERTILIZERS

State/Situation	Recommended dose of N:P:K (kg/ha)	Specific recommendation
Andhra Pradesh		
Coastal region	40-40-20	-
Telangana region	30-30-20	-
Gujarat		
<i>Kharif</i>	30-25-0	Apply sulphur 20-40 kg/ha
<i>Semi-Rabi</i>	25-25-0	
	37.5-25-25	Half N + full P ₂ O ₅ and K ₂ O as basal remaining half N at 30-35 DAS
Madhya P./Chhattisgarh		
Rainfed	40-30-20	Apply 25 kg/ha zinc sulphate once
Summer	60-40-20	in three years in zinc deficient soils

State/Situation	Recommended dose of N:P:K (kg/ha)	Specific recommendation
Maharashtra		
	50-0-0	Half N at 3 weeks after sowing and remaining half 6 weeks thereafter
Rajasthan		
Heavy soils	20-20-0	For areas with less than 350 mm rainfall
Light soils	40-25-0	For areas with more than 350mm rainfall
Odisha		
	30-20-30	-
Tamil Nadu		
Irrigated	35-23-23	Apply full dose of N, P ₂ O ₅ , K ₂ O as basal
Rainfed	25-15-15	Seed may be treated with <i>Azospirillum</i>
Uttar Pradesh/Uttarakhand		
	20-10-0	-
West Bengal		
Irrigated	50-25-25	No fertilizer if sown after potato
Rainfed	25-13-13	

5.10.7 Weeding and Inter Culture

The crop is very sensitive to weed competition during the first 20-25 days. Two weedings, one after 15-20 days of sowing and other at 30-35 days after sowing are required to keep the field weed free and to make moisture and nutrients available to the crop.

5.10.8 Irrigation

For good seed filling and yield, irrigations at flower initiation and capsule formation are the most essential.

5.10.9 Crop Protection

Major insect pests and diseases, their characteristic and control measures recommended for their management are given in Table 46 & 47.

TABLE 46: IMPORTANT INSECT PESTS OF SESAME AND THEIR INTEGRATED MANAGEMENT

Pests	Nature of damage	Stage when crop is damaged	Period of pest activity	Integrated management
Leaf Roller and Capsule Borer (<i>Antigastra catalaunalis</i> Dup.)	In early stage of crop, caterpillars feed on tender leaves and remain inside the leaf web.	The first attack of the pest starts when the crop is 15 days old.	July to September	Crop rotation is effective in reducing pest population. Birds eat the Caterpillars. Apply Phorate 10 G@10 kg ai/ha as basal application. Two sprays of Endosulfan 0.07% or Monocrotophos 0.05% or Quinalphos 0.05%, at 30 and 45 days after sowing. Two rounds of dusting with Phosalone 4%, Malathion 5% Endosulfan 4% dusts 25 kg/ha at 30 and 45 days after sowing.
Gall fly (<i>Asphondylia sesami</i> Folt.)	Maggots feed inside the floral bud leading to formation of gall like structure and do not develop into flower/capsule.	At the time of bud initiation	Sept. to Nov.	Spray crop at bud initiation stage with Dimethoate 0.03% or Endosulfan 0.07%.
Bud fly (<i>Dasygnura sesami</i> G&P)	Maggots feed inside the floral bud leading to formation of gall like structure.	At the time of bud initiation	Sept. to Oct	As in the case of gall fly. Use tolerant varieties like MT-75 and Shekhar.
Sesame Leaf Hopper (<i>Orosius albicinctus</i> Dist.)	Nymph & adults suck sap of tender parts of plants.	From vegetative to capsule stage	July to end of September	As in the case of gall fly.
Hawk moth (<i>Acherontia styx</i> W.)	Caterpillars feed on the leaves and defoliates the plant.	Throughout the crop.	August to October	Deep ploughing exposes the pupae for birds. Collection and destruction of caterpillars. Two rounds of dusting with Phosalone 4% or Malathion 5% or Endosulfan 4% dust 25 kg/ha, first at 30 DAS and second at 45 DAS.

Pests	Nature of damage	Stage when crop is damaged	Period of pest activity	Integrated management
Bihar Hairy Caterpillar (<i>Spilosoma obliqua</i>)	At early stages, larvae are gregarious feeders.	Starting from vegetative stage till maturity.	August to October	Spray at the bud initiation stage with Dimethoate (0.03%) or Endosulfan (0.07%). Dusting with Phosalone 4%, Malathion 5% or Endosulfan 4% @ 25 kg/ha at 30 & 45 DAS.

TABLE 47: IMPORTANT DISEASES OF SESAME AND THEIR MANAGEMENT

Disease	Symptoms	Stage of crop when disease appears	Management
<i>Phytophthora</i> blight (<i>Phytophthora nicotianae</i> var. <i>parasitica</i> f. sp. <i>sesami</i>)	Initially water soaked spots appear on leaves & stem. The spots brown in beginning turn to black. In humid weather severity of disease increases & causes death of plant with blighted appearance.	Seedling to flowering stage.	Summer deep ploughing Improve drainage. Two years crop rotation. Use disease free seed. Intercropping, sesame + pearl millet (3:1) Use tolerant varieties viz. TKG-21, TKG-22, TKG-55, JTS-8, AKT-64. Seed treatment before sowing with Apron 35SD (0.3%) or Ridomil Mz (0.25%) <i>Trichoderma harzianum</i> or <i>T. viride</i> or <i>Bacillus subtilis</i> (0.4%). Spray crop three times with Ridomil Mz (0.25%) or Copper oxychloride (0.25%) at an interval of 10 days from the initiation of disease.
Stem and Root rot (<i>Macrophomina phaseolina</i> / <i>Rhizoctonia bataticola</i>)	Disease appears on root and stem. The affected plants show wilting.	Seedling to maturity.	Two years crop rotation. Summer deep ploughing. Use disease free seed. Follow intercropping sesame + mothbean 1:1 or 2:1 ratio. Use tolerant varieties viz. RT-46, RT-54, RT-103, RT-125, RT-127, TKG-55, JTS-8, MT-75, Nirmala. Treat the seed with <i>T. viride</i> or <i>T. harzianum</i> or <i>Bacillus subtilis</i> (0.4%) or Thiram 75 SD (0.2%) + Bavistin (0.1%) or Thiram 75 SD (0.3%). Uproot and destroy the infected plants. Irrigate field to avoid stress condition.

Disease	Symptoms	Stage of crop when disease appears	Management
Bacterial Blight (<i>Xanthomonas campestris</i> pv. <i>sesami</i>)	Water soaked, small and irregular spots are formed on the leaves, which later increase in number and turn brown, under favourable conditions.	Spots appears from 4-leaf stage of the crop and continue till maturity.	Seed treatment with hot water at 52°C for 10 min. Foliar spray of Streptocycline or Plantomycin (500ppm) as soon as symptoms are noticed. Continue 2 more sprays at 15 days interval if necessary. Destruction of weed <i>Acantho -spermum hispidum</i> .
Bacterial Leaf spot (<i>Pseudomonas syringae</i> pv. <i>sesami</i>)	Small angular light brown to brown spots confined to veins with dark margins.	From 4-6 leaf stage of crop.	As in case of Bacterial Blight.
Cercospora Leaf spot (<i>Cercospora sesami</i> , <i>C. sesamicola</i>)	Disease appears as small, angular brown leaf spots of 3mm diameter with gray center & dark margin delimited by veins.	4-6 leaf stage of the crop and continue till maturity.	Early planting i.e. immediately after onset of monsoon. Follow intercropping of Sesame + Pearl millet (3:1). Treat the seed with Thiram (0.2%) + Bavistin (0.1%). Use resistant variety TKG-21. Three sprays of Dithane M-45 (0.25%) or Topsin M (0.1%) at 15 days interval.
Alternaria Leaf spot (<i>Alternaria sesami</i>)	Spots on leaves are brown circular to irregular in shape and often have concentric rings.	Spots appears at 1 month crop age	Use tolerant varieties viz. TC-25, RT-46, RT-54, JTS-8, Sekhar, Usha, TSS-6, Nirmala, RT-125. Spraying with Dithane M-45 (0.2%) at 15 days interval when disease appears.
Powdery Mildew (<i>Oidium</i> sp., <i>Sphaerotheca</i> sp., <i>Leveillula</i> sp.)	Small cottony spot appears on the infected leaves.	45 days to maturity.	Early planting i.e. immediately after onset of monsoon. Use resistant varieties viz. Swetha, RT-127, MT-75. Foliar spray (2-3 times) of Wettable sulphur (0.2%) or Bavistin (0.1%) or Tilt (0.1%) at 10 days interval.

Disease	Symptoms	Stage of crop when disease appears	Management
Phyllody (Phytoplasma)	All floral parts are transformed into green leafy structures. Such plants generally do not bear capsules.	Flowering stage.	Rogue out diseased plants. Use intercropping, sesame + Pigeonpea (1:1). Use tolerant varieties <i>viz.</i> JT-21, Swetha, Rama, Sekhar. Soil application of Phorate 10G kg/ha. Three sprays of Dimethoate (0.3%) at 30, 40 and 60 days after sowing.

5.10.10 Harvesting and Threshing

The best time of harvesting is when the leaves turn yellow and start drooping and the bottom capsules are lemon yellow.

► 5.11 Nutritive Values

According to Hindu mythology and beliefs, sesame seeds and oil are considered as symbol of immortality and most auspicious. Sesame seeds are a very good source of copper, magnesium and calcium. Sesame flour has high protein, high levels of methionine and tryptophan. Sesame oil is considered to be one of the most healthy cooking oil due rich source of oleic (40-50%) and linoleic (35-45%) fatty acids. In additions to high value oil, sesame seeds are used in large number of confectionary products and sweets. Besides, sesame seeds and oil have industrial, nutraceutical and pharmaceutical uses.

► 5.12 Marketing/Export

Sesame is covered under Minimum Support Price (MSP) scheme of the Government. Among oilseeds, sesame occupies 2nd position after groundnut as far as exports of oilseeds are concerned. More than 40% of the sesame seeds produced in India are exported every year. The average export price of ₹ 96.37 per kg as against the MSP of ₹ 42/- per kg during 2012-13 indicates that market price might have been much higher than MSP. The status of sesame seeds production and export during 2010-13 is given in Table 48.

TABLE 48: STATUS OF SESAME SEEDS PRODUCTION AND EXPORT

Year	Production (lakh tonnes)	Quantity (lakh tonnes)	Value (₹ in crores)	Price (₹ per kg)
2010-11	8.93	3.98	2307.52	58.27
2011-12	8.10	3.89	2641.66	67.91
2012-13	6.85	2.99	2881.54	96.37

► 5.13 Researchable Issues

- Development of varieties with high seed yield, oil content, with resistance to biotic and a-biotic stresses.
- Development of white bold seeded varieties with low anti-nutritional factors (oxalic/phytic acid).
- Development of sesame hybrid.
- Development of short duration varieties for *Rabi* Summer season for paddy fallows.
- Development of PoP for organic sesame.
- Development of IPM modules for diseases and insect pests.



CHAPTER 6

SUNFLOWER



► 6.1 Crop Description

Sunflower (*Helianthus annuus* L.) belongs to the family Compositae. It is a diploid with chromosome number $2n=34$ and genotypes are characterized by a single stem terminating in a capitulum and protandrous in nature wherein pollens and stigma mature at different times. Therefore, it has been essentially categorised a cross pollinated plant.



Sunflower field at flowering stage

► 6.2 Centre of Origin

The cultivated sunflower is native of Southern United States and Mexico, during late 70s, the crop was introduced to India as an oilseed crops.

► 6.3 Climatic Requirement

The crop requires a low temperature (3-6°C) during germination and optimum temperature of 20-26°C later on. Warm weather and non-cloudy sunny days are considered favorable during reproductive phase i.e. flowering to maturity. The crop can be sown in all the season and across the country. Temperature above 40°C would cause desiccation of pollen and drying of stigma attributing to poor seed set and low yield. Deccan plateau, hot semi-arid eco region has largest area under sunflower, whereas, Northern Plains have shown higher productivity of sunflower during summer season with assured irrigation.

► 6.4 Global Scenario

Sunflower is grown over an area of >25 million ha in >70 countries with a World Average Yield of 1611 kg/ha. Russian Federation, Ukraine, Argentina, Romania, China, Kazakhstan, Spain, Tanzania, Bulgaria, France, India, Turkey, South Africa, USA and Myanmar are the major sunflower growing countries. China, France, Turkey are the highest yielding countries with an average yield of >2 tonnes/ha as against the lowest yielding countries like Kazakhstan, Myanmar and India with <1 tonne per ha. Russia and Ukraine have largest share of about 50% in total sunflower production in the World. The country wise area, production and yield are given in Table 49.

TABLE 49: AREA, PRODUCTION AND PRODUCTIVITY OF MAJOR SUNFLOWER GROWING COUNTRIES

Sl. No.	Country	Area in lakh ha			Production in lakh tonnes			Yield in kg/ha		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
1	Russian Fed.	72.21	61.59	67.96	96.97	79.93	105.34	1343	1298	1550
2	Ukraine	47.17	50.82	50.92	86.71	83.87	110.50	1838	1651	2170
3	Romania	9.93	10.65	10.95	17.89	13.98	21.96	1802	1313	2006
4	China	9.40	9.50	9.30	23.13	23.69	23.80	2460	2494	2559
5	Kazakhstan	8.83	6.82	8.22	4.09	4.00	5.73	464	587	696

Sl. No.	Country	Area in lakh ha			Production in lakh tonnes			Yield in kg/ha		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
6	Spain	8.63	7.61	8.49	10.90	6.19	10.29	1263	813	1212
7	Tanzania	7.54	8.4	8.1	7.86	11.25	10.83	1044	1339	1337
8	Bulgaria	7.47	7.81	8.60	14.40	13.88	19.37	1927	1778	2253
9	France	7.41	6.80	7.71	18.81	15.73	15.82	2539	2313	2053
10	India	7.30	8.20	6.80	5.17	5.81	6.00*	708	709	882
11	Turkey	6.56	6.05	6.10	13.35	13.70	15.23	2036	2265	2498
12	South Africa	6.43	5.00	5.05	8.60	6.30	5.57	1338	1260	1103
13	USA	5.90	7.45	5.96	9.24	12.63	9.22	1567	1696	1547
14	Myanmar	5.43	5.40	5.70	4.90	3.50	3.60	902	648	632
15	Pakistan	3.01	3.55	2.83	4.04	4.73	3.78	1345	1332	1336
World + (Total)		257.21	251.08	255.90	408.63	375.35	447.53	1589	1495	1749
India (As per DES data)		7.32	8.23	7.06	5.17	5.80	4.70	706	705	666

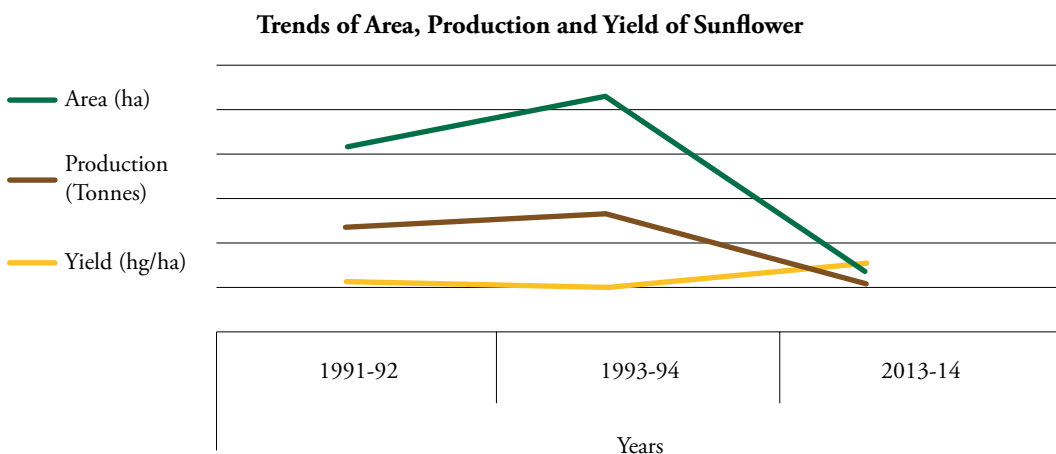
**As per second advance estimates of DES area of 7.06 ha, production of 4.70 lakh tonnes and yield of 666 kg/ha has been estimated.*

► 6.5 National Scenario

Sunflower has several positive features like, it can be grown around the year and across the country; fits well under inter-cropping; being a short duration crop suits well as an contingency crop including cultivation under rice fallows; availability of hybrids with high yield potential and larger market demand for sunflower oil. Commercial cultivation of sunflower as an oilseed crops was started during late 70s with an area of 12,000 ha mainly in Karnataka. State wise trend of area, production and yield of sunflower is given in **Table 50**. National Average Yield (NAY) of sunflower was around 666 kg/ha as against the World Average of 1749 kg/ha and highest yield of 2559 kg/ha of China during 2013-14. However, State Average Yield (SAY) of sunflower in case of Haryana (1714 kg/ha), Punjab (1818 kg/ha) and UP (2000 kg/ha) are either at par or higher than the World Average Yield (1749 kg/ha). Maximum area of 2.67 million ha was achieved under sunflower during 1993-94 in the country. Thereafter, area under sunflower declined to 0.7 million ha during 2013-14. Despite, high productivity in Haryana, Punjab and UP, area under sunflower has also been declined drastically in these States.

TABLE 50: STATE WISE AREA, PRODUCTION AND YIELD TRENDS OF SUNFLOWER IN INDIA

State	Area in lakh ha			Production in lakh tonnes			Yield kg/ha		
	1991-92	1993-94	2013-14	1991-92	1993-94	2013-14	1991-92	1993-94	2013-14
AP	2.82	3.90	1.00	1.87	2.17	0.88	663	556	880
Haryana	1.00	0.40	0.07	1.62	0.65	0.12	1620	1625	1714
Karnataka	11.97	14.69	4.43	5.16	4.75	2.97	431	323	670
MP	0.21	0.18	0.00	0.07	0.07	0.00	333	389	0.00
Maharashtra	3.76	5.72	0.61	1.39	3.54	0.38	370	619	623
Punjab	0.83	0.85	0.11	1.45	1.46	0.2	1747	1718	1818
TN	0.23	0.40	0.08	0.13	0.33	0.12	565	825	1500
UP	0.17	0.36	0.03	0.17	0.43	0.06	1000	1194	2000
Others	0.15	0.18	0.58	0.08	0.08	0.74	533	444	1276
All India	21.14	26.68	6.91	11.94	13.48	5.47	565	505	792



6.5.1 Potential Districts

There are about 40 potential districts of sunflower in the States of AP (4), Bihar (2), Chhattisgarh (1), Haryana (1), Karnataka (16), Maharashtra (7), Punjab(2), Tamil Nadu(2), Telangana(3) and UP (1), wherein sunflower is grown during *Kharif/Rabi*/Summer season. Details of potential district are given in *Annexure-IX*.

6.5.2 New/Non-Traditional Areas of Season

As the crop is largely photo and thermo-insensitive, there is scope to grow the crop in all the seasons of the year in many parts of the country. It can also be introduced as a contingent crop when the season for planting regular crop is delayed or the regular crop has failed. Some of the potential areas for introducing sunflower are given below:

- In *Kharif* fallows, as mid-season contingency crop in central and peninsular India.
- As a summer crop after potato, mustard, sugarcane, pea, cotton, vegetables and late rice in Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal.
- As a alternative crop for sorghum under delayed onset of monsoon in peninsular India.
- As an alternate crop in Rice-Fallow lands with supplemental irrigation in Odisha, Chhattisgarh, Andhra Pradesh, Maharashtra and Karnataka.
- As an intercrop with Fingermillet, Pigeonpea, Groundnut, Soybean, Castor, Sesame, Urdbean and Mungbean in different regions.

► 6.6 Cropping System

The availability of early and medium duration varieties and hybrids, responsive to high input management and its relatively less thermo-and photo-insensitivity renders sunflower an ideal crop for all seasons. Due to its wider adaptability, the crop is ideally suited for intercropping system. It is estimated that about 10% of the area of sunflower is under intercropping. Sunflower + pigeonpea and sunflower + groundnut are popular in southern states. The intercropping of sunflower + castor in Andhra Pradesh and Gujarat, sunflower + soybean in Marathwada and Vidarbha region of Maharashtra, sunflower + urdbean in Uttar Pradesh are found to be efficient for increasing productivity and monetary returns. On an average, groundnut + sunflower registered 36% yield advantage, while pigeonpea + sunflower gave 23% higher additional yield advantage over sole crop of sunflower. The degree of profitability of intercropping system depends on the pattern of rainfall distribution and the risk factors faced by either of the crops besides the proportion of companion crops. State efficient intercropping systems identified in different agro-climatic zones are given in Table 51.

TABLE 51: STATE WISE INTERCROPPING SYSTEMS IN SUNFLOWER

State	Soil type	Efficient intercropping	Row ratio
Karnataka	Alfisols	Groundnut+Sunflower	4:2, 3:1
	Alfisols	Pigeonpea+Sunflower	1 :2/1:1
	Vertisols	Pigeonpea+Sunflower	3:1
	Alfisols	Fingermillet+Sunflower	4:2

State	Soil type	Efficient intercropping	Row ratio
Maharashtra	Vertisols	Pigeonpea+Sunflower	3:3
	Vertisols	Soybean+Sunflower	2:1
	Vertisols	Groundnut+Sunflower	6:2
Andhra Pradesh	Alfisols	Groundnut+Sunflower	4:2
	Alfisols	Pigeonpea+Sunflower	1:2
	Alfisols	Castor+Sunflower	1:1
Tamil Nadu	Alfisols	Groundnut+Sunflower	3:1
	Alfisols	Castor+Sunflower	1:1
Gujarat	Alfisols	Groundnut+Sunflower	1:1
	Vertisols (irrin)	Castor+Sunflower	1:1
Non-traditional areas	Inceptisols	Urdbean/Mungbean+ Sunflower	4:2/3:1

► 6.7 Yield Gap

NAY of sunflower reveals a large yield gap of > 110% over World Average and almost 200% over the highest yield of France. FLD organized by Institutions of ICAR/SAUs during 2011-12 and 2012-13 indicates an yield gap of 10%-43% in case of Haryana, Punjab and West Bengal may be because of large area cultivation of sunflower is under irrigated condition. However, large yield gap of >100% in case of Karnataka and Maharashtra may not be very realistic because sunflower in these States is largely raised under residual moisture, whereas, results of FLD pertains to irrigated condition. The State wise yield gap are given in Table 52.

TABLE 52 YIELD GAPS RECORDED UNDER FLDS OF SUNFLOWERS

State	Yield kg/ha		Yield gap %
	SAY	FLD	
2011-12- Rabi/Summer (Irrigated)			
Haryana	1800	2579	43
Karnataka	505	2415	378
Maharashtra	611	1321	116
Punjab	1857	2038	10
WB	1203	1562	30
Kharif-2012 (Rainfed)			
Maharashtra	545	1094	101
Kharif-2012 (Irrigated)			
TN	926	1886	104

► 6.8 Varieties and Seed Scenario

Directorate of Oilseed Research (DoR), an Institution of ICAR is entrusted with crop improvement of sunflower. A large number of hybrids and composite varieties of sunflower have been developed by both public and private sector. List of hybrids/varieties released after 2001 along with their salient features is given in *Annexure-X*. However, State wise list of hybrids/varieties preferred by the farmer is given in **Table 53**.

TABLE 53: STATE WISE LIST OF HYBRIDS/VARIETIES PREFERRED BY THE FARMER

State	HyB/VrS	Name of Varieties/hybrids
Andhra Pradesh	Hybrids	BSH-1, APSH-11, MSFH-8, KBSH-1, MSFH-17, Jwalamukhi, Sungene-85, PAC-36, PAC-1091, MLSFH-47, KBSH-44, Pro. Sun.09, NDSH-1, SH-416, DRSH-1
	Varieties	Morden, TNAUSUF-7, DRSF-108, DRSF-113
Haryana	Hybrids	BSH-1, KBSH-1, Jwalamukhi, Sungene-85, PAC-36, KBSH-44, Pro. Sun.09, HSFH-848, DRSH-1
Karnataka	Hybrids	BSH-1, MSFH-8, KBSH-1, MSFH-17, Jwalamukhi, Sungene-85, PAC-36, PAC-1091, DSH-1, MLSFH-47, KBSH-41, KBSH-42, KBSH 44, Pro.Sun. 09, RSFH-1, SH-416, KBSH-53, DRSH-1
	Varieties	Morden, TNAUSUF-7, DRSF-108, DRSF-113
Maharashtra	Hybrids	BSH-1, MSFH-8, KBSH-1, MSFH-17, LSH-1, LSH-3, PKVSH-27, Sungene-85, PAC-36, PAC-1091, MLSFH-47, KBSH-44, Pro. Sun.09, SH-416, DRSH-1, LSFH-35
	Varieties	Morden, TNAUSUF-7, Surya, SS-56, LS-11 (Sidheswar), DRSF-108, DRSF-113, TAS-82, LSF-8, PKVSF-9, Phule Raviraj
Punjab	Hybrids	BSH-1, KBSH-1, PSFH-67, Jwalamukhi, Sungene-85, PAC-36, PSFH-118, KBSH-44, DRSH-1, PSFH-118, PSFH 569
Tamil Nadu	Hybrids	BSH-1, MSFH-8, KBSH-1, MSFH-17, Jwalamukhi, Sungene-85, PAC-36, PAC-1091, TCSH-1, MLSFH-47, KBSH-44, Pro. Sun.09, SH.416, DRSH-1
	Varieties	Morden, TNAUSUF-7, CO-1, CO-2, DRSF-108, DRSF-113, COSFV-5

More than 90% area of sunflower is under hybrid cultivation, wherein, seed is replaced every year. Being a highly cross pollinated crop, seed of varieties/composite also need to be replaced every year. However, farm save seed, which is based on mass selection, is used by the farmers in case of composite varieties.

► 6.9 Best Practices

6.9.1 Soils

Sunflower performs well on a wide range of soils such as sandy loams, black soils and alluviums. Nevertheless, it does best on fertile, well-drained neutral soils. As a rainfed crop during *Rabi* season, sunflower can profitably be cultivated in moisture retentive soils like Vertisols. The ideal pH is around 6.5-8.0. It can tolerate slight alkaline conditions but not acidity.

6.9.2 Sowing Time

Although sunflower is recommended for cultivation in all the seasons, its performance is superior in *Rabi* or spring/early summer. Sowing time should be decided in such a way that the flowering and seed filling stages of the crop do not coincide with continuous rainy period or high temperatures above 38°C. State/season wise recommended sowing time for sunflower is shown in Table 54.

TABLE 54: RECOMMENDED SOWING TIME FOR SUNFLOWER

State	<i>Kharif</i>	<i>Rabi</i>	Summer
Maharashtra	July 1 st week	1 st FN of October	Last week of January to First week of February.
Karnataka	July	2 nd FN of September to 1 st FN of October	January to 1 st FN of February.
Tamil Nadu	July 15	November 1	February 15
Andhra Pradesh	July 10 to August 20	2 nd FN of November	-
Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, Odisha and Chhattisgarh	-	-	End of January to February.

6.9.3 Seed Bed Preparation

Sunflower requires well prepared seed bed for better germination, establishment and growth.

6.9.4 Seed Rate

Normally, a seed rate of 5 kg/ha is adequate to achieve the required plant population given in Table 55. However, seed rates of 6-7 kg/ha is suggested for rainfed.

TABLE 55: RECOMMENDED SPACING FOR SUNFLOWER

Soil	Spacing (cm)	Optimum plant population/ha
Light	45 x 30	74,000
Heavy	60 x 30	55,000

6.9.5 Seed Treatment

Seed should be treated with Thiram or Captan @ 2-3 g/kg of seed to protect from seed-borne diseases. Seed treatment with Metalaxyl @ 6 g/kg can protect the crop against downy mildew disease. Treat the seed with Imidacloprid @ 5 g/kg before sowing against insect vectors for the necrosis management. For quick germination and better stand in dryland conditions, soaking of seeds in fresh water for about 10 hours is also recommended.

6.9.6 Thinning

Maintenance of optimum population by judicious thinning at 10-15 days after germination to retain single healthy plant per hill is essential for obtaining optimum yields. Additional yield advantage from 18 to 23% is recorded.

6.9.7 Manures and Fertilizers

Sunflower is an exhaustive crop and for every tonne crop removes as much as 63.3 kg N, 19.1 kg P₂O₅, 126.2 kg K₂O, 11.7 kg S, 68.3 kg Ca, 26.7 kg Mg, 47g Zn and 1075 g Fe. Inadequate or imbalanced use of fertilizer has been one of the critical constraints in sunflower production. Incorporate 7-8 t/ha of well decomposed FYM 2-3 weeks prior to sowing. Apply recommended levels of nutrients based on soil test values. The State wise Fertilizer recommendations are given in Table 56.

TABLE 56: STATE WISE FERTILIZER RECOMMENDATION FOR SUNFLOWER

State	Fertilizer (kg/ha)		
	N	P ₂ O ₅	K ₂ O
Andhra Pradesh			
Rainfed	60	60	30
Irrigated	60	90	30
Karnataka			
Rainfed	50	25	25
Irrigated	60	75	60

State	Fertilizer (kg/ha)		
	N	P ₂ O ₅	K ₂ O
Maharashtra			
Rainfed	40	60	0
Irrigated	60	95	60
Tamil Nadu			
Rainfed	40	20	20
Irrigated	60	90	60
Uttar Pradesh, Punjab, Bihar and Haryana			
	80	60	40
Rice fallow situation			
Rainfed	80	60	40
Irrigated	40	40	20
West Bengal, Bihar, Odisha, Chhattisgarh, Madhya Pradesh			
Irrigated	80	60	40

6.9.8 Use of Sulphur

Sulphur is emerging as fourth major nutrients especially for oilseeds due to its involvement in oil synthesis. S deficiency is widespread across soil types and crops. Sunflower has been found responsive to direct and residual sulphur fertilisation.

6.9.9 Boron Application

Among different micronutrients, boron is the most important for sunflower. Providing directly spray of borax (0.2% i.e. 2 g/l of water) to capitulum at ray floret opening stage increases seed filling, yield and oil content.

6.9.10 Bio-fertilizers

Seed treatment with *Azospirillum* and/or *Azotobacter* can save 50% recommended nitrogen fertilizers. Similarly, use of PSB in sunflower – sorghum cropping system can meet 50% of P requirement of sorghum (30kg P₂O₅/ha).

6.9.11 Irrigation Management

Critical stages of sunflower for irrigation are given in Table 57.

TABLE 57: CRITICAL STAGES OF IRRIGATION IN SUNFLOWER

Stage	Days after planting	
	Short duration varieties	Long duration varieties
Bud initiation	30-35	35-40
Flower opening	45-50	55-65
Seed filling	55-80	65-90

6.9.12 Weeding and Inter-Culture

Provide two hoeings followed by one hand weeding at an interval of 15 days commencing from 15-20 DAS. Alternatively, use of alachlor or pendimethalin or fluchloralin at the rate of 1.0 kg ai/ha in 600 litres of water as pre-emergence spray on the same evening after sowing (ensure enough soil moisture at the time of weedicide spray) followed by one hand weeding and interculture at 35 DAS provide effective control of weeds. Application of pendimethalin @ 1.0kg ai/ha as pre-emergence followed by interculturing at 21 DAS and hand weeding at 40 DAS was effective and profitable resulting in a B:C ratio of 2.98.

6.9.13 Role of Bee Keeping in Sunflower

Honey bees play a very important role in increasing seed set in sunflower. Maintaining 5 hives/ha provides optimum requirement, besides yielding valuable honey. Avoid spray of insecticide at the blooming period as it affects the visit of pollinators (bees). If absolutely essential, spray or dust in the evenings after 3 P.M. preferably with relatively safer insecticides like endosulfan or phosalone.

6.9.14 Seed Setting and Filling

It is generally seen that the seed filling under good management conditions is around 75%. Apart from genetic factors, environmental factors greatly influence the seed setting and filling in sunflower. Some of the factors attributing to poor seed filling are listed as under:

- Higher seed filling during *Rabi*/summer than *Kharif* season.
- Application of $MgSO_4$ has shown increased seed filling as well as seed yield.
- Boron application at ray floret opening stage improved seed set, filling percent, test weight, yield and quality.
- Availability of pollinators viz., honey bees also affects the seed setting and seed yield.

6.9.15 Crop Protection

The major insect pests/diseases and their management are given in Table 58 & Table 59.

TABLE 58: INSECT PESTS OF SUNFLOWER AND THEIR MANAGEMENT

Insect Pests	Pest Management Practices
I. Seedling Pests	
Cut Worm (<i>Agrotis</i> sp.)	<ul style="list-style-type: none"> Sow the seeds on slopes of ridges (6-8 cm height) Apply Chlorpyrifos (20 EC) @ 3.75 l/ha to soil with irrigation water.
Grasshoppers (<i>Attractomorpha crenulata</i>)	Follow clean cultivation by keeping bunds and fields weed free. Apply methyl parathion 2% dust @ 25 kg/ha.
II. Sucking Pests	
Leaf Hopper(<i>Amrasca biguttula biguttula</i>) White fly(<i>Bemesia tabaci</i>) Thrips (<i>Scirtothrips dorsalis</i> and <i>Thrips</i> sp.)	<ul style="list-style-type: none"> Seed treatment with Imidacloprid 70 WS @ 5 g/kg of seed. Apply Imidacloprid 200 SL @ 0.1 ml/l of water at 15-20 days interval. Spray with Phosphamidon (0.03%) or Dimethoate (0.03%) or Monocrotophos (0.05%).
III. Foliage Pests	
Tobacco Caterpillar(<i>Spodoptera litura</i>) Bihar Hairy Caterpillar(<i>Spilosoma obliqua</i>) and green Semilooper (<i>Thysanoplusia orichalcea</i> and <i>Trichoplusia ni</i>)	<ul style="list-style-type: none"> Spray neem seed kernel extract (NSKE) 5% or Endosulfan (0.07%) or Dichlorvos (0.05%) or Fenitrothion (0.05%) in 500-700 lit of spray solution/ha or dust Methyl Parathion (2%) @ 25 kg/ha.
IV. Capitulum Borer	
(<i>Helicoverpa armigera</i>)	<ul style="list-style-type: none"> Spray <i>Bacillus thuringiensis</i> @ 2 l/ha or <i>Helicoverpa</i> NPV @ 250 LE/ha or Endosulfan (0.07%) or Monocrotophos (0.05%) or Fenvalerate (0.005%) or Profenophos @ 0.05% in 500-700 l of spray solution/ha.
V. Mealy Bugs	
	<ul style="list-style-type: none"> Spray Dichlorvos 76 EC (0.05%).

TABLE 59: DISEASES OF SUNFLOWER AND THEIR MANAGEMENT

Disease/causal organism	Management Practice/Control
I. Alternaria Blight and Leaf Spot	
(<i>Alternaria helianthi</i>)	<ul style="list-style-type: none"> ▪ Treat the seed with Captan/Thiram @ 2.5 g or Carbendazim 1.0 g/kg seed. ▪ Early planting (<i>Kharif</i>) escapes the disease. ▪ Spray the crop with Mancozeb (0.3%), 3-4 times at 15 days interval or rovril (0.05%) 2 sprays at 15 days interval.
II. Rust	
(<i>Puccinia helianthi</i>)	<ul style="list-style-type: none"> ▪ Removal and destruction of crop residues, volunteer sunflower plants reduce the disease severity. ▪ Foliar spray with Mancozeb/Zineb 0.2% or calixin 0.1% at 30 days interval.
III. Downy Mildew	
(<i>Plasmopara halstedii</i>)	<ul style="list-style-type: none"> ▪ In endemic areas avoid continuous sunflower growing, follow 3-4 yearly crop rotation. ▪ Early sowing, shallow planting escapes from the disease. ▪ Treat the seed with Metalaxyl 35 SD @ 6 g/kg of seed and followed by foliar spray of Metalaxyl/Ridomyl). ▪ In disease prone areas use resistant hybrids such as LDMRSH-1 and LDMRSH-3.
IV. Sclerotium Wilt	
(<i>Sclerotium rolfsii</i>)	<ul style="list-style-type: none"> ▪ Seed dressing with Captaf/Carboxin 3-6 g/kg of seed. ▪ Adding of soil amendments and antagonistic fungi such as <i>Trichoderma harizanum</i> incorporated into soil reduces the disease incidence. ▪ Crop rotation for 3-4 years to be adopted. ▪ Avoid moisture stress/water logging conditions in the field.
V. Charcoal Rot	
(<i>Macrophomina phaseolina</i>)	<ul style="list-style-type: none"> ▪ Seed treatment with Thiram 3 to 4 g/seed. ▪ Avoid moisture stress during high summer. ▪ Follow deep ploughing in summer and crop rotation.
VI. Head Rot	
(<i>Rhizopus arrhizus</i>)	<ul style="list-style-type: none"> ▪ Spray with Copper Oxychloride @ 0.4% or Mancozeb 0.3% combined with Endosulfan (0.05%) at 50% flowering stage.

Disease/causal organism	Management Practice/Control
VII. Sunflower Necrosis Disease	
	<ul style="list-style-type: none"> Follow clean cultivation and remove weeds specially <i>Parthenium</i>, <i>Commelina</i> etc. both from inside and neighbouring fields. Seed treatment with Imidacloprid @ 5 g/kg of seed against insect vectors. Give prophylactic spray 2-4 times at 15-30 days interval with Imidacloprid (confidor) (0.01%) for vectors control.

6.9.16 Harvesting and Threshing

Sunflower can be harvested at physiological maturity when the back of the head turns to lemon yellow colour and the bottom leaves start drying and withering. A list of improved threshers developed by various State Agricultural Universities/ICAR Institutions is given in **Table 60**. Dry the seed before storage so as to bring the moisture content to around 9-10%.

TABLE 60: LIST OF SUNFLOWER THRESHERS

Implements Name	Developed by
APAU Sunflower Thresher	ANGRAU
PAU Axial Flow Sunflower Thresher	PAU
Phule Sunflower Thresher	MPKV
Sunflower Seed Sheller	TNAU
Sunflower Thresher	PAU

► 6.10 Marketing Support

Sunflower is covered under Minimum Support Price (MSP) declared by Government of India. National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED) is the Nodal agency for organising procurement of sunflower under Price Support Scheme (PSS). Procurement is undertaken when the prices of sunflower fall below the MSP. The year wise details of MSP, average market price and quantity of sunflower procured by NAFED during the last 05 years given in **Table 61** indicates that price of sunflower quite often fall below the MSP.

TABLE 61: QUANTITY AND VALUE OF SUNFLOWER PURCHASED ON MSP

Year	MSP (₹/qtls)	Avg. Market price	Quantity procured in MTs	States
2007-08	1510	Nil	Nil	
2008-09	2215	2533	10342	Karnataka, Maha, AP
2009-10	2215	1978	3376	Mah, Karnataka, Har, AP
2010-11	2350	2104	845	Haryana, Odisha
2011-12	2800	2759	-	
2012-13	3700	2932	-	

► 6.11 Nutritive Values

It is considered to be one of the healthiest oil with an ideal ratio of poly-unsaturated (linoleic) fatty acid (44-75%) and mono-unsaturated (oleic) fatty acid (14-35%). Therefore, it is a preferred cooking oil in India. Total imported vegetable oil (10.38 million tonnes) includes about 1 million tonnes of sunflower oil during 2012-13. Sunflower oil was so expensive that brands tended to blend cheaper soya oil in it. Change of duty structure on import of crude sunflower oil from 65% (24.01.2007) to 0% (01.04.2008) and 2.5% (23.1.2013) has made such blending unnecessary. Russia and Ukraine have largest stake in import of sunflower oil to India.

Being a rich source of linoleic & oleic acid and presence of Vitamin-A, roasted sunflower seeds are also used as snacks. During 2012-13 around 5000 tonnes of sunflower seed was exported with a value of ₹ 43.74 crore. There are several other uses of sunflower seeds and other plant parts as given in Table 62.

TABLE 62: USES OF SUNFLOWER PRODUCTS AND BY-PRODUCTS

Product/By-product	Usage
Immature seed	Feed for poultry
Latex from leaves	Source of rubber
Ray florets	Yellow dye extracted for dye industry
Flower	Source of nectar and pollen for honey
Stalks	Raw material for paper industry
Thalamus after de-seeding	Used for complete feed for Mulch animals
Sunflower seed/kernel	Confectionary industry
Deoiled meal	Animal feed

► 6.12 Researchable Issues

- Development of early maturing sunflower hybrids for rice fallow areas.
- Development of resistance for biotic stresses such as *Alternaria helianthi*, Powdery Mildew and Sunflower Necrosis Disease.
- Development of Integrated Pest Management package for *Alternaria*, SND and Headborer in sunflower.



CHAPTER 7

SAFFLOWER



►7.1 Crop Description

Safflower (*Cartamus tinctorius* L) belongs to family Asteraceae. Plant is highly branched, herbaceous, thistle-like annual, varying in height from 30-150 cm. Leaves are spiny or non-spiny. Inflorescence is broad, flat or slightly carved and densely bristled owing to the presence of numerous floral bracts. It is cross pollinated.



Safflower crop at flowering stage

►7.2 Centre of Origin

Safflower is believed to be originated in an area bounded by the eastern Mediterranean and Persian Gulf, encompassing southern parts of former USSR, Western Iran, Iraq, Syria, Southern Turkey, Jordan and Israel.

►7.3 Climatic Requirement

Safflower is more or less a day-neutral plant but it is thermosensitive. The crop is tolerant to low temperature at seedling and vegetative stages. Safflower comes up better in relatively drier areas. Frequent and prolonged rains and heavy dew at flowering stage adversely affect pollination, seed development and causing dis-colouration of the seed. There is no germination below 20°C. The optimum temperature at flowering is between 24° and 32°C, however, adequate soil moisture reduces the adverse effect of high temperature. High temperature also tends to decrease seed weight. In India safflower is mostly cultivated between 14 and 22°N and 73.5 and 79°E during the *Rabi* season (September/October to March/April).

►7.4 Global Scenario

Safflower is cultivated by more than 20 countries on an average area (2007-12) of 7.30 lakh ha with a production of 6.27 lakh tonnes and productivity of 859 kg/ha. India has largest coverage but the lowest yield among the major safflower producing countries. The details of average area, production and yield in major safflower producing countries in the world is given in Table 63.

TABLE 63: AVERAGE AREA, PRODUCTION AND YIELD OF SAFFLOWER IN MAJOR CROP GROWING COUNTRIES

<i>(Area: lakh ha, Production: lakh tonnes, Yield: kg/ha)</i>				
Crop	Major countries	Area	Production	Yield
Safflower	India	2.794	1.777	636
	USA	0.669	1.047	1564
	Mexico	0.740	1.029	1390
	Kazakhstan	1.145	0.756	660
	Argentina	0.721	0.557	772
Total Safflower (World)		7.298	6.272	859

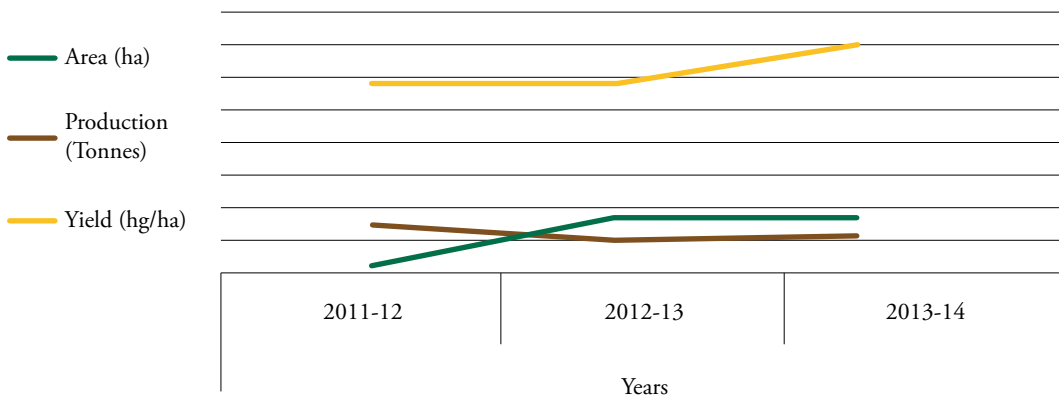
►7.5 National Scenario

Karnataka and Maharashtra are the major safflower growing states, which contribute >90% of India's production of safflower. The area under safflower cultivation is declining year-after-year. An area of only 1.78 lakh ha was covered under safflower during 2013-14 as against average area of 2.79 lakh ha during 11th Plan. The State wise area, production and yield of major safflower producing states is given in Table 64.

TABLE 64: AVERAGE AREA, PRODUCTION AND YIELD OF SAFFLOWER IN MAJOR CROP GROWING STATES

State	Area in lakh ha			Production in lakh tonnes			Yield kg/ha		
	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
AP	0.10	0.10	0.08	0.07	0.07	0.05	700	700	625
Gujarat	0.60	0.18	0.15	0.35	0.11	0.09	583	611	600
Karnataka	0.55	0.45	0.45	0.35	0.23	0.37	636	511	822
Maharashtra	1.23	0.90	1.07	0.67	0.49	0.61	545	544	570
Others	0.02	0.07	0.03	0.01	0.08	0.02	500	1143	667
All India	2.50	1.70	1.78	1.45	0.98	1.14	580	576	640

Trends of Area, Production and Yield of Safflower



► 7.6 Potential Districts

More than 50% area and production of safflower comes from 5 potential districts namely Parbhani, Usmanabad, Hingoli, Latur and Jalna of Maharashtra and 2 districts namely Bidar and Gulbarga of Karnataka. Detail of the districts is given at *Annexure-XI*.

► 7.7 New/Non-Traditional Areas

Being a hardy crop, safflower has a good scope for area expansion under residual soils of paddy fallows in Chhattisgarh, Eastern UP, Odisha, West Bengal and after soybean in Bundelkhand Region and Malwa Plateau of Madhya Pradesh.

► 7.8 Yield Gap

The National and International scenario given in **Table 62 & 63** indicates an yield gap of >21% over World Average and >100% yield gap over highest yield of 1564 kg/ha in USA. FLD organized by Institutions of ICAR/SAUs during *Rabi* 2012-13 indicates an average yield gap of 109% over National Average Yield (NAY) and 21% to 300% over SAY under irrigated/rainfed conditions in the safflower growing States (**Table 65**), which could be minimized by adoption of improved package of practices including application of protective irrigation.

TABLE 65: YIELD GAPS RECORDED UNDER FLDS OF SAFFLOWERS

State	Yield kg/ha		Yield gap %
	SAY	FLD	
Rabi 2012-13 (Irrigated)			
AP	700	1214	73
Chhattisgarh	667*	976	46
Maharashtra	544	1079	98
UP	1500	1820	21
Rabi-2012-13 (Rainfed)			
AP	700	1188	70
Karnataka	511	1116	118
MP	250	1008	303
Maharashtra	544	1038	91
UP	1500	1397	-7
All India	576	1203	109

* SAY of 2010-11

► 7.9 Cropping System

A number of productive cropping sequences are identified for various agro-ecological regions of the country as given in Table 66.

TABLE 66: CROPPING SEQUENCES FOR SAFFLOWER

State	Suggested crop sequence
Transitional tract of Karnataka (Dharwad, Belgaum and adjoining areas)	Mungbean – Safflower, Soybean – Safflower, Groundnut – Safflower
Scanty rainfall areas of Karnataka (Medium deep black soils of Bijapur & western parts of Bellary)	Hybrid Sorghum – Safflower Mungbean – Safflower
Northern Telangana of Andhra Pradesh (parts of Ranga Reddy and Mahaboobnagar district, Adilabad, Medak and Nizamabad)	Mungbean – Safflower, Maize – Safflower, Hybrid Sorghum – Safflower, Sesame – Safflower
Assured moisture areas of Maharashtra (Khandesh tract, parts of Marathwada and Vidarbha)	Mungbean – Safflower, Urdbean – Safflower, Hybrid Sorghum – Safflower, Groundnut – Safflower, Sesame – Safflower, Sunflower – Safflower

► 7.10 Varieties and Seed Scenario

A dozen of varieties/hybrids of safflower released after 2001 are given in *Annexure-XII*. These varieties/hybrids also include spineless varieties like JSF-97 and hybrid NARI-NH-1.

► 7.11 Best Practices

7.11.1 Soils

Safflower requires fairly deep, moisture retentive and well drained soils. The crop is fairly tolerant to saline conditions.

7.11.2 Seeding Time

The optimum time of seeding stipulated for different safflower growing areas is given in Table 67.

TABLE 67: STATE WISE OPTIMUM TIME FOR SEEDING

Region	Recommended seeding time
Andhra Pradesh	October
Telangana	Late September or early October
Maharashtra	Second fortnight of September to mid of October
Karnataka	Second fortnight of September.
Rainfed Irrigated	Mid September to early November
Gujarat	Last week of October to first week of November
Madhya Pradesh	Last week of September to second week of November
Chhattisgarh	Second week of October to second week of November
Odisha	Second week of September to mid October

7.11.3 Seed Rate and Spacing

The details of state wise seed rate and spacing for safflower are given in Table 68.

TABLE 68: STATE WISE SEED RATE AND SPACING FOR SAFFLOWER

Region		Seed rate (kg/ha)	Spacing (cm)
Andhra Pradesh		7.5–10	45 x 20
Maharashtra	Kharif fallows	10–12	45 x 20
	Double cropped areas	15	45 x 20

Region		Seed rate (kg/ha)	Spacing (cm)
Karnataka		7.5	60 x 30
Gujarat		10 12	45 x 20
Madhya Pradesh		20	45 x 20-25
Chhattisgarh	Rice fallows	10 15	45 x 20
Odisha	Rice fallows	20	30 x 15
Uttar Pradesh and Bihar	Adequate moisture	12-15	45 x 20
	Scanty moisture	15-20	45 x 20

7.11.4 Seed Treatment

Seeds should be treated with Thiram, Captan or Carbendizim @ 3 g/kg seed before sowing.

7.11.5 Manures and Fertilizers

The recommended levels of manures and fertilizers for different regions are given in Table 69.

TABLE 69: STATE WISE RECOMMENDED DOSES OF MANURES AND FERTILIZERS

Region		FYM (t/ha)	Fertilizer (kg/ha)		
			N	P ₂ O ₅	K ₂ O
Andhra Pradesh	Rainfed	-	40	25	-
Maharashtra					
Western Maharashtra	Rainfed	-	50	25	-
	Scarcity zone	-	25	12.5	-
Marathwada	Rainfed	-	40	20	-
	Irrigated	-	60	40	-
Vidarbha	Rainfed	5-10	25	25	
	Irrigated	5-10	50	50	-
Karnataka	Rainfed	6	35	50	-25
	Irrigated	6	75	75	35
Gujarat	Rainfed	-	25	10	-
Odisha	Rainfed	6	25	25	-
Uttar Pradesh	Rainfed	-	40	30	20
	Irrigated	-	60	30	20
Madhya Pradesh	Rainfed	-	40	40	20
Malwa tract	Irrigated	-	60	40	30
Chhattisgarh	Rainfed	-	20-30	15-20	10-15
	Irrigated	-	50-60	20-30	20

7.11.6 Irrigation and Water Management

Under scanty moisture conditions in drylands, yield can be boosted by 40 to 60% by providing just one life saving irrigation (5 to 8 cm) at critical phases of crop growth (early stem elongation or flowering) or before soil moisture becomes limiting for crop growth.

7.11.7 Crop Protection

Safflower is affected by a number of insect pests and diseases. However, aphid is a major problem under late sown conditions. The details of integrated management of insect pests and diseases of safflower are given in Table 70.

TABLE 70: INTEGRATED MANAGEMENT OF INSECT PESTS AND DISEASES OF SAFFLOWER

Insect Pest	Integrated Management
Aphids (<i>Uroleucon compositae</i> Theobald)	Avoid delayed planting. Spray Dimethoate (0.05%) or Methyl Parathion (0.05%) or Monocrotophos (0.05%) or Chlorpyrifos or Endosulfan (0.05%) or alternatively dust Quinalphos (1.5%) or Methyl parathion (2.5%) or Malathion (5%) or Endosulfan (4%) at 40 and 60 DAS. Use 500 litres of spray mixture and 20 kg dust formulation/ha. Spraying on the field borders (1.8 m around the field) is as effective as complete coverage of the field with spray for aphid management.
Alternaria leaf spot (<i>Alternaria carthami</i> Chowdhary)	Timely sowing. Avoid growing in low-lying areas and flooding under irrigation. Avoid continuous growing of safflower. Remove and destroy the diseased plants. Spray Mancozeb (0.25%) immediately after disease is noticed and repeat the spray 15 days later depending on the intensity of disease.
Rust (<i>Puccinia carthami</i> Corda)	Timely sowing. Avoid growing in low-lying areas and flooding irrigation. Avoid continuous growing of safflower. Remove and destroy the diseased plants.
Wilt (<i>Fusarium oxysporum</i> f.sp. <i>carthami</i>)	Grow wilt resistant hybrid like MRSA-521. Timely sowing. Avoid growing in low-lying areas and flooding under irrigation. Avoid continuous growing of safflower. Remove and destroy the diseased plants.
Root rot (<i>Rhizoctonia bataticola</i>)	Timely sowing. Avoid growing in low-lying areas and flooding irrigation. Avoid continuous growing of safflower. Remove and destroy the diseased plants.

7.11.8 Bird Damage

Birds, particularly parrots, pose a serious problem to safflower, which could be minimized by promoting safflower in contiguous areas.

7.11.9 Harvesting and Threshing

The crop is ready for harvest when the leaves and most of the bracteoles become dry and brown. Hand gloves may be used to protect legs and hands against spines. Effect of spines could also be minimized by harvesting of crop before rising of sun. Multi-crop threshers and combine harvester could be used for harvesting and threshing.

7.12 Nutritive Values

Safflower oil, which is sold as saffola, is considered to be most preferred oil due to rich in poly-unsaturated fatty acids (73-79% of lenoleic), which helps in reducing the blood cholesterol level. Dried red or orange flowers are sold as substitute for saffron in the markets of Middle East and are used to colour foods and beverages. The petals are also used in preparation of herbal tea in India. The flowers are also used for making dye. The stalks can be used for preparation of particle board.

7.13 Marketing

Safflower is covered under Minimum Support Price (MSP) scheme of the Government and procurement is arranged through NAFED as and when price fall below the MSP. Besides, good demand of safflower oil, export of safflower seed fetched a price of ₹ 45/- per kg as against the MSP of ₹ 28/- per kg during 2012-13. Therefore, the price of safflower seeds is generally remain higher than MSP. The year wise quantity and value of safflower exported during last 3 years is given in Table 71.

TABLE 71: YEAR WISE DETAIL OF QUANTITY AND VALUE OF SAFFLOWER SEED EXPORT

Year	Qty. (000 tonnes)	Value (₹ in crores)	Price (₹ per kg)	MSP (₹ per kg)
2010-11	10.00	28.00	28.00	16.80
2011-12	15.00	55.50	37.00	25.00
2012-13	10.00	46.75	46.75	28.00

7.14 Researchable Issues

- Development of CMS based hybrids and varieties with high oil content (35 to 38%).
- Evolve early maturing and non-spiny varieties for paddy fallows.
- Develop integrated insect pest and disease management modules

CHAPTER 8

NIGER



► 8.1 Crop Description

Niger (*Guizotica abyssinica*) is an annual dicotyledonous herb belongs to family Asteraceae. The plant is an erect, stout and branched. First leaf is paired, small and successive leaves are larger. The leaf margin varies from pointed to smooth and leaf colour varies from light green to dark green. The number of branches per plant varies from five to twelve and plant height of about 1.4 m. The niger flowers are yellow and rarely, slightly green and two to three capitulate grow together. The hermaphrodite disk florets are arranged in three whorls. It is categorized as a cross pollinated crop. The head produces about 40 seeds. The embryo is white. The crop is capable to grow well under low soil fertility and moisture stress.



Niger crop is at flowering stage

► 8.2 Crop History and Origin

Cultivation of the plant originated in the Ethiopian highlands and has since spread from Malawi to India.

► 8.3 Climatic Requirement

Niger require moist soil to grow properly. It grow well under light black soils or brownish loam with sufficient depth but it can also be grown on well drained heavy soils or rocky laterite soils. It requires moderate annual rainfall between 1000-1250 MM.

► 8.4 Global Scenario

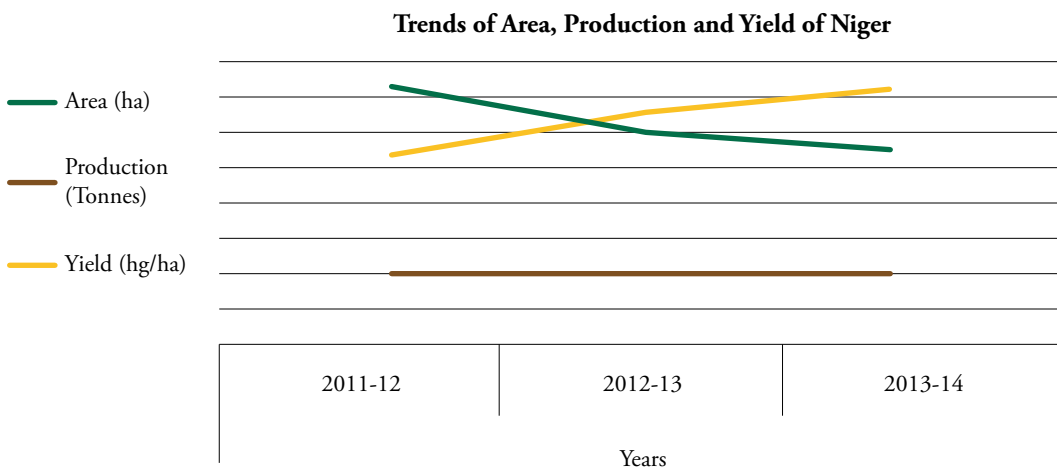
Niger is grown as an oilseeds in Ethiopia, Germany, West Indies, Brazil, Maxico, China, Nepal, Myanmar and India.

► 8.5 National Scenario

Niger is grown over an area of about 3 lakh ha in India in 10 States, with larger area in Chhattisgarh, MP, Maharashtra and Odisha. It is considered as a tribal crop and mostly grown traditionally with low input application and without much care. Area under niger indicates a declining trends during last 3 years. The State wise Area, production and yield of niger is given in Table 73.

TABLE 73: STATE WISE AREA, PRODUCTION AND YIELD OF NIGER

State	Area in lakh ha			Production in lakh tonnes			Yield kg/ha		
	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
AP	0.07	0.08	0.09	0.03	0.06	0.04	429	750	444
Assam	0.08	0.08	0.08	0.04	0.04	0.04	500	500	500
Chhattisgarh	0.69	0.64	0.65	0.12	0.11	0.12	174	172	185
Gujarat	0.1	0.07	0.16	0.03	0.02	0.05	300	286	313
Jharkhand	0.06	0.05	0.03	0.02	0.02	0.02	333	400	667
Karnataka	0.21	0.14	0.11	0.07	0.05	0.03	333	357	273
MP	1.18	0.87	0.74	0.21	0.3	0.25	178	345	338
Maharashtra	0.37	0.28	0.22	0.12	0.08	0.08	324	286	364
Odisha	0.86	0.76	0.65	0.32	0.27	0.23	372	355	354
WB	0.04	0.04	0.04	0.02	0.03	0.02	500	750	500
All India	3.64	3.01	2.77	0.98	0.99	0.89	269	329	321



► 8.6 Potential Districts

Chhattisgarh, MP, Maharashtra and Odisha contributes >75% of niger production in the country. This production largely comes from 12 districts of these States. District wise details are given in *Annexure-XIII*.

► 8.7 Yield Gap

Limited choice of high yielding varieties, use of farm saved seeds and low input application are the majoe factors attributing to low yield in almost all the states. However, FLDs conducted by the institutes if ICAR including SAUs during *Kharif* 2012-13 indicates an average yield gap of 31% over NAY and yield gap of 18-48% over SAY in the States of Jharkhand, MP and Maharashtra as indicated in the **Table 74**.

TABLE 74: YIELD GAPS RECORDED UNDER FLDS OF NIGER

State	Yield kg/ha		Yield gap %
	SAY	FLD	
Kharif 2012-13 (Irrigated)			
Jharkhand	400	471	18
MP	345	498	44
Maharashtra	286	422	48
Odisha	355	332	-
All India	329	431	31

► 8.8 Cropping System

Generally, niger is grown as *Kharif* and late *Kharif* crop. Since, niger is largely grown by the tribal/small/marginal farmers, it is largely cultivated in the crop sequences of short duration millets and pulses. Some of the common crop sequences followed by the niger growing farmers are given in Table 75.

TABLE 75: SEQUENCE CROPPING IN DIFFERENT STATES

State	Crop sequence
Madhya Pradesh/Chhattisgarh	Early Urd – Niger
Maharashtra	Early Ragi – Niger
	Horsegram – Niger
Odisha	Littlemillet – Niger
	Early Ragi – Niger
	Frenchbean – Niger
Jharkhand/Bihar	Early Rice – Niger
	Littlemillet – Niger
	Early Ragi – Niger
	Urdbean – Niger

Niger is also grown as a mixed/inter-crop largely with millets and pulses. The state wise feasible intercropping systems are given in Table 76.

TABLE 76: STATE WISE INTER CROPPING SYSTEM

State	Intercropping	Row ratio
Madhya Pradesh	Niger + Kodo/Kutki/Pearlmillet/Moongbean	2:2
Maharashtra	Niger + Ragi/Horsegram/Ricebean	2:2 or 4:2
	Niger + Pearlmillet	3:3
Odisha	Niger + Ragi/Urdbean	2:2 or 4:2
	Niger + Ricebean/Cowpea/Frenchbean	4:2
Bihar	Niger + Ragi/Urdbean	2:2
	Niger + Redgram	3:2
	Niger + Ricebean	4:2
AP	Niger + Cowpea	4:2
Karnataka	Niger + Groundnut	3:6
	Niger + Ragi	1:1

► 8.9 Varieties and Seed Scenario

Project coordinated unit of Sesame and Niger is entrusted with the task of crop improvement of niger. Due to limited genetic variability, development of high yielding varieties in case of niger is much slow than any other oilseed crops. Only 10 varieties of niger have been released during 2001-2010. Details of these varieties are given in *Annexure-XIV*. Out of these varieties, JNC-6, JNC-9, Utkal niger-150 and BNS-10 are in demand in niger growing States but non-availability of seeds of these varieties is a major area of concern. The task of seed production of niger may be assigned to Central Seed Agencies. The State wise list of farmer preferred varieties of niger are given in Table 77.

TABLE 77: STATE-WISE FARMERS PREFERRED VARIETIES OF NIGER

State	Varieties
Madhya Pradesh/Chhattisgarh	JNC-6, JNC-1, JNC-9
Maharashtra	IGP-76, IGP-2004-1 (Phule Karala-1)
Karnataka	RCR-317, RCR-18, KBN-1
Odisha	GA-10, Utkal niger-150
Jharkhand	Birsa Niger-1, Birsa Niger-2, BNS-10
Gujarat	Gujarat Niger-1, NRS-96-1
Tamil Nadu	Paitur-1

► 8.10 Best Practices

Niger is sown under rainfed situations in *Kharif* and *Rabi* seasons as a sole crop or mixed with little millet, ragi, bajra, groundnut or pulse crops in different states. Agronomic practices are summarized as under:

8.10.1 Soil

Niger is adapted to a wide range of soil types from clay loam to sandy loam, sandy and gravelly soil, however, it thrives best on well drained, loamy soils of good depth and texture with pH range of 5.5 to 6.5. It can withstand slight alkalinity and salinity also.

8.10.2 Time of Sowing

Appropriate sowing period for different states is given in Table 78.

TABLE 78: STATE WISE SOWING PERIOD

State	Optimum time of sowing
MP/Chhattisgarh	Third week of July to second week of August
Maharashtra	July and continue to early September
Odisha	Second fortnight of August to first week of September
Bihar/Jharkhand	Second fortnight of August to first week of September
Andhra Pradesh	Second week of August
Gujarat	July-August
Karnataka	July-August

8.10.3 Seed Rate

Generally 5 kg/ha seed is required for the sole crop.

8.10.4 Seed Treatment

Seed should be treated with Thiram or Captan 3.0 g/kg seed before sowing. Seed treatment with Phosphorus Solubilising Bacteria (PSB) 10 g/kg seed gives higher yield.

8.10.5 Sowing Method

The crop is largely sown by broadcasting. However, line sowing has been found beneficial with spacing of 30x10 CMS. Seeds are mixed with sand/powdered FYM/ash to increase the bulk, 20 times to ensure even distribution of seed.

8.10.6 Nutrient Management

The crop is mostly grown on marginal and submarginal land without manure or fertilizer application. However, application of recommended N through urea + seed treatment with PSB 10 g/kg seed enhances yield significantly. Application of sulphur (20-30 kg/ha) increases seed yield and oil content in niger. The details of state wise recommended dose of fertilizer are given in Table 79.

TABLE 79: STATE WISE RECOMMENDED DOSE OF FERTILIZER

State	Recommended dose of fertilizer
Madhya Pradesh	10 kg N + 20 kg P ₂ O ₅ /ha at sowing and 10 kg N/ha 35 DAS.
Maharashtra	Four tonnes of FYM and 20 kg N/ha at sowing.

State	Recommended dose of fertilizer
Odisha	20 kg N + 40 kg P ₂ O ₅ /ha at sowing and remaining 20 kg N/ha at 30 days after sowing.
Bihar/Jharkhand	20 kg N + 20 kg P ₂ O ₅ + 20 kg K ₂ O + 15 kg ZnSO ₄ as basal.
Andhra Pradesh	Five tonnes of FYM and 10 kg N/ha at sowing.
Karnataka	g N + 20-40 kg P ₂ O ₅ + 10 kg K ₂ O/ha at sowing.

8.10.7 Weeding

First weeding is needed 15-20 days after sowing. In Odisha, *Cuscuta* (*Cuscuta hyalina*/ *C. chinensis*) infestation has become a major problem. Seed should be obtained from *Cuscuta* free areas. *Cuscuta* seeds could be separated with a 1 mm sieve.

8.10.8 Plant Protection

The major insect pests and diseases and their management are given in Table 80 & 81.

TABLE 80: INSECT PESTS AND THEIR MANAGEMENT

Common name	Nature of damage	Management/control
Niger Caterpillar (<i>Condica conducta</i>)	The Caterpillar green with purple markings, feeds on leaves and defoliates the plants.	Proper weeding reduces hiding places. Dusting with 4% Phosalone or 5% Carbaryl 20-25 kg/ha or spray Endosulfan 0.07%, or Dichlorvos 0.05%.
Cutworm (<i>Agrotis ipsilon</i>)	The moth hides under dried twigs during day time and lays eggs on leaves. Larvae attack the crop and plants at ground level.	Keep grass bundles or crop refuges in cluster in field for the caterpillars to hide during evening and collect the caterpillar early in the morning and kill them by dusting 4% Phosalone or 5% Carbaryl. Spray with Endosulfan (0.07%).
Bihar Hairy Caterpillar (<i>Spilosoma obliqua</i>)	The Caterpillars remain gregarious under sheath leaves in early stages	Collection and destruction of egg masses and early instars of caterpillars. Spray Dichlorvos 0.05%. Dusting with 4% Phosalone or 5% Carbaryl 20-25 kg/ha.
Surface Grasshopper (<i>Chrotogonus sp.</i>)	These are usually active in early stage of the crop.	Dusting with 4% Phosalone or 5% Carbaryl 25 kg/ha can control the pest in early stage.

Common name	Nature of damage	Management/control
Aphids (<i>Uroleucon carthami</i>)	This is one of the sucking pest of niger during later period of crop growth.	Spray Dimethoate 0.03% or Methyl Demeton 0.025%.
Semilooper (<i>Plusia orichalcea</i>)	The semilooper feeds on the leaves and defoliates the plant.	As recommended in case of Hairy Caterpillar.
Niger Capsule Fly (<i>Dioxya sarorcula</i>)	Maggot feeds on seed and pulp inside the capitula.	Install the light trap one per ha. Spray Endosulfan 0.07% or Acephate 0.07%.

TABLE 81: IMPORTANT DISEASES AND THEIR MANAGEMENT

Disease	Symptoms	Management
Cercospora Leaf Spot (<i>Cercospora guizoticola</i>)	Disease appears as small straw to brown coloured spots with gray centre on the leaves.	Seed treatment with Thiram (0.2%) + Bavistin (0.1%). Two foliar sprays with Bavistin (0.1%).
Alternaria Leaf Spot (<i>Alternaria sp.</i>)	Spots are brown to black with concentric rings.	Seed treatment with Thiram (0.3%). Spraying with Dithane M 45 (0.2%) at 15 days interval.
Powdery Mildew (<i>Sphaerotheca sp.</i>)	Small powdery spots appear on leaves, which gradually spread on the lamina and stem resulting in defoliation.	Foliar spray of 0.2% Wettable sulphur or Bavistin (0.1%) when disease appears.
Stem/Root Rot (<i>Macrophomina phaseolina</i>)	Infected roots are light blackish to black in colour, which are covered with black sclerotia and are brittle. The blackening extends from ground level upward on the stem giving black colour to stem.	Deep ploughing in the summer. Seed treatment with Thiram (0.2%) + Bavistin (0.1%) before sowing.
Cuscuta weed (<i>Cuscuta chinensis</i> / <i>C. hyalina</i>)	Infested plants are stunted, pale yellow with small flowers.	Removal of <i>Cuscuta</i> seed by sieving before sowing. Steeping of <i>Cuscuta</i> seed in brine solution before sowing. Pre sowing soil application of Fluchloralin (1 kg ai/ha), or Pre emergence application of Pendimethalin (1.5 kg ai/ha).

8.10.9 Harvesting

Niger usually matures in 95-105 days after sowing. The crop should be harvested when the leaves dry up and the capitula turns brownish/blackish in colour.

8.10.10 Threshing

After drying for a week by stacking, the crop is threshed by beating with sticks.

8.10.11 Post Harvest Handling

The threshed material is cleaned by winnowing. The produce is dried for quality up gradation to reach moisture content up to 8% and then stored properly.

► 8.11 Marketing/Export

Niger is covered under Minimum Support Price (MSP) scheme of the Government and procurement is arranged through NAFED as and when the prices fall below the MSP. Though, niger is considered as a poor man crop but it contains a most healthy oil with high amount of polyunsaturated fatty acid (45-66% linoleic acid) and mono-unsaturated fatty acid (13-39% oleic acid), which is desirable for maintaining balance between Omega-3 and Omega-6. The seeds are also rich in protein (10-25%), soluble sugar (12-18%) and fibre (10-20%). Niger seeds are in great demand for export, which are reported to be used as bird feed. Niger seeds of 17,09,000 tonnes was exported during 2012-13 with a value of ₹ 90.13 crores with an average price of ₹ 52.74/- per kg as against the MSP of ₹ 35/- per kg. Therefore, the price of niger seeds is generally remains higher than the MSP. The year wise quantity and value of niger seeds exported during last 3 years is given in Table 82.

TABLE 82: YEAR WISE DETAIL OF QUANTITY AND VALUE OF NIGER SEED EXPORT

Year	Qty. (000 tonnes)	Value (₹ in crores)	Price (₹ per kg)	MSP (₹ per kg)
2010-11	12.8	44.51	34.77	24.50
2011-12	28.20	117.27	41.58	29.00
2012-13	17.09	90.13	52.74	35.00

► 8.12 Researchable Issues

- Development of varieties with high seed yield, oil content.
- Development of integrated management module for *Cuscuta*.
- Development of Integrated nutrient management.
- Development of production technology for resource poor farmers.



CHAPTER 9

LINSEED



► 9.1 Crop Description

Cultivated linseed can be characterised as an annual, glabrous having one to many stems, 20-110 cm tall, leaves alternate, sessile, linear-lanceolate, about 40 mm long and 4.7 to 7.5 mm wide, acuminate and ciliate on the inner sides, pollen three colpate, styles almost free to the base, stigma clavate, capsules globose, mostly indehiscent, seeds ovate and brown or yellow in colour. Two distinct morphological types viz., seed type and flax/dual purpose type are recognized.



Linseed crop at flowering stage

► 9.2 Centre of Origin

Carbonised seeds of *Linum* spp. are known from 1600-1400 BC at Navdatoli, MP. The diversity found in India suggests that flax originated here and spread northwards and westwards. Linnacus (1857) first time gave botanical name *Linum usitatissimum* to the cultivated species. Cultivated flax is probably originated from two or more species independently, which united into one species *Linum usitatissimum* L as per polyphyletic origin hypothesis. Basically, it is an industrial oilseed crop and its each and every part is endowed with commercial or medicinal importance.

► 9.3 Climatic Requirement

Linseed is plant grown as winter crop. Moderate temperature (21-27°C) is ideal during vegetative and reproductive phase. High temperature (above 32°C) accompanies with

moisture stress during flowering stage reduces the seed yield. Linseed is cultivated in four agro-climatic zones of India viz. **Zone I:** Himachal Pradesh, Punjab, Haryana, J&K, **Zone II:** Uttar Pradesh excluding Bundelkhand, Bihar, Jharkhand, West Bengal, Assam & Nagaland, **Zone III :** Bundelkhand area of Uttar Pradesh, Madhya Pradesh & Rajasthan and **Zone IV:** Chhattisgarh, Odisha, Maharashtra & Karnataka.

► 9.4 Global Scenario

Linseed is cultivated by more than 50 countries on an average (2007-12) area of 21.28 lakh ha with a production of 18.68 lakh tonnes and productivity of 877 kg/ha. The details of average area, production and yield in major linseed producing countries is given in **Table 83**.

TABLE 83: AVERAGE AREA, PRODUCTION AND YIELD OF LINSEED OF MAJOR COUNTRIES

<i>(Area: lakh ha, Production: lakh tones, Yield: kg/ha)</i>				
Crop	Major countries	Area	Production	Yield
Linseed	Canada	4.798	6.432	1341
	China	3.409	3.252	954
	USA	1.290	1.569	1216
	India	3.799	1.571	413
	Russian Federation	1.823	1.367	750
Total Linseed (World)		21.275	18.667	877

► 9.5 National Scenario

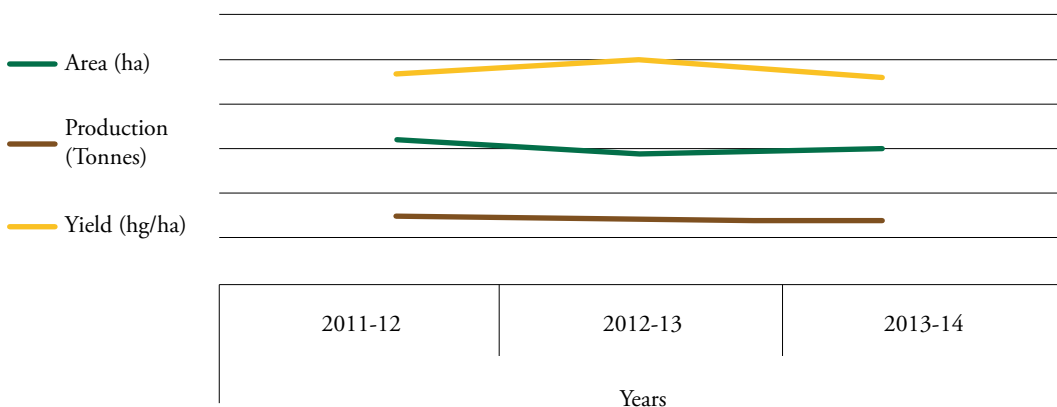
Bihar, Chhattisgarh, Jharkhand, Karnataka, MP, Maharashtra, Nagaland, Odisha, UP and WB are the major linseed growing State. Area under linseed cultivation has declined from 4.68 lakh ha (2007-08) to 3.03 lakh ha during 2013-14. However, the productivity of linseed has increased from 413 kg/ha to 462 kg/ha during the same period. The State wise area, production and productivity of linseed during last 3 years is given in **Table 84**.

TABLE 84: STATE WISE AREA, PRODUCTION AND YIELD OF LINSEED

States	Area in lakh ha			Production in lakh tonnes			Yield kg/ha		
	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
Assam	0.07	0.07	0.07	0.04	0.04	0.04	571	571	571
Bihar	0.23	0.24	0.2	0.2	0.21	0.17	870	875	850
Chhatt.	0.39	0.31	0.26	0.14	0.09	0.11	359	290	423

States	Area in lakh ha			Production in lakh tonnes			Yield kg/ha		
	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
Jharkhand	0.24	0.25	0.26	0.13	0.16	0.15	542	640	577
Karnataka	0.09	0.07	0.06	0.02	0.02	0.02	222	286	333
MP	1.2	1.1	1.02	0.57	0.57	0.53	475	518	520
Maharashtra	0.31	0.26	0.31	0.08	0.09	0.08	258	346	258
Odisha	0.25	0.25	0.23	0.12	0.12	0.11	480	480	478
UP	0.31	0.3	0.26	0.14	0.12	0.12	452	400	462
WB	0.04	0.04	0.1	0.02	0.02	0.02	500	500	200
All India	3.23	2.97	2.87	1.53	1.5	1.43	474	505	498

Trends of Area, Production and Yield of Linseed



► 9.6 Potential Districts

Maximum area of linseed is covered by 18 districts of Bihar (2), Chhattisgarh (4), MP (5), Maharashtra (3), Odisha (1) and UP (3). Details of these potential districts are given in *Annexure-XV*.

► 9.7 Cropping System

Soybean-linseed at Sagar (MP) and Raipur (Chhattisgarh) whereas, black gram – linseed followed by paddy-linseed at Kanke (Jharkhand) were observed remunerative cropping systems under rainfed situation. Under irrigated situation, maize-linseed at Palampur (HP) and paddy-linseed at Kanpur (UP) were found most profitable crop sequences. Linseed crop

may be intercropped with cereals, pulses and oilseeds of *Rabi* season very well. When linseed is intercropped with chickpea, the incidence of wilt and pod borer in chickpea is reduced. Some of the efficient intercropping systems for various states are given in Table 85.

TABLE 85: INTERCROPPING SYSTEMS IN LINSEED

State	Situation	Intercropping system
Uttar Pradesh (Excluding Bundelkhand)	Rainfed	Linseed + Chickpea/Lentil (3:1 or 1:3)
	Irrigated	Linseed + Wheat (4:2),
		Linseed + Mustard (5:1)
		Linseed + Potato (3:3)
Bundelkhand of UP	Rainfed	Linseed + Chickpea/Lentil (3:1 or 1:3)
		Linseed + Wheat (1:3)
Madhya Pradesh and Chhattisgarh	Rainfed	Linseed + Chickpea (3:1)
Bihar and Jharkhand	Rainfed	Linseed + Chickpea (3:1)
		Linseed + Mustard (5:1)
West Bengal	Irrigated	Linseed + Mustard (5:1)
		Linseed + Potato (3:3)
Maharashtra and Karnataka	Rainfed	Linseed + Chickpea (3:1 or 1:3)
		Linseed + Safflower
		(Different row ratio)
Punjab and HP	Rainfed	Linseed + Chickpea (3:1)
	Irrigated	Linseed + Mustard (5:1)
		Linseed + Wheat (4:2)

- Linseed variety Kiran at Raipur, Kiran and J-23 at Powarkheda, Janki at Palampur and Garima at Kanpur have shown better performance under inter-cropping of linseed + mustard (5:1).
- Fertilizer application under rainfed situation in linseed + safflower (4:2) intercropping system @100% RDF to main crop and 50% RDF to sub-crop on area basis was observed remunerative at Sagar.
- Fertilizer application under irrigated situation in linseed + wheat (4:2) intercrop system @100% RDF to both the crops on area basis at Palampur and Faizabad, whereas, in linseed + mustard (5:1) intercrop system @100% RDF to main crop and 50% RDF to sub-crop at Palampur recorded highest net monetary returns.

► 9.8 Yield Gap

Limited choice of high yielding varieties, use of farm saved seeds and low input application are the major factors attributing to low yield in almost all the States. However, FLDs conducted by the institutes of ICAR including SAUs during *Kharif* 2012-13 indicates an yield gap of 38-200% over SAY under irrigated condition, and yield gap of 4-155% over SAY under rainfed condition and 42-98% over SAY under Utera condition as shown in Table 86.

TABLE 86: YIELD GAPS RECORDED UNDER FLDS OF LINSEED

State	Yield kg/ha		Yield gap %
	SAY	FLD	
Rabi 2012-13 (Irrigated)			
Bihar	863	1189	38
Chhattisgarh	285	712	150
MP	523	1573	200
Maharashtra	346	950	174
UP	400	1178	195
Rabi 2012-13 (Rainfed)			
Assam	571	680	19
Bihar	863	901	4
Chhattisgarh	285	551	93
Karnataka	286	610	113
MP	523	950	82
Maharashtra	346	884	155
Odisha	482	730	51
UP	400	892	123
Rabi 2012-13 (Utera)			
Chhattisgarh	285	465	63
Odisha	482	685	42
UP	400	799	98

► 9.9 Varieties and Seed Scenario

Project coordinated unit of linseed, located at Kanpur is entrusted with the task of crop improvement of linseed. Due to limited genetic variability, development of high yielding

varieties in case of linseed is slow than other oilseed crops. Detail of varieties of linseed released during 2001-2010 is given in *Annexure-XVI*. The task of seed production of linseed may be assigned to Central Seed Agencies for promotion of new varieties. The State wise list of farmer preferred varieties of niger are given in **Table 87**.

TABLE 87: STATEWISE FARMERS PREFERRED VARIETIES OF LINSEED

State	Name of varieties
Less than 10 years old varieties	
Madhya Pradesh	Indira Alsi-32, Kartika, Suyog, Azad Alsi-1
Chhattisgarh	RLC 92, Deepika, Kartika, Indira Alsi-32, Sharda
Uttar Pradesh	Sharda, Azad Alsi-1, Ruchi
Bihar	Shival, Ruchi, Azad Alsi-1
Jharkhand	Shival, Ruchi, Azad Alsi-1
More than 10 years old varieties	
Madhya Pradesh	JLS 9, Padmini, Parvati
Chhattisgarh	J 552, Padmini
Uttar Pradesh	Shekhar, Padmini, Parvati, Garima, Shikha
Rajasthan	Meera
Bihar	Shekhar, Parvati, Shikha
Jharkhand	Shekhar, T-397, Padmini, Sweta, Shubhra

► 9.10 Best Practices

Linseed crop is under cultivation in three ecosystems namely *Utera*, rainfed and irrigated. The improved agro-techniques for linseed cultivation under these eco-systems are given below:

9.10.1 *Utera System*

Growing linseed in *Utera* system is the predominant practice of regions like Dharbhanga and Madhubani area of Bihar, Jharkhand, Mayurbhanj area of Odisha, Vidarbha region of Maharashtra, Balaghat area of MP, Eastern part of Uttar Pradesh and Kangra district of Himachal Pradesh etc. Some salient features of this system are given below:

- High yielding varieties like R552 for **zone III & IV** and Baner and Surabhi for Palampur state have been released. A dose of 10-20 kg N/ha should be applied

in standing paddy 2 or 3 days before sowing linseed. Problem of *Cuscuta* weed in Chhattishgarh, Balaghat area of MP and Vidarbha region of Maharashtra. To ensure clean cultivation, *cuscuta* seeds should be separated before sowing of linseed. *Rabi* season weeds could be managed by post emergence application of weedicides isoproturon @1.00kg/ha at 30-35 DAS. However, 2,4-D (Na) @0.5kg/ha may also be mixed in the tank with Isoproturon if broad leaf weeds are also problem. Seeding linseed @40kg/ha with the help of desi-plough alongwith *Navagaon nari* attachment may be an alternative of *Utera* system of cultivation in Chhattishgarh.

9.10.2 Rainfed Eco-System

The linseed is predominantly grown under rainfed situation. The research achievements for rainfed eco-system are given below:

- Application of fertilizer @ 40 kg N + 20 kg P_2O_5 and 20 kg/ha K_2O has been found quite beneficial in increasing yield of this crop in rainfed eco-system at various locations. Application of Sulphur @15 kg/ha to linseed has been observed to enhance linseed yield in many areas.

9.10.3 Irrigated Eco-System

Seed type linseed

- Application of fertilizer @ 60 kg N + 20-40 kg P_2O_5 and 20-30 kg K_2O per hectare has been found very effective in increasing the seed yield.
- Application of Sulphur @ 20-30 kg/ha to linseed and Zinc through $ZnSO_4$ @ 25 kg/ha either of the crop in rotation proved useful. Post emergence application of Isoproturon @ 1.00 kg/ha and 2,4-D @0.5 kg/ha could control weeds effectively. Seed inoculation with *Azotobactor* was found beneficial at different locations. Application of FYM @5 t/ha in *Kharif* crop was found quite effective to increase linseed yield at various locations. Integrated nutrient management module 75% RDF + 5 t FYM + 5 kg zinc through $ZnSO_4$ + 25 kg/ha Sulphur either with or without biofertilizer (*Azotobactor* + PSB) was found quite effective in increasing linseed yield and soil health.

Dual Purpose (DP) linseed

Dual purpose linseed can be grown successfully in Kangra district of Himachal Pradesh, Indogangetic plains and irrigated areas of Bundelkhand of UP, Tawa command area of

MP and Kota command area of Rajasthan. The recent advances for the cultivation of such type of linseed are given below:

- A seed rate of 45 kg/ha for Indogangetic plains of UP and Tawa command area of MP, 55 kg/ha for irrigated areas of Bundelkhand of UP and 62.5 kg/ha for Himachal Pradesh were found optimum.
- The crop could be sown successfully during October to first fortnight of November depending upon the soil moisture and irrigation facilities.
- Fertilizer application @ 80 kg N + 30 kg P₂O₅ + 30 kg K₂O has been found optimum.
- Finest fibre with flax (Vr Ariane) could be obtained when harvested at 50% flowering stage but without seed.
- The details of Agronomical Practices for linseed in different crop growing situations are given in **Table 88**.

TABLE 88: AGRONOMICAL PRACTICES FOR LINSEED IN DIFFERENT CROP GROWING SITUATIONS

State	Situation	Recommended Varieties	Optimum time sowing	Spacing (cm)	Seed rate (kg/ha)	Fertilizers N:P (kg/ha)
Assam	Rainfed	Shekhar, Sweta, Shubhra, T397	I st fortnight of October	25	30	40:20
	Irrigated	Shekhar, Garima, Shubhra	II nd fortnight of October	25	25-30	60-80:30
	DP	Rashmi, Meera, Shikha, Gaurav, Parvati, Ruchi	I st week of November	20	45	80:30
Bihar	Rainfed	Shekhar, Sweta, Shubhra, T397	Mid October	25	30	40:20
	Irrigated	Shekhar, Garima, Shubhra	II nd fortnight of October	25	25-30	60-80:30
	DP	Rashmi, Meera, Shikha, Gaurav, Parvati, Ruchi	II nd fortnight of October	20	45	80:30
Chhattisgarh	Rainfed	Indira Alsi-2, Sharda, Deepika, Padmini, Mau Azad Alsi2	I st fortnight of October	25	25-30	30:15
	<i>Utera</i>	R552, Kartika, Padmini, Kiran, T397	I st to 3 rd week of October	Broad cast	35-40	10-20:00
	Irrigated	Suyog, JLS-9, J23 T397, RLC92	Mid October.	25	25-30	60-80:30

State	Situation	Recommended Varieties	Optimum time sowing	Spacing (cm)	Seed rate (kg/ha)	Fertilizers N:P (kg/ha)
Haryana	Irrigated	Binwa, Himalini, LC-54	II nd fortnight of Oct. to I st week of November	25	20-25	60-80:30
	DP	Nagarkot, Jeevan	II nd fortnight of Oct. to I st week of November	20	45	80:30
HP and J&K	Rainfed	Surabhi, Janki, Sheela	II nd fortnight of October	25	25-30	40:20
	<i>Utera</i>	Baner, Surabhi, Himalini, Bhagsu	October	Broad cast	50-60	20:00
	Irrigated	Binwa, Janki, Himalini, LC-54	II nd week of Oct. to I st fortnight of November	25	25-30	60-80:30
	DP	Nagarkot, Jeevan	Mid October	20	65-75	90:30
Jharkhand	Rainfed	Shekhar, Sweta, Shubhra, T397	Mid October	25	30	40:20
	Irrigated	Shekhar, Garima, Shubhra, T397	I st fortnight of October	25	25-30	60-80:30
	DP	Rashmi, Meera, Shikha, Gaurav Parvati, Ruchi	I st fortnight of October	20	45	80:30
Karnataka	Rainfed	Indira Alsí-2, Padmini, Kiran, Sharda, Mau Azad Alsí2	Up to I st week of October	25	25-30	40:20
	Irrigated	Suyog, J-23	Up to Mid Oct.	25	25-30	60-80:30
MP	Rainfed	Padmini, Kiran, T-397, JLS9, SLS67 SLS73, SLS66	I st fortnight of October	25	25-30	30:15
	<i>Utera</i>	R-552, Sweta	I st to 3 rd week of Oct.	Broad-cast	35-40	10-20:00
	Irrigated	Suyog, J-23, T-397, Azad Alsí 1, SLS 41	Mid October	25	25-30	60-80:30
Uttar Pradesh	Rainfed	Shekhar, Sweta, Shubhra, T397, SLS67, SLS73	Mid October	25	30	40:20
	Irrigated	Shekhar, Garima, Shubhra, T397, Azad Alsí 1	I st fortnight of October	25	25-30	60-80:30
	DP	Rashmi, Meera, Shikha, Gaurav Parvati, Ruchi	I st fortnight of October	20	45	80:30

- Application of phosphorus in black gram-linseed crop sequence @ 50% P+5 t/ha FYM+PSB to blackgram and 100% P to linseed proved optimum at Kanpur (UP) and Kanke (Jharkhand) found beneficial.
- Application of 75% P+PSB to both the crops for phosphorus management in maize-linseed (Kanpur), rice-linseed (Patna) and soybean-linseed (Nagpur and Pawarkheda) found beneficial.
- Application of 50% P+5 t/ha FYM+PSB to soybean and 75% P+PSB to linseed at Sagar whereas 100% P to soybean and 75% P to linseed at Raipur in soybean-linseed crop sequence were proved useful.
- Fertilizer application in soybean-linseed crop sequence @ 75% NPK+5 t/ha FYM+ rhizobium+ PSB to soybean and 50% NPK+ Azotobactor + PSB to linseed at Sagar and 75% NPK+5 t/ha FYM+ rhizobium+ PSB to soybean and 75% NPK+ azotobactor+ PSB to linseed at Pawarkheda were proved useful.
- Application of fertilizer in Blackgram-linseed crop sequence @ 75% NPK+5 t/ha FYM to blackgram and 75% NPK to linseed at Kanpur, whereas, it was 75% NPK + 5 t/ha FYM+ rhizobium+ PSB to blackgram and 75% NPK+ azotobactor+ PSB to linseed at Kanke found beneficial.
- Integrated nutrient management @ 75% NPK+3 t/ha FYM + azotobactor+ PSB to maize and 75% NPK+ azotobactor+ PSB to linseed proved optimum for getting higher net monetary return from maize-linseed crop sequence at Kanpur condition found beneficial.
- Linseed varieties Padmini (Sagar), PKVNL 260 (Nagpur), J 23/Indira Als 32 (Raichur), Suyog/RL 914 (Kota), Shekhar/Sweta/Shubhra (Shillongani) and Padmini/JLS 67/JLT 26/JLS 9 (Tikamgarh) were found suitable varieties of linseed for chickpea + linseed (4:2) intercropping system.
- Two fortnightly sprays of spinosad 45 SC (0.015%) reduces upto 78% bud fly infestation, which enhances upto 63% seed yield.
- Two application of neem based commercial formulation containing Azadirachtin 300 ppm reduces upto 63% bud infestation and thereby enhancement upto 40% in seed yield.

► 9.11 Nutritive Values

Among oilseeds linseed oil is the richest source of linolenic (18:3) poly unsaturated fatty acid (35-60%), which has quick drying property, therefore, linseed oil is largely used in paint

and varnish industry. It is also used in production of printing ink and soap. As for as the nutritive value of linseed is concerned, seeds are the best source of omega-3 and omega-6. Therefore, these seed have high medicinal value in control of cardiovascular, cancerous, diabetic and rheumatic arthritis diseases. Roasted seeds of linseeds are used under various food preparation in different part of the country and seeds are being sold in consumer friendly pouches in retail chains.

► 9.12 Researchable Issues

- Development of short duration and heat tolerant high yielding varieties of linseed particularly for paddy fallows.
- Development of location specific integrated crop management practices for high input use efficiency.
- Development of eco-friendly IPM technologies.
- Development of varieties/technologies for utera cultivation.
- Climate change concomitant to pests and diseases scenario.



CHAPTER 10

CASTOR



► 10.1 Crop Description

Castor belongs to genus *Ricinus* and family Euphorbiaceae. The stem is erect, circular, partially hollow, smooth, glabrous, with primary and secondary branching. Leaves are alternate, large, palmate with 5-11 lobes, acuminate, margins notched, serrate or indented. Castor is normally cross-pollinated.



Castor crop at fruiting stage

► 10.2 Center of Origin

Castor is indigenous to Eastern Africa and native of Ethiopia. It is also reported as of polyphyletic origin with four centers of variability viz., Afghanistan, former USSR region, Palestine-West Asia, Indo-China and Arabian Peninsula.

► 10.3 Climatic Requirement

Castor is tolerant to drought and grows well in relatively dry and warm regions having a well distributed rainfall of 500-750mm. In heavy rainfall areas, the crop puts an excessive vegetative growth and assumes a perennial habit. Castor requires a moderate temperature (20⁰-26⁰C) with low humidity throughout the growing season to produce maximum yields. In India, the crop is usually raised during *Kharif*. It is also cultivated as a *Rabi* crop in Andhra Pradesh and Odisha with assured irrigation. It can withstand long dry spells as well as heavy rains, but is highly susceptible to water logging.

► 10.4 Global Scenario

Castor is cultivated by more than 29 countries over an average area of 15.74 lakh ha (2006-07 to 2011-12) with a production of 17.94 lakh tonnes and productivity of 1140 kg/ha.

India has the largest area and highest productivity of castor in the World. The details of average area, production and yield of major castor producing countries in the world is given in Table 89.

TABLE 89: AREA, PRODUCTION AND YIELD OF IN MAJOR CASTOR GROWING COUNTRIES

(Area: lakh ha, Production: lakh tonnes, Yield: kg/ha)

Crop	Countries	Area	Production	Yield
Castor	India	9.478	13.758	1451
	China	2.100	1.780	848
	Brazil	1.681	1.053	627
	Paraguay	0.108	0.125	1157
	Thailand	0.131	0.115	876
Total Castor (World)		15.738	17.937	1140

► 10.5 National Scenario

Castor is cultivated under two contrasting environments *viz.*, irrigated intensive cultivation with high productivity in Gujarat and Rajasthan largely with hybrids and rainfed cultivation coupled with low input application and varieties attributing to very low productivity in Andhra Pradesh, Karnataka, Tamil Nadu, Odisha, etc. Area, Production and Yield of major castor growing State during last 03 years is given in Table 90.

TABLE 90: AREA, PRODUCTION AND YIELD OF IN MAJOR CASTOR GROWING STATES

Sl. No.	States	Area (Lakh ha)			Production (Lakh tonnes)			Yield (kg/ha)		
		2011-12	2012-13	2013-14	2011-12	2012-13	2013-14	2011-12	2012-13	2013-14
1	AP	2.54	2.09	1.28	0.52	1.03	0.81	205	493	633
2	Gujarat	8.78	8.27	6.27	18.03	17.04	12.92	2054	2060	2061
3	Rajasthan	2.91	2.23	1.95	4.10	3.41	2.86	1409	1529	1467
Others		0.48	0.58	0.50	0.30	0.29	0.30	625	500	600
All India		14.71	13.17	10.00	22.95	21.77	16.89	1560	1653	1689

► 10.6 Potential Districts

There are 24 potential districts of castor in AP (05), Gujarat (13), Odisha (01), Rajasthan (05), which contributes >95% castor production in the country (*Annexure-XVII*).

► 10.7 New/Non-Traditional Areas

Rabi season offers good scope for area expansion under castor with higher productivity and least problem of *Botrytis*. There are bright prospects for growing castor in non-traditional areas like coastal regions where *Kharif* castor crop is not possible due to biotic (*Botrytis*) and a-biotic (cyclone, water logging) stresses. Non-traditional areas/season also offer opportunity for off season seed production in isolation.

► 10.8 Cropping System

Castor is raised either as a sole crop or mixed crop with *Kharif* cereals/millets (sorghum, finger millet, pearl millet, maize), legumes (pigeonpea, groundnut, mungbean, urdbean and cowpea, horse gram) and sometimes with horticultural crops like chillies, turmeric, ginger, dolichos and cucumber. A large number of remunerative and viable intercropping systems have been identified and recommended for different regions in the country. Most popular inter-cropping, which are widely adopted by the farmers includes castor + pigeon pea, castor + groundnut, castor + millets and castor + moth bean.

► 10.9 Varieties and Seed Scenario

Five hybrids and six varieties of castor have been released after 2001. List of these varieties/hybrids along with their salient feature are given in *Annexure-VIII*. However, State wise farmer preferred varieties/hybrids are given in Table 91.

TABLE 91: STATEWISE FARMERS PREFERRED HYBRIDS/VARIETIES OF CASTOR

State		Recommended varieties/hybrids
Andhra Pradesh	Varieties	Jyothi, Kranti, Kiran, Haritha, 48-1 (Jwala)
	Hybrids	GCH-4, DCH-32, DCH-177, PCH-1, DCH-519
Gujarat	Varieties	VI-9, GAUC-1, SKI-73 (GC 2), 48-1, GC-3
	Hybrids	GAUCH-1, GCH-2, GCH-4, GCH-5, GCH-6, GCH-7, DCH-519
Karnataka	Varieties	RC-8, Jyothi, 48-1
	Hybrids	GCH-4, DCH-32, DCH-177, DCH-519
Maharashtra	Varieties	Jyothi, AKC-1, 48-1
	Hybrids	GCH-4, DCH-177, DCH-32, DCH-519
Rajasthan	Varieties	Jyothi, 48-1
	Hybrids	GCH-4, GCH-5, DCH-32, RHC-1, DCH-177, DCH-519

State		Recommended varieties/hybrids
Tamil Nadu	Varieties	SA-2, TMV-5, TMV-6, Jyothi, Co-1, 48-1
	Hybrids	GCH-4, DCH-32, TMVCH-1, DCH-177, DCH 519, YRCH-1
UP	Varieties	T3, T4, 48-1, Kalpi-6, Chandra Prabha
Haryana & Punjab	Varieties	CH-1, Jyothi, 48-1
	Hybrids	GAUCH-1, GCH-2, GCH-4, GCH-5, DCH-32, DCH-177, DCH-519

More than 70% area of castor is under hybrid cultivation with an SRR of 100%. However, for remaining area SRR is about 28-30% with varietal cultivation.

► 10.10 Yield Gap

It is evident from the data given in Table 89 that India has highest productivity of castor mainly because of cultivation of hybrids with optimum input management. Results of FLD conducted by the Institutions of ICAR/SAUs during *Kharif*-2012 indicates an yield gap of 12-60% in Gujarat and 130% in Rajasthan under irrigated condition as given in Table 92.

TABLE 92: STATE WISE YIELD GAP OF CASTOR UNDER IRRIGATED CONDITION.

State	Location	Castor		
		<i>Kharif</i> -2012		
		SAY	FLD	Yield gap (%)
				Over SAY
Gujarat	Anand	2060	2781	35
	Junagarh		3292	60
	Navsari		2313	12
Rajasthan	Mandsore	1529	3514	130
Mean		1795	2975	66

► 10.11 Best Practices

10.11.1 Seed Bed Preparation and Sowing

Deep summer ploughing helps to break the hard soil pan and facilitates easy root penetration apart from controlling weeds, insect pests and diseases. Castor is generally sown in line with country plough or seed-cum-ferti drills.

11.11.2 Seeding Time

Optimum seeding time for rainfed castor is second fortnight of June. Under irrigated condition sowing continued upto end of August.

11.11.3 Quality Seed

Purchase of hybrid seeds every year and renewal of seed stock of improved varieties once in 4-5 years.

11.11.4 Spacing and Plant Population

Plant population of 18,500/ha and 14,000/ha was found to be optimum for rainfed and irrigated areas respectively with 5 kg seeds/ha. The State wise recommended spacing is given in Table 93.

TABLE 93: STATEWISE RECOMMENDATION OF SPACING FOR CASTOR

Region	Situation	Spacing (cm)
Andhra Pradesh	Rainfed	90 x 60
	Delayed	60 x 30
Karnataka	Rainfed	60 x 30
	Irrigated	90 x 60
Tamil Nadu	Rainfed	90 x 60
Maharashtra	Rainfed	90 x 60
Delayed sowings	Rainfed	60 x 30/90 x 20
Gujarat		
North-west Gujarat	Rainfed	90 x 60
	Irrigated	120 x 60
Saurashtra	Rainfed	120 x 60
Rajasthan	Irrigated	90 x 60

10.11.5 Seed Treatment

Seeds treatment with Thiram or Captan @ 3g/kg seed or Carbendazim 2 g/kg to protect plants from seed borne diseases like *Alternaria* Leaf Blight, Seedling Blight and Wilt. Treat the seed with *Trichoderma viride* @ 10 g/kg seed and soil application of 2.5 kg incubated in 125 kg FYM/ha for managing wilt. Soaking the seed with 1% sodium chloride (common salt) for 3 hours before sowing imparts tolerance to sodicity wherever the problem exists.

10.11.6 Fertilizer Application

Castor crop with an yield of 10 qtl/ha removes 40 kg N, 9 kg P₂O₅ and 16 kg K₂O/ha under rainfed conditions, whereas, an irrigated crop with an yield of 22.8 q/ha removes 84 kg N, 26 kg P₂O₅ and 31 kg K₂O/ha. Application of 10-12 t FYM/ha helps in moisture retention and provides nutrition to the crop. Nitrogen is normally used in split doses under irrigated condition and also under rainfed conditions subject to receipt of rains. The State wise fertilizer recommendations are given in Table 94.

TABLE 94: STATE WISE FERTILIZER RECOMMENDATIONS FOR CASTOR

Region	Situation	N	P ₂ O ₅	K ₂ O	S
Andhra Pradesh	Rainfed	60	40	30	
Tamil Nadu	Rainfed	30	15	15	
Karnataka	Irrigated	75	50	25	
	Rainfed	40	40	20	
Maharashtra	Rainfed	60	30	0	
Rajasthan	Irrigated	80	50	0	20
North Gujarat	Irrigated	120	25	0	
	Rabi castor	80	50	0	
Saurashtra (Gujarat)	Irrigated	120	50	0	20
	Rainfed	100	50	0	20

10.11.7 Irrigation

All hybrids/varieties require 5-7 irrigations in sandy loam soils of Gujarat and Rajasthan for realizing the full productivity potentials. Drip irrigation in hybrid castor saves 24% water and offers 36% higher yield.

10.11.8 Weeding and Intercultural

Two or three weeding at intervals of 15-20 days in order to keep weeds under check. Alternatively preplant application of herbicides such as Fluchloralin or Trifluralin @ 1.0 kg ai/ha or pre-emergence application of Alachlor @ 1.25 kg ai/ha is equally effective under irrigation.

10.11.9 Crop Protection

The important diseases and insect pests of castor and their control methods are given in Table 95.

TABLE 95: INTEGRATED MANAGEMENT OF IMPORTANT INSECT PESTS AND DISEASES OF CASTOR

Insect/diseases	Integrated management
Insects	
Red Hairy Caterpillar (<i>Amsacta albistriga</i> Wlk.)	Set up light traps on community basis with the first monsoon rains to attract the moths and kill them. Sow cucumber alongwith Castor. Place the twigs of <i>Ipomoea</i> , <i>Jatropha</i> and <i>Calotropis</i> to attract the migrating caterpillars and kill them mechanically. Spray of Monocrotophos (0.05%) or Fenvalerate (0.02%) or Quinalphos (0.05%).
Semilooper (<i>Achoea janata</i> L.)	Hand picking of older larvae during early stages of crop growth. Manipulate parasitic activity by avoiding chemical spray, when 1-2 larval parasites are observed on castor plant. Spray of Monocrotophos (0.05%), Endosulfan (0.07%), if 4-5 semiloopers/ plant are observed with more than 25% defoliation.
Tobacco Caterpillar (<i>Spodoptera litura</i> Fabr.)	Collect and destroy egg masses and gregarious stages of the larvae alongwith damaged leaves. Spray Chlorpyrifos (0.05%) or Monocrotophos (0.05%) if defoliation is above 25%.
Capsule Borer (<i>Dichocrosis punctiferalis</i>)	Spray Monocrotophos (0.05%) or dust the spike with Quinalphos (1.5%) if more than 10% capsules are damaged.
Leaf Hopper (<i>Empoasca flavescens</i> Fabr.)	Grow double/triple bloom genotypes like GCH-4, DCS-9, GCH-5, 48-1 etc. Spray Monocrotophos (0.05%) or Dimethoate (0.05%). Repeat spray, if required, after a fortnight.
Whitefly (<i>Trialeurodes ricini</i> Misra)	Spray Monocrotophos (0.05%) or Dimethoate (0.05%). Repeat spray, if required, after a fortnight.
Red Spider Mite (<i>Tetranychus telarius</i> L.)	Spray Dicofol (0.05%).
Diseases	
Wilt (<i>Fusarium oxysporum</i>)	Avoid continuous cultivation of castor and rotate with pearl millet/finger millet or cereals. Avoid waterlogging. Grow tolerant/resistant varieties like Jyoti, Jwala, Harita, GCH-4, DCH-32, GCH-5, DCH-177, 48-1 and DCH-519. Intercropping castor + pigeonpea 1:1. Treat the seed with Carbendazim 2 g/kg seed/ <i>Trichoderma viride</i> 10 g/kg seed and soil application of 2.5 kg/ha incubated in 125 kg FYM.

Insect/diseases	Integrated management
Root rot/die back (<i>Macrophomina phaseolina</i> L.)	<p>Burn and destroy crop debris.</p> <p>Follow crop rotation with cereal crops.</p> <p>Grow tolerant varieties like Jwala, and JHB-665.</p> <p>Maintain sufficient soil moisture through soil moisture conservation practices and irrigation at critical stages.</p> <p>Treat the seed with Thiram @ 3g/kg or Carbendazim 2g/kg seed or <i>Trichoderma viride</i>, 4 g/kg seed.</p>
Grey rot (<i>Botrytis ricini</i>)	<p>Use of non spiny varieties (48-1).</p> <p>Adopt wider spacing and avoid close spacing.</p> <p>Remove infected spikes/capsules and destroy.</p> <p>Provide additional dose of 10 kg N/ha after cessation of rains/cyclonic storms.</p> <p>Spray Carbendazim (0.05%) or Thiophanate methyl (0.05%) before onset of cyclonic weather based on weather forecast.</p>

10.11.10 Harvesting and Threshing

The main spike is ready for harvest within 90-120 days after planting. The subsequent pickings can be taken up at intervals of 30 days. Physiological maturity in castor is attained when some of the capsules in a spike turn brown in colour. The matured spikes are cut and dried in sun for few days for easy threshing. Threshing is usually done by either beating the capsules with sticks or alternatively by trampling with Bullocks or Tractor wherever possible. Of late, power operated mechanical threshers are also available for the purpose.

► 10.12 Market Prices

Though, castor is not covered under MSP, however, it has become a most remunerative oilseeds during last few years with growing export and indigenous demand. Castor which was earlier sold at much below the price of major edible oilseeds like groundnut, mustard and soybean, is now being sold at a much higher price than these oil seeds. Castor has become 2nd largest export earner next to soybean among oilseeds. Quantity and value of castor oil and oil meal exported during last 3 years is given in Table 96.

TABLE 96: QUANTITY AND VALUE OF EXPORT OF CASTOR OIL AND OIL MEAL

(Quantity in lakh tonnes and value ₹ in crores)

Commodity	2010-11		2011-12		2012-13	
	Quantity	Value	Quantity	Value	Quantity	Value
Castor Oil	4.25	2982.92	4.92	4571.67	5.66	4314.78
Oil Meal	2.09	97.11	3.41	178.20	3.83	208.85
Total	6.34	3080.03	8.33	4749.87	9.49	4523.63

**TABLE 97: MARKET PRICES OF CASTOR, GROUNDNUT, SOYBEAN AND MUSTARD
(20/11/2014)**

(₹/qtls)

Market	State	Castor	Groundnut	Soybean	Mustard
Kurnool	AP	3586	3449	-	-
Deesa	Gujarat	4600	4000	-	3290
Dahod	Gujarat	-	4300	3135	-
Indore	MP	-	-	3000	-
Jodhpur	Rajasthan	4125	3400	-	3050

► 10.13 Products and By-Products

All plant parts of castor i.e. leaf, stem, seed, oil and cake are in demand by various Industries. Some of the uses are given Table 98.

TABLE 98: USES OF PRODUCTS AND BY-PRODUCTS OF CASTOR

Products/by-products	Uses
Green leaves	As a feed for eri silk worm
Powdered leaves	As repellants for aphids, mosquitoes, and mites.
Stem pulp	Paper and straw boards.
Castor lipase	Laundering and dry cleaning formulations.
Cotyledon of dry seed without testa	Nutritive food called Ogilli-isi or Awka.
Castor oil	Medicinal-laxative, purgative and cathartic, preventing hair losses
Castor oil	Industrial -lubricants, oleo chemicals, plastics, surfactants, cosmetics, urethanes, coatings, etc.

► 10.14 Researchable Issues

- Evaluation of germplasm for agro-economic traits and resistance to wilt, *Botrytis*, leaf hopper and capsule borer in castor.
- Development of bio-intensive integrated pest management strategies for wilt, *Botrytis* and capsule borer in castor.
- Development of transgenic for resistance to *Botrytis*.
- Value addition to the raw castor oil for oleo-chemicals.



ANNEXURE-I

POTENTIAL DISTRICTS OF SOYBEAN

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2009-10	2010-11	2011-12	2009-10	2010-11	2011-12	2009-10	2010-11	2011-12
Madhya Pradesh										
1	Ujjain	453800	451800	456600	673000	502800	632900	1483	1113	1386
2	Sehore	284400	283900	289800	433900	536300	357900	1526	1880	1235
3	Dewas	306600	321600	324300	394000	343500	418000	1285	1068	1289
4	Dhar	268100	267900	277500	443900	340300	363000	1656	1270	1308
5	Shajapur	340500	348600	355400	305100	443000	395900	896	1271	1114
6	Sagar	308500	303600	318000	282000	406200	316800	914	1338	996
7	Vidisha	217900	249200	242200	255600	372200	290500	1173	1493	1199
8	Harda	172800	171500	180200	291300	314800	258700	1686	1835	1436
9	Indore	226800	223100	226400	401500	192300	262900	1770	862	1161
10	Rajgarh	292100	299000	313100	255800	314500	268000	876	1052	856
11	Chhindwara	157200	161600	146700	266000	288600	264400	1692	1786	1803
12	Betul	210300	229000	206900	256700	295700	262500	1220	1291	1269
13	Mandsaur	262600	261500	270500	184100	254700	374000	701	974	1383
14	Hoshangabad	214700	216700	220700	283000	321200	141500	1318	1482	641
15	Guna	188900	212000	213000	196300	229700	298600	1039	1083	1402
16	Ratlam	208200	210700	216900	191900	188600	273300	922	895	1260
17	Raisen	123300	143900	174900	141100	157400	127000	1144	1094	726

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2009-10	2010-11	2011-12	2009-10	2010-11	2011-12	2009-10	2010-11	2011-12
18	Bhopal	103300	106800	107700	137800	150600	128800	1334	1410	1195
19	Narsingpur	79700	71000	75700	148900	138300	123300	1869	1949	1630
20	Shivpuri	119000	121600	166500	107500	127400	169600	904	1047	1019
21	Seoni	113200	120200	122100	123400	136600	122100	1090	1136	999
22	Neemuch	120000	119800	123000	115100	149800	102100	959	1250	830
23	Khandwa	154400	165400	169400	97600	118100	94000	632	714	555
24	Ashoknagar	65200	65800	108000	72900	82200	127300	1298	1250	1178
25	Damoh	91000	62100	50500	101800	85900	65100	1119	1383	1288
26	Tikamgarh	36700	31500	39200	44600	39900	31400	1217	1269	799
27	Jhabua	43700	47300	49000	31400	36100	33400	719	764	682
28	Khargone	48200	43700	41100	33900	37700	23700	704	864	577
29	Satna	54200	46400	50600	29700	31800	26400	548	685	521
30	Chhatarpur	41600	47400	60900	26300	31900	25400	632	672	416
31	Rewa	28500	29700	35500	18800	18600	18200	659	625	514
32	Barwani	31400	33100	35400	14600	16600	12300	764	500	348
Maharashtra										
33	Amravati	373000	317600	273300	124200	256900	444500	1287	1187	1422
34	Nagpur	303200	285100	242400	257200	219800	287100	1287	1187	1422
35	Latur	211100	217700	194500	91000	142600	431800	1287	1187	1422
36	Buldhana	240000	212800	225500	68700	156500	416100	1287	1187	1422
37	Yavatmal	311800	311800	198500	103700	126600	273100	1287	1187	1422
38	Nanded	163200	188300	181200	129900	86100	268400	1287	1187	1422

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2009-10	2010-11	2011-12	2009-10	2010-11	2011-12	2009-10	2010-11	2011-12
39	Washim	226400	222600	209200	77300	80200	298700	1287	1187	1422
40	Hingoli	129900	137400	148300	76300	123900	237400	1287	1187	1422
41	Akola	137500	151500	126600	28300	147000	238400	1287	1187	1422
42	Wardha	249900	178900	137800	146100	104000	151600	1287	1187	1422
43	Kolhapur	58700	59100	49200	128300	114500	137100	1287	1187	1422
44	Chandrapur	181900	179800	148300	119700	62100	148600	1287	1187	1422
45	Sangli	55700	56000	57300	119900	84900	119600	1287	1187	1422
46	Parbhani	74000	103500	107900	64600	82000	165200	1287	1187	1422
47	Nasik	39700	55100	56900	51100	65400	80900	1287	1187	1422
48	Satara	29200	32500	40100	62900	65000	65400	1287	1187	1422
49	Ahmednagar	55500	58000	50700	40100	53200	90800	1287	1187	1422
50	Jalna	37400	39300	49300	23000	45600	80000	1287	1187	1422
51	Beed	71400	68800	70400	14500	35400	96600	1287	1187	1422
52	Osmanabad	26200	46100	65200	7000	22400	111400	1287	1187	1422
53	Nandurbar	27100	30000	33100	34500	39800	53600	1287	1187	1422
Rajasthan										
54	Jhalwar	236786	243664	240086	229662	293778	316766	970	1206	1319
55	Baran	208708	194417	195086	191400	221611	357107	917	1140	1831
56	Pratapgarh	98225	99490	101124	118954	155618	136652	1211	1564	1351
57	Kota	132164	122293	112195	111617	145587	153568	845	1190	1369
58	Bundi	76488	55461	55169	74531	37813	79778	974	682	1446
59	Chittore	45702	37171	36310	56526	36688	46425	1237	987	1279

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2009-10	2010-11	2011-12	2009-10	2010-11	2011-12	2009-10	2010-11	2011-12
60	Banswara	23953	18958	19030	16776	15404	18316	700	813	962
Chhattisgarh										
61	Rajnandgaon	45750	47220	48460	51550	59260	57430	1127	1255	1185
62	Kabirdham	33800	39980	43480	46670	49540	55350	1381	1239	1273
63	Durg	31220	33960	42160	30410	28760	44390	974	847	1053
Karnataka										
64	Belgaum	70104	97400	78662	47152	49318	64416	708	533	862
65	Bidar	23924	33508	47434	16091	7894	44882	708	248	996
66	Dharwad	27471	36033	30809	19991	19204	26869	766	561	918
Andhra Pradesh										
67	Nizamabad	44082	57852	58470	73088	73530	123079	1658	1271	2105
68	Adilabad	96223	92093	61932	118547	52677	84847	1232	572	1370

DETAILS OF VARIETIES OF SOYBEAN RELEASED AFTER 2001

Soybean variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/regions situations	Salient features/traits
LSb 1	2001	ANGRAU Hyderabad	1200-1500	15.68	Andhra Pradesh	Determinate, white flowers, light green leaves, cream coloured seed occasionally 4 seeded pods, maturity 65-71 days
Indira soya 9	2001	IGKV Raipur	2200-2300	19.03	North eastern zone and Madhya Pradesh	Semi determinate plants having grey pubescence, yellow seeds and black hilum, maturity 106 days. Resistant to rust. Moderately resistant to stem tunnelling and girdle beetle and leaf folder.
Hara soy (Himso 1563)	2001	HPKV Palampur	1500-2000	20.04	Himachal Pradesh, Uttarakhand	Semi-determinate, white flowers, dark brown pubescence on stem, leaves. Leaves remain green in colour even at senescence. Seed green, round, bold with black hilum maturity 117 days. Immune to bacterial pustule, highly resistant to brown spot, bacterial blight, and resistant to frog eye leaf spot and pod blight. First ever culinary purpose variety in soybean.
Ahilya 4 (NRC 37)	2001	DSR Indore	3500-4000	19.77	Central zone	Determinate, erect plants, white flowers, tawny pubescence, spherical yellow seeds with light to dark brown hilum. Maturity 99-105 days. Moderately resistant to collar rot, bacterial pustule, pod blight and bud blight like syndrome. Moderately resistant to stem fly and leaf miner
Samrudhi (MAUS 71)	2002	MAU, Parbhani	2000-2500	18.24	North Eastern Zone	Semi determinate, purple flowers, glabrous leaves, yellow seed with black hilum, maturity 93-100 days.
Pratishra (MAUS 61-2)	2002	MAU, Parbhani	2000-2500	19.66	Central zone	Semi determinate, purple flowers, glabrous leaves, yellow seeds, brown hilum maturity 100-105 days

Soybean variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/regions situations	Salient features/traits
Pratikar (MAUS 61)	2002	MAU, Parbhani	2600-2800	18.77	Southern zone	Semi determinate, purple flowers, grey pubescence, yellow seed with brown hilum, maturity 95-100 days. Resistant to Myrothecium leaf spot
JS 93-05	2002	JNKVV Jabalpur	2000-2500	18.15	Central zone	Semi determinate, violet flowers, four seeded pods, glabrous stem & pods, non shattering, black hilum, maturity 90-95 days. Resistant to major diseases and insect pests.
MAUS 81 (Shakti)	2003	MAU, Parbhani	3300	17.34	Central Zone	Semi determinate plants with dark green glabrous leaves, purple flowers, yellow oblong seed and brown to blackish hilum, maturity 93-97 days. Tolerant to common diseases and pests
Palam soya (P-30-1-1)	2003	HPKV, Palampur	-	19.12	Himachal Pradesh and Uttarakhand	Resistant to frog eye leaf spot
Pant Soybean 1241	2003	GBPUA&T, Pantnagar	1800-2000	16.57	Uttarakhand	Semi determinate with yellow seed and black hilum, 100 seed weight 14 to 15 gms, maturity 121 days. Resistant to YMV, fungal complex and tolerant to <i>rhizoctonia</i> .
TAMS 38	2003	PDKV, Akola	2200	16.09	Maharashtra Vidarbha region	Determinate plants with white flower, brown hairs present on stem and pods, cream colour seeds with grey hilum, maturity 95 days
SL 525	2004	PAU, Ludhiana	2300	17.33	Northern Plain Zone	Determinate plants with white flower, brown hairs present on stem and pods, cream colour seeds with grey hilum, oil 21.2% and protein 38. 9%, maturity 121 days. Resistant to YMV, tolerant to stem blight and root knot nematode.
Phule Kalyani (DS 228)	2005	MPKV, Rahuri	2400	19.08	Maharashtra	Determinate plants with white flower, brown hairs present on stem and pods, cream colour seeds with grey hilum, maturity 95-100 days.
CO 3	2005	TNAU, Coimbatore	1400	16.65	Tamil Nadu	Medium duration photo insensitive variety with high oil and protein content, maturity 85-90 days. Resistant to YMV

Soybean variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/regions situations	Salient features/traits
PRS 1	2005	GBPUA&T, Pantnagar	2000	17.76	Uttarakhand mid hills	Determinate, pink flower colour, 100 seed weight: 13 gm., maturity 100 days.
DS 97-12	2005	IARI, New Delhi	2200-2500	18.01	North Plain Zone	Determinate growth habit, light green leaves, white flowers and non shattering type, maturity 116 days. Resistant to YMV and moderately resistant to stem fly.
JS 95-60	2006	JNKVV, Jabalpur	1800-2000	16.60	Madhya Pradesh	Determinate, extra earliness, high seed germinability and longevity, lodging and shattering resistance erect plant, flower color violet, glabrous pods with 4 seeds per pod, seed size bold, hilum color grey, maturity 82-88 days. Resistant to stem fly and defoliators and moderately resistant to girdle and blue beetles, resistant/tolerant to root rot, bacterial pustule, RAB, TLS
PS 1347	2006	GBPUA&T, Pantnagar	3100	15.54	North Plain Zone	Determinate compact plant type, tawny pubescence and yellow bold seeds, maturity 123 days. Resistant to YMV, rhizoctonia aerial blight, bacterial pustule, SMV and charcoal rot.
DS 98-14	2006	IARI, New Delhi	1900-2200	16.89	North Plain Zone	Determinate growth habit with average plant height and white flowers, maturity 125 days. Resistant to YMV, SMV, pod blight and moderately resistant to stem fly
Pratap Soya 1 (RAUS 5)	2007	MPUA&T, Udaipur	3000-3500	17.98	North Eastern Zone	Determinate, purple flower, yellow seed, hilum light to dark brown, maturity 96-104 days. Resistant to girdle beetle and moderately to stem fly and defoliators
Pratap Soya 2 (RKS 18)	2007	MPUA&T, Udaipur	2300	17.13	Southern & North Eastern Zone	Determinate variety with medium plant height. Purple flower. The plant is glabrous. Seed light yellow in colour round in medium size, Hilum gray to black, maturity 91 days. Moderately resistant to BP, girdle beetle and leaf miner but susceptible to rust.
TAMS 98-21	2007	PDKV, Akola	2200-2600	18.08	Maharashtra	Determinate, erect, purple flower, brown pubescence, yellow seed with hilum brown, gray pod, maturity 95-100 days. Moderately resistant to rust, leaf spot disease and insects

Soybean variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/regions situations	Salient features/traits
PS 1225	2007	GBPUA&T, Pantnagar	3000-3200	18.01	Tarai and Bhabar Region of UP and Uttarakhand	Grey pubescence, light brown hilum, Improved seed longevity, Shattering and lodging resistance, maturity 125 days. Multiple disease resistance. Resistant to resistant YMV, bacterial pustule, collar rot anthracnose, pod blight and SMV.
JS 97-52	2008	DSR Indore and JNKVV, Jabalpur	2500-3000	17.48	Central Zone and North Eastern Zone	While flower, tawny pubescence, large number of plant per plant, tolerance to excessive soil moisture, good seed longevity, maturity 100 days. Resistance to YMV and Collar rot, moderately resistant to Rhizoctonia aerial blight, moderately resistance to insects
SL 688	2008	PAU, Ludhiana	2500	20.54	North Plain Zone	Determinate and erect plants, brown pubescence, protein content 40.3% and oil content 19.4%, maturity 125 days. Resistant to YMV
VL Soya 59	2008	VPKAS, Almora	2600	20.04	North Hill Zone	Low linolenic acid, better oil quality, protein content 39.15% and oil content 19.35%, maturity 135 days. Resistant to pod blight, target leaf spot
VL Soya 63	2008	VPKAS, Almora	2700	20.23	North Hill Zone	Determinate and erect plants, protein content 41% and oil content 17.9%, maturity 130 days. Resistant to pod blight and target leaf spot, moderately resistant to frog eye leaf spot
VL Soya 65	2009	VPKAS, Almora	1500-1800		Uttarakhand hills	Moderately resistant to frog eye leaf spot, pod blight and leaf blight.
	2009	Adilabad			Andhra Pradesh	Resistant to bacterial pestule, pod blight & tolerant to bud blight
MAUS-158	2009	Parbhani	2260		Marathawada region	Tolerant to bacterial pustules, Rhizoctonia root rot & aerial blight, collar rot and charcoal rot.
Pusa 97-12	2009	IARI			Northern Zone	Resistant YMV, Charcoal rot
RVS 2001-4	2009		2500		Madhya Pradesh	Tolerant to major leaf, pod & root diseases. Tolerant to girdle beetle & semi looper

Soybean variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/regions situations	Salient features/traits
Birsa Safed Soybean-2	2009	Ranchi	2500		Jharkhand	Resistant to bacterial pastures, cercospora leaf spot, blue beetle and bihar hairy caterpillar, moderately resistant to frog eye leaf spot
Soybean variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/regions situations	Salient features/traits
Pusa DS 9814	2006	IARI				Resistant to YMV and charcoal rot, Northern zone
PS-19	2010	Pantnagar	2121		Tarai Bhabar and hills of Uttarakhand	Resistant to major foliar diseases, YMV, Bacterial pustule & rhizoctonia aerial blight
NRC-77	2010	DSR, Indore	2400		Southern zone Karnataka, Tamil Nadu, A P, South Maharashtra	Resistant to charcoal rot, Rhizoctonia root rot and moderately resistant to RAB and BP
MACS-1188	2013	ARI, Pune	2475		Southern zone (Karnataka, Tamil Nadu, A P, South Maharashtra)	High Oil content, early maturity, resistant to pod shattering and Rhizoctonia aerial blight, bacterial pastures, charcoal rot, stem fly, pod borer, leaf folder, leaf minor and defoliators
RKS-24	2011	ZARS, Kota	2200-2400	19%	Rajasthan	Resistant to shattering, Rhizoctonia aerial blight and bacterial pastures.
GC-00209-4-1-1 (Karune)	2011	UAS, Bangalore	7000-8000 (green pods)		South Karnataka	Vegetable type
DSb-1	2012	UAS, Dharwad	2500-3000	18.2%	Karnataka	Better germinability, Resistant to rust and tolerant pod shattering
SL 744	2012	Ludhiana	18400	21%	Northern Zone (Punjab)	Timely sown irrigated condition

ANNEXURE-III

POTENTIAL DISTRICTS OF GROUNDNUT

Sl. No.	District	Area in ha			Production in tonnes			Yield in kg/ha		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Andhra Pradesh										
1	Anantpur	870456	530381	834070	100012	141976	480996	115	268	577
2	Mahabubnagar	99472	118474	113386	162913	218559	228593	1638	1845	2016
3	Chittoor	188903	139431	161957	130616	130855	191073	691	938	1180
4	Kurnool	246143	191356	178892	176146	123775	150898	716	647	844
5	Kadapa	141012	130118	160595	64371	95683	138876	456	735	865
6	Warangal	34479	34631	29665	54344	53113	51743	1576	1534	1744
7	Vizianagaram	38231	31531	25758	40522	32501	28300	1060	1031	1099
8	Srikakulam	29837	28212	26898	30556	34006	36685	1024	1205	1364
9	Nalgonda	25339	25401	22625	25693	33848	24314	1014	1333	1075
Gujarat										
10	Junagadh	423000	409200	442600	809200	372200	956700	1913	910	2162
11	Jamnagar	399400	393200	396300	656500	664200	717400	1644	1689	1810
12	Rajkot	386800	367400	321200	375900	100300	651000	972	273	2027
13	Amreli	252300	236000	221000	123200	41700	382500	488	177	1731
14	Bhavanagar	125200	95200	131800	145000	62000	270800	1158	651	2055
15	Porbandar	89700	85900	83300	213600	170400	73700	2381	1984	885
16	Kutch	64000	86200	103600	102300	139200	170100	1598	1615	1642
17	Sabarkanth	60800	63100	77500	62800	71900	122200	1033	1139	1577

Sl. No.	District	Area in ha			Production in tonnes			Yield in kg/ha		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
18	Banaskantha	26500	27100	32800	37100	51000	45800	1400	1882	1396
19	Vadodara	16500	8300	38800	28700	14400	60000	1739	1735	1546
Karnataka										
20	Chitradurga	148266	123845	157064	33404	66607	136634	225	566	870
21	Tumkur	156642	99773	135019	46171	36132	97973	295	381	726
22	Gadag	49785	68484	66286	19922	24896	66163	400	383	998
23	Bijapur	49465	77615	68491	27275	37391	41999	551	507	613
24	Belgaum	50971	51663	42950	30213	31416	40131	593	640	934
25	Bellary	71925	70932	72263	24085	23424	52424	335	348	725
26	Dharwad	41073	39107	35689	19213	36703	42253	468	988	1184
27	Koppal	41909	48093	47001	25578	25744	44054	610	563	937
28	Raichur	39240	38922	37622	29736	25748	34319	758	696	912
29	Chickballapur	45711	21692	36674	30241	10420	37004	662	506	1009
30	Bagalkot	18787	23808	23235	17977	22055	30536	957	975	1314
31	Gulbarga	41327	60036	5767	26747	38817	3476	647	681	603
32	Haveri	20876	20395	18988	13081	13871	22283	627	716	1174
Maharashtra										
33	Kolhapur	60500	60700	61000	90200	86100	95400	1491	1418	1564
34	Satara	49700	53300	53600	74000	72000	90100	1489	1351	1681
35	Pune	34900	39000	40100	36200	40900	54100	1037	1049	1349
36	Sangli	21200	26200	28700	15100	28300	37200	712	1080	1296
37	Nasik	29900	24800	34300	27800	18700	29900	930	754	872
38	Dhule	24900	24000	27900	10800	20500	36300	434	854	1301

Sl. No.	District	Area in ha			Production in tonnes			Yield in kg/ha		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Rajasthan										
39	Bikaner	63143	78547	85189	110337	65760	229912	1747	837	2699
40	Jaipur	46231	47016	44801	87189	72192	91168	1886	1535	2035
41	Jodhapur	37639	43892	49084	66352	53606	75328	1763	1221	1535
42	Sikar	23266	22064	23763	40503	29988	50344	1741	1359	2119
43	Chittore	25013	18847	18637	27842	20851	29803	1113	1106	1599
Tamil Nadu										
44	Thiruvanamalai	97552	68856	62296	146618	125139	115184	1503	1817	1849
45	Villupuram	51326	47957	39556	125605	138908	94634	2447	2897	2392
46	Vellore	51061	43685	43182	88329	84027	97821	1730	1923	2265
47	Kancheepuram	21293	17478	16327	76318	73184	72969	3584	4187	4469
48	Namakkal	31188	29550	32639	59329	46377	76371	1902	1569	2340
49	Erode	24994	19392	19895	53514	32860	37026	2141	1695	1861
50	Salem	25547	21939	21900	38250	33769	48011	1497	1539	2192
Odisha										
51	Jaipur	30590	31270	31800	58330	56380	50730	1907	1803	1595
52	Baragarh	34300	29240	30170	53180	37420	42860	1550	1280	1421
53	Ganjam	22810	20910	21840	40570	33950	35190	1779	1624	1611

ANNEXURE-IV

DETAILS OF VARIETIES OF GROUNDNUT RELEASED AFTER 2001

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
VRI (Gn) 5	2001	TNAU, Riddhachalam	2133 (R) 2384(I)	50	Tamil Nadu	Resistant to rust and Late Leaf spot (LLS); suitable for both <i>Kharif</i> and <i>Rabi</i> -summer seasons
Co (Gn) 4 (TNAU 269)	2001	TNAU, Coimbatore	1500 (R), 1950(I)	53	Tamil Nadu	Resistant to rust and LLS; suitable for all seasons
GG 7 (J-38)	2001	GAU, Junagadh	2149	49	Gujarat & Southern Rajasthan	Tolerant to LLS; suitable for <i>Kharif</i> season
AK 159	2002	PKV, Akola	1606	51	Maharashtra and Madhya Pradesh	Early (105-110 days) maturity; recommended for <i>Kharif</i> season
Kalahasti (TCGS 320)	2002	ANGRAU, Tirupati	3764	52	Andhra Pradesh	Tolerant to Peanut Bud Necrosis Disease (PBND) and Jassids; suitable for <i>Rabi</i> season in kalahasti malady endemic areas and also for <i>Kharif</i> in north coastal and north Telangana regions
Narayani (TCGS 29)	2002	ANGRAU, Tirupati	3764	48	Andhra Pradesh	Tolerant to mid-season moisture stress conditions; recommended for both <i>Kharif</i> and <i>Rabi</i> -summer seasons
Sneha*	2002	KAU, Vellayani	-	-	Kerala	Recommended for <i>Kharif</i> season
Snigdha*	2002	KAU, Vellayani	-	-	Kerala	Recommended for <i>Kharif</i> season
GG 6	2003	JAU, Junagadh	2782	50	Gujarat	Suitable for cultivation in summer
GG 14 (JSP 28)	2003	JAU, Junagadh	2159	52	Northern Rajasthan, Punjab, Haryana, Uttar Pradesh	Tolerant to thrips, <i>Spodoptera</i> and leaf miner; recommended for <i>Kharif</i> season

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
TPG 41	2004	BARC, Mumbai	2008	49	All India	Moderately resistant to rust; bold-seeded (HSM > 60g); high O/L ratio; recommended for <i>Khharif</i> season
TG 37A	2004	BARC, Mumbai	1900	48	All India	Tolerant to collar rot, rust and late leaf spot; suitable for both <i>Khharif</i> and <i>Rabi</i> -summer seasons; possess fresh seed dormancy up to 15 days
Vikas (GPBD 4)	2004	UAS, Dharwad	1900-2200	49	All India	Resistant to LLS and rust; recommended for <i>Khharif</i> season
TLG 45	2004	MAU, Latur	1506	51	Maharashtra	Large-seeded (HSM = 59g); medium maturity (114 days); recommended for <i>Khharif</i> season
SG 99	2004	PAU, Ludhiana	2501	52	Punjab	Tolerant to bud necrosis disease; possess long fresh seed dormancy (30 days); suitable for summer season
Phule Unap (JL 286)	2004	MPKV, Jalgaon	2231	49	Maharashtra	Tolerant to LLS, rust and stem rot; also tolerant to thrips, leaf miner and <i>Spodoptera</i>
Prutha (Dh 86)	2005	UAS, Dharwad	4022	48	Recommended for All India	Tolerant of LLS and sucking pests; suitable for <i>Rabi</i> -summer season
Kadiri 5	2005	ANGRAU, Kadiri	1800-2200	48	Andhra Pradesh	Tolerant to leaf spots and drought; recommended for <i>Khharif</i> season
Kadiri 6 (K 1240)	2005	ANGRAU, Kadiri	1800-2400	49	Andhra Pradesh	Tolerant to leaf spots; recommended for <i>Khharif</i> season
Pratap Mugphali 2 (ICUG 92195)	2005	MPUA&T, Udaipur	1800-2800	49	Rajasthan	Tolerant to Early Leaf Spot (ELS), LLS and PBND; tolerant to Spodoptera, leaf miner and thrips; recommended for <i>Khharif</i> season
Pratap Mugphali 1 (ICUG 92035)	2005	MPUA&T, Udaipur	2500-3000	49	Rajasthan	Moderately resistant to ELS, LLS and PBND; moderately resistant to <i>S. litura</i> , leaf miner and thrips; recommended for <i>Khharif</i> season

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
Co (GN) 5	2005	TNAU, Vridhachalam	1585	54	Tamil Nadu	Tolerant to rust, PBNB; tolerant to leaf miner and Spodoptera; recommended for <i>Kharif</i> season
Rateshwar (LGN 1)	2005	MAU, Latur	1487	51	Maharashtra	Moderately resistant to LLS, stem rot, rust and PBNB; tolerant to sucking pests; recommended for <i>Kharif</i> season
Utkarsh (CSMG 9510)	2005	CSAUAT, Mainpuri	21.92	49	Uttar Pradesh, Punjab, Northern Rajasthan	Resistant to rust, possess fresh seed dormancy up to 40-45 days; recommended for <i>Kharif</i> season
Durga (RG 382)	2005	RAU, Durgapura	2203	55	Rajasthan	Suitable for sandy and loamy soils; recommended for <i>Kharif</i> season
TMV (Gn) 13	2006	TNAU, Coimbatore	2580	50	Tamil Nadu	Tolerant to early and mid season moisture deficit stress conditions; recommended for <i>Kharif</i> season
GG 8 (J 53)	2006	JAU, Junagadh	1716	46	Northern Maharashtra and Madhya Pradesh	Moderately tolerant to PBNB, collar rot and stem rot diseases
TG 38B (TG 38)	2006	BARC, Mumbai	2768	48	Odisha, West Bengal and north eastern states	Tolerant to stem rot; suitable for <i>Rabi</i> -summer season
Prasuna (TCGS 341)	2006	ANGRAU, Tirupati	2000-2500 (R) 4000-4500 (I)	50	Andhra Pradesh	Tolerant to <i>Kalahasti</i> malady; recommended for <i>Kharif</i> season
Abhaya (TPT 25)	2006	ANGRAU, Tirupati	2300 (R) 3756 (I)	52	Andhra Pradesh	Tolerant of LLS, jassids and thrips and <i>Spodoptera</i> , tolerant to early and mid season moisture deficit stress; suitable for both <i>Kharif</i> and <i>Rabi</i> -summer seasons

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
GG 16 (JSP 39)	2006	JAU, Junagadh	2058	46	Tamil Nadu, Andhra Pradesh, Kerala, southern Maharashtra	Tolerant to bud necrosis, root rot diseases; tolerant to <i>thrips</i> , <i>Spodoptera</i> , leaf miner; recommended for <i>Kharif</i> season
Vasundhara (Dh 101)	2007	UAS, Dharwad	2877	50	West Bengal, Odisha, Jharkhand and Assam	Tolerant to stem rot and PBND; tolerant to <i>thrips</i> ; and <i>Spodoptera</i> ; suitable for <i>Rabi</i> -summer season
ICGV 91114	2007	ICRISAT, Hyderabad	2000	48	Andhra Pradesh	Tolerant to rust and LLS; early maturity (100 days); tolerant to drought; recommended for <i>Kharif</i> season
AK 265	2007	PDKV, Akola	1903	47	Southern Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu	Resistant to foliar diseases; drought tolerant; recommended for <i>Kharif</i> season
M 548	2007	PAU, Ludhiana	2185	51	Punjab	Tolerant to leaf spots and collar rot; recommended for <i>Kharif</i> season
AK 303	2007	PDKV, Akola	2100	49	Maharashtra	Bold seeded (HSM = 80g); recommended for <i>Kharif</i> season
TG 51	2008	BARC, Mumbai	2675	49	West Bengal, Odisha, Jharkhand and Assam	Tolerant to stem rot and root rot; suitable for <i>Rabi</i> -summer season
Ajeya (R 2001-3)	2008	UAS, Raichur	2440	46-48	Southern Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu	Resistant to PBND; drought tolerant; recommended for <i>Kharif</i> season

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
Girnar 2 (PBS-24030)	2008	NRCG, Junagadh	2907	51	Uttar Pradesh, Punjab, northern Rajasthan	Virginia bunch type with 'stay green' leaves and bold seeded (HSM = 62g); tolerant to rust, LLS PSND; recommended for <i>Kharif</i> season
ICGV 00348	2008	TNAU, Vridhachalam	2013	47	Southern Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu	Tolerant to late leaf spot and rust; recommended for <i>Kharif</i> season
VRI (Gn) 7	2008	TNAU, Vridhachalam	1865	48	Tamil Nadu	Moderately resistant to leaf miner; LLS and rust; recommended for <i>Kharif</i> season
VL-Moon-gphali-1	2008	VPKAS, Almora	1943	-	Uttarakhand	Resistant to late leaf spot and root rot; recommended for <i>Kharif</i> season
VRI (Gn) 6 (VG 9816)	2009	TNAU, Vridhachalam	2259	47	Southern Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu	Tolerant to LLS, rust, PBND; recommended for <i>Kharif</i> and <i>Rabi</i> -summer seasons
Jawahar Groundnut 23 (JGN 23)	2009	JNKVV, Khargone	1631	49	Madhya Pradesh	Tolerant to ELS and LLS; drought tolerant; recommended for <i>Kharif</i> season
Kadiri 9	2009	ANGRAU, Kadiri	2500-3000	52	Andhra Pradesh	Tolerant of thrips, jassids, and nematodes. Tolerant to late leaf spot, rust, dry root rot and collar rot. Recommended for <i>Kharif</i> season
Greeshma	2009	ANGRAU, Tirupati	2000-2500 (R); 4000-4700 (I)	49	Andhra Pradesh	Tolerant to LLS, drought, high temperature and aflatoxin; recommended for <i>Kharif</i> and <i>Rabi</i> -summer season

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
Kadiri 7	2009	ANGRAU, Kadiri	1643	47	Andhra Pradesh	Tolerant to sucking pests and leaf spots; bold seeded (HSM = 65-75 g); recommended for <i>Kharif</i> season
Kadiri 8	2009	ANGRAU, Kadiri	1523	47	Andhra Pradesh	Tolerant to sucking pests and leaf spots; bold seeded (HSM = 65-75g)
Mallika (ICHG 00440)	2009	RAU, Hanumangarh	2579	48	All India	Resistant to collar rot and PBNB; bold seeded (HSM=73g), recommended for <i>Kharif</i> season
TGLPS 3 (TDG-39)	2009	UAS, Dharwad	2500-3000	-	Karnataka	-
GG-21 (JSSP 15)	2005	JAU, Junagadh	1843	53	Uttar Pradesh, Punjab, northern Rajasthan	Recommended for <i>Kharif</i> season
JSP-39	2009	UAS, Dharwad	3000	49	AP, Karnataka, TN, Maharashtra	Tolerant to foliar diseases and root rot
JL 501	2010	MPKV, Jalgaon	1661	48	Gujarat and southern Rajasthan	Suitable for early as well as late sown rainfed condition
Vijetha (R 2001-2)	2010	UAS, Raichur	1600	47	West Bengal, Odisha and Jharkhand, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu	Resistant to PBNB; recommended for <i>Rabi</i> -summer season
HNG 69	2010	RAU, Hanumangarh	2800	50	Uttar Pradesh, Punjab, northern Rajasthan	Tolerant to collar rot, stem rot and ELS; recommended for <i>Kharif</i> season

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
Girnar 3 (PBS 12160)	2010	DGR, Junagadh	1520	45	West Bengal, Odisha, Manipur	Tolerant to leaf miner and thrips; recommended for <i>Kharif</i> season
Kadiri haritandhra (K 1319)	2010	ANGRAU, Kadiri	3728	48	Karnataka and Maharashtra	Multiple diseases and insect pests resistant, possess fresh seed dormancy upto 20 days; recommended for <i>Rabi</i> -summer season
VL-Moon-gphali-1	2010	VPKAS, Almora	1940	42.2	Uttarakhand (<i>Kharif</i>)	Resistant to LLS and root rot diseases. (State release)
GPBD-5	2010	UAS, Dharwad	1500	46.0	Jharkhand and Manipur (K)	Resistant to LLS and rust
GJG-HPS-1 (JSP-HPS-44)	2010	JAU, Junagadh	2120	49.0	Gujarat (<i>Kharif</i>)	Rose colour seed
Phule vyas (JL-220)	2010	MPKV, Jalgaon	2000	52	Maharashtra	Early maturing, High oil content.
Bheema	2010	RARS, Tirupati	3500-5000	45	Andhra Pradesh	Suited to <i>Kharif</i> and <i>Rabi</i> regions
Rohini	2010	RARS, Tirupati	3700-4000	50	Andhra Pradesh	Suited to <i>Kharif</i> and <i>Rabi</i> areas. Tolerant to mid and end season.
Pratap Raj Munghalli	2011	MAUT, Udaipur	1600-2200	48	Rajasthan	Moderately tolerant to ELS, LLS and PBND, Suited for <i>Kharif</i> and Summer
ALG-06-320	2011	TNAU, Aliyarnagar	3500	49	Vidharbha & Southern MP	Suitable for <i>Rabi</i> /summer
RG-510	2011	RAU, Durgapur	2600	49	Rajasthan and Punjab	Resistant to collar rot, stem rot, early leaf spot, rust and stem necrosis.
RG 425	2011	RAU, Durgapur	1800-3600	48	Rajasthan	Resistant to collar rot and tolerant to drought. Suitable for <i>Kharif</i>

Variety	Year of release	Releasing centre	Yield Potential (kg/ha)	Oil content (%)	Recommended for (state/region)	Specific features
RHRG-6021	2011	MPKV, Rahuri	3800	51	Western Maharashtra	Resistant to rust, LIS and stem rot and spodoptera
Divya (CSMG-2003-19)	2011	CAUAST, Mainpuri	3000	49	Uttar Pradesh	Resistant to leaf spots and tolerant to BND
HNG-123	2012	RAU, Hanumangadh	3000	49	Rajasthan, UP & Punjab	Virginia bunch variety, Tolerant collar rot, stem rot, LLS, Spodoptera
RARS-T-1	2011	ANGRAU, Tirupati	2500(K) 4000(R)	44	Andhra Pradesh	<i>Khharif, Rabi</i> -summer, Bold seeded pods
RARS-T-2	2011	ANGRAU, Tirupati	3734(K) 4200(R)	48	Andhra Pradesh	<i>Khharif, Rabi</i> -summer, Early maturity
ICGV-00350	2012	RARS, Tirupati	3000-4400	48	Tamil Nadu & Andhra Pradesh	Tolerant to LLS, rust, stem rot, High fodder value
CO-6	2012	TNAU, Coimbatore	1914	50-51	Tamil Nadu	<i>Khharif</i> , Resistant to LLS & Rust
GJG-31 (J-71)	2012	JAU, Junagadh	1632	49	Gujarat	Tolerant to stem rot, Free from PBND, Suitable for Summer
GJG-9 (J69)	2012	JAU, Junagadh	3483	49	Gujarat	Suitable for Summer, tolerant to stem rot
GJG-22 (JSP 36)	2013	JAU, Junagadh	1770	52	Gujarat	Suited to <i>Khharif</i> , semi spreading groundnut area. Tolerant to collar rot
GJG-17 (JSP-48)	2013	JAU, Junagadh	1798	48	Gujarat	Suitable for <i>Khharif</i> , spreading groundnut area. Tolerant to stem rot

ANNEXURE-V

POTENTIAL DISTRICTS OF RAPESEED & MUSTARD

Sl. No.	District	Area (hectares)		Production (tonnes)		Yield (kg/ha)				
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11			
Rajasthan										
1	Alwar	269865	251375	252730	448122	392953	426074	1661	1563	1686
2	Ganganagar	231071	212656	281408	368312	313417	565310	1594	1474	2009
3	Bharatpur	223223	200126	202688	366371	346158	374189	1641	1730	1846
4	Tonk	240420	173695	181304	221329	133548	277740	921	769	1532
5	S. Madhopur	173914	158433	151682	181030	175731	221220	1041	1109	1458
6	Hanumangadh	90324	89868	108061	141921	153655	222070	1571	1710	2055
7	Jaipur	137879	99209	130121	167028	101960	169984	1211	1028	1306
8	Baran	108438	114176	77635	152097	164496	122116	1403	1441	1573
9	Kota	90776	86065	55614	142971	126606	92662	1575	1471	1666
10	Karoli	88410	75293	74140	123322	104629	124837	1395	1390	1684
11	Jhunjhunu	83496	78412	93383	118970	101985	126198	1425	1301	1351
12	Dausa	85941	78748	71186	118240	103626	117594	1376	1316	1652
13	Dholpur	69802	65931	60772	104311	95340	108787	1494	1446	1790
14	Jalore	85607	62612	105461	72083	80878	145588	842	1292	1380
15	Jodhapur	91805	74197	78487	99212	94360	85521	1081	1272	1090
16	Sikar	70069	59702	74672	87893	74181	96870	1254	1243	1297
17	Nagaur	81540	46544	52924	94544	57654	71626	1159	1239	1353
18	Chittore	81026	39415	53119	92548	48215	71543	1142	1223	1347

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
19	Bundi	84285	63718	41701	85378	70656	48689	1013	1109	1168
20	Jhalwar	38038	39401	32622	52384	54250	38485	1377	1377	1180
21	Jaisalmer	76764	34680	69288	47574	22078	54207	620	637	782
22	Bikaner	42257	30279	42172	35144	19693	55065	832	650	1306
23	Bhilawara	44019	9614	32230	39779	7512	41228	904	781	1279
24	Pali	39303	10528	44012	25580	9817	34654	651	932	787
26	Barmer	24715	16854	25982	10668	14909	40522	432	885	1560
Haryana										
27	Bhiwani	140000	139000	138000	214000	214000	238000	1529	1541	1727
28	M. Garh	93000	94000	94000	173000	145000	171000	1855	1541	1902
29	Rewari	66000	65000	65000	131000	119000	125000	1981	1834	1979
30	Hisar	51000	53000	70000	90000	102000	141000	1757	1930	2012
31	Sirsa	42000	42000	42000	70000	75000	83000	1658	1781	1982
32	Jhajjar	35000	33000	27000	65000	52000	48000	1866	1597	1795
33	Mewat	29000	28000	23000	48000	42000	42000	1658	1503	1845
Madhya Pradesh										
34	Bhind	176700	177600	156500	226700	224400	262300	1283	1264	1676
35	Morena	151900	150600	155300	202500	196400	250400	1333	1304	1613
36	Sheopur Kalan	83700	75800	26000	102400	94000	30900	1224	1240	1189
37	Gwalior	58900	64400	65300	58600	70500	82900	994	1095	1271
38	Shivpuri	60200	61100	74800	45800	49200	57800	760	805	773
39	Mandsaur	36000	36000	29500	35800	36300	23200	995	1008	788
40	Neemuch	269000	193000	186000	242000	170000	206000	898	879	1106
41	Tikamgarh	24000	30800	44300	13000	15000	15600	539	488	352
42	Dindori	176000	172000	258000	112000	97000	133000	635	464	517

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Uttar Pradesh										
43	Mathura	61463	58042	51457	96378	83443	90358	1568	1438	1756
44	Agra	43615	44505	46861	78332	72096	85053	1796	1620	1815
45	Budaun	36305	28493	26479	34888	40023	34730	9.61	9.61	9.61
46	Aligarh	21944	20655	18910	30664	29306	27672	1397	1419	1463
47	Kanpur Dehat	22804	22614	22707	29481	23600	31871	1293	1044	1404
48	Kheri	31065	30431	30715	27370	23950	28258	881	787	920
Chhattisgarh										
49	Sarguja	42100	47030	34150	22210	26020	19230	528	553	563
Gujarat										
50	Banaskantha	150900	102500	120000	171300	164400	184800	1135	1602	1540
51	Patan	48200	45000	35400	54800	69500	55300	1138	1543	1532
52	Mehsana	52000	38500	34800	54500	59400	55000	1138	1544	1582
West Bengal										
53	Murshidabad	83585	83151	88694	65269	111039	97736	781	1335	1102
54	Nadia	63379	63286	72847	51776	69633	74915	817	1100	1028
55	24 Parganas (N)	39652	40553	37474	37025	52327	52882	934	1290	1411
56	Dinaipur (N)	38637	43587	42403	22380	41419	35010	579	950	826
57	Malda	32680	32698	30370	27216	38375	31788	833	1174	1047
58	Birbhum	34257	32833	32361	28956	34136	29152	845	1040	901
59	Bardhaman	27097	25480	20278	19885	24067	20091	734	945	991
60	Dinaipur (S)	23167	21226	21379	17169	17454	21381	741	822	1000
Assam										
61	Lakhimpur	24670	23428	23830	13257	11252	21793	537	480	915
62	Kokrajhar	16345	24571	25667	8486	15812	17413	519	644	678

ANNEXURE-VI

DETAILS OF VARIETIES/HYBRIDS OF RAPESEED & MUSTARD RELEASED AFTER 2001: INDIAN MUSTARD (*Brassica juncea*)

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
Aravali Mustard	2001	RAU, ARS Navgoan	1265	42	Haryana, Punjab and Rajasthan	Suitable for rainfed conditions
RCC 4	2001	SAREC, HPKVV, Kangra	1000-1200	39-40	Himachal Pradesh	Compact plant type
Basanti	2001	CSAUAT Kanpur	1179-1226	40-42	Uttar Pradesh	Yellow seeded, white rust resistant
NDRE 4	2001	NDUAT Faizabad	800-1000	40	Uttar Pradesh	Early maturing
Urvashi	2001	CSAUAT Kanpur	1600-1700	39	Uttar Pradesh	Tolerant to high temperature at seedling stage
Geeta (RB 9901)	2003	CCSHAU, RRS, Bawal	1773	40-42	Delhi, Haryana, Punjab and South Rajasthan	Suitable for rainfed conditions
Kanti	2003	CSAUAT Kanpur	1458-2068	40-42	Uttar Pradesh	Tolerant to high temperature at seedling stage
Maya (RK 9902)	2003	CSAUA&T, Kanpur	2500-2900	39-40	Madhya Pradesh and Uttar Pradesh	Suitable for irrigated conditions, resistant to white rust
RGN 13	2003	RAU, ARS Sriganaganagar	2200	41-43	Rajasthan	Suitable for normal sown irrigated conditions
Swaran Jyoti (RH 9801)	2003	CCSHAU, Hisar	1377	39-43	Haryana, Madhya Pradesh, South Rajasthan and Uttar Pradesh	Suitable for irrigated late sown and frost conditions
Vasundhra (RH 9304)	2003	CCSHAU, Hisar	2109	38-40	Haryana, Madhya Pradesh, South Rajasthan, Uttar Pradesh and Uttanchal	Suitable for normal sown irrigated conditions

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
CS 54 (CS 614-4-1-4)	2005	CSSRI, Karnal	1932	39-41	Haryana, MP, Rajasthan, UP and Gujarat	For salt affected soils
Ashirwad (RK-01-03)	2005	CSAUA, Kanpur	1450- 2358	31-41	Madhya Pradesh, Rajasthan, Uttar Pradesh and Uttarakhand	Moderately resistant at leaf and pod stage for <i>alternaria</i> blight and resistant for White rust. Suitable for irrigated late sown conditions
Jawahar Mustard 2	2005	ZRS Morena	1632- 2588	38-41	Madhya Pradesh and Chhattisgarh	White rust resistant
Jawahar Mustard 3	2005	ZRS Morena	1500- 2500	40	Madhya Pradesh	Tolerant to <i>Alternaria</i> blight
Narendra Swarna Rai 8	2005	NDUAT Faizabad	1681- 2211	36-45	Uttar Pradesh	Yellow seeded, high oil content
Pusa Karishma	2005	IARI, New Delhi	1731- 2506	37-38	Delhi	Low erucic acid, yellow seeded
Pusa Mahak (JD-6)	2005	IARI, New Delhi	597-1049	39-44	Odisha, WB, Bihar, Jharkhand, Chhattisgarh and Assam	An early maturing, for rainfed areas
Shivani	2005	BAU Kanke	653-930	37-41	Jharkhand	Suitable for rainfed
Gujarat Mustard 3	2006	SDAU, SK Nagar	Rainfed : 901-1362 Irrigated : 1673-2317	35-40	Gujarat	Tolerant to high temperature and salinity
RGN-48	2006	RAU, ARS, Sriganaganagar	1692- 2924	39-41	Haryana, Punjab and Rajasthan	Suitable for rainfed and frost conditions
Navgold (YRN-6)	2006	RAU, ARS, Navgoan	1253- 1803	39-40	Punjab and Haryana	Yellow seeded and suitable for late sown condition

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
RRN 505	2006	RAU Navgaon	1200- 1400	40	Rajasthan	Suitable for late sown conditions
PBR 210	2007	RSS, PAU Bathinda	2080- 2532	38-39	Punjab	Early maturity in Punjab conditions
RLC 1(ELM 079)	2007	PAU Ludhiana	1600- 2000	38	Punjab	Low erucic acid
NRCDR-2	2007	DRMR, Bharatpur	2213	39	Haryana, Punjab, Jammu, parts of Rajasthan and Delhi	Suitable for Irrigated conditions
Pusa Mustard-21 (LES 1-27)	2007	IARI, New Delhi	2111	34.0 – 40.0	Delhi, Haryana, Jammu & Kashmir (Plains) Punjab, Rajasthan and Western Uttar Pradesh	Low erucic acid (<2%)
RGN-73	2007	RAU, ARS, Sriganganagar	2006	40	Uttar Pradesh, Uttrakhand, Madhya Pradesh and parts of Rajasthan	Suitable for Irrigated, frost conditions
Shatabdi (ACN 9)	2007	PDKV Akola	468-1291	32-40	Maharashtra	Suitable for timely and late sown conditions
Pusa Mustard-22 (LET 17)	2008	IARI, New Delhi	2007	35.5	Haryana, Punjab, Jammu, parts of Rajasthan and Delhi	Suitable for Irrigated conditions, low erucic acid variety
TPM 1	2007	MPKV Jaigaon	1127- 1682	34-39	Maharashtra	Yellow seeded
Pusa Vijay (NPJ 93)	2008	IARI, New Delhi	1870- 2715	35-41	Delhi	High temperature tolerant at seedling stage and salinity
CS 56 (CS-234-2)	2008	CSSRI, Karnal	1170- 1423	34.2- 38.0	Haryana, Punjab and parts of Rajasthan	Suitable for late sown conditions, salt tolerant, 1000 seed weight more than 6 g.

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
Pusa Mustard-24 (LET-18)	2008	IARI, New Delhi	1241- 2904	32.0- 39.7	Haryana, Punjab, New Delhi and parts of Rajasthan	Low erucic acid (<2%)
Dhara mustard hybrid 1 (DMH 1) Hybrid	2009	Dhara Vegetable Oils	1782- 2249	38-42	Delhi, Haryana, Punjab, J&K and Rajasthan	High pod density, resistant to white rust
NRC HB 101	2009	DRMR, Bharatpur	1382- 1491	35-42	Madhya Pradesh, Uttar Pradesh, Uttarakhand and Eastern Rajasthan	Suitable for late sown irrigated conditions
NRCHB506 (Hybrid)	2009	DRMR, Bharatpur	1550- 2542	39-43	Madhya Pradesh, Uttar Pradesh, Uttarakhand and Eastern Rajasthan	High adaptation
RB 50	2009	CCSHAU, RRS, Bawal	846-2425	39-40	Delhi, Haryana, Punjab, J&K and Rajasthan	Suitable for rainfed conditions
RGN 145	2009	RAU, ARS, Sriganagar	1448- 1640	35-39	Delhi, Haryana, Punjab, J&K and Rajasthan	Suitable for late sown irrigated conditions
Pusa Mustard 25 (NPJ 112)	2010	IARI, New Delhi	1324- 1654	36-41	Delhi, Haryana, Punjab, J&K, Rajasthan, Western and Uttar Pradesh	Suitable for early sown irrigated conditions, high temperature tolerance at juvenile stage
Pusa Tarak	2009	IARI, New Delhi	1852- 1996	38-42	Delhi	High temperature tolerant and bold seeded
Coral PAC 432 (Hybrid)	2010	United Phosphorus, Bangalore	1831- 2581	40-42	Uttar Pradesh, Uttarakhand and Rajasthan	Hybrid
NRCDR 601 (DMR 601)	2010	DRMR, Bharatpur	1939- 2626	39-42	Delhi, Haryana, Punjab, J&K and Rajasthan	Tolerant to salinity and high temperature at sowing time

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
Pusa Mustard 26 (NPJ 113)	2011	IARI, New Delhi	1481- 1895	30-41	J&K, Punjab, Haryana, Rajasthan, Delhi and UP	Suitable for late sown irrigated conditions in <i>Rabi</i> season
Pusa Mustard 27 (EJ 17)	2011	IARI, New Delhi	1437- 1659	40-45	UP, MP, Uttarakhnad and Rajasthan	Suitable for early sown irrigated conditions and for multiple cropping
Pusa Mustard 28	2012	IARI, New Delhi	1912- 2098	40- 42.8	Delhi, Haryana, J&K, Punjab and Rajasthan	Early sown
Coral 437	2012		1831- 2581	39.2- 41.2	Delhi, Haryana, Punjab, J&K and Rajasthan	Hybrid, WRE resistant
RGN 229	2011	RAU, ARS, Sriganagar	2162- 2568	37.8- 42.1	Delhi, Haryana, Punjab, J&K and Rajasthan	Tolerant to high temperature and salinity during seedling stage
RGN 236	2011	RAU, ARS, Sriganagar	1485- 1808	36.3- 40.8	Delhi, Haryana, Punjab, J&K and Rajasthan	Tolerant to high temperature and salinity during seedling stage
LET-36	2013		1927- 2568	30- 39.8	Delhi, Haryana, Punjab, Jammu and Rajasthan	Low erucic acid content
LET-43	2013		1564- 2238	36- 39.4	UP, Uttarakhnad, MP and Estern Rajasthan	Low erucic acid content
DRMRJ 31	2013		2246- 2757	38.7- 42.5	Delhi, Haryana, Punjab, Jammu and Rajasthan	High seed yield & bold seed size
PR 20061 (Pant rai 19)	2011/ 201		1831- 2511	40.9- 41.8	Delhi, Haryana, Punjab, Jammu and Rajasthan	Tolerant to high temperature at early stage
RLC-2 (ELM 123)	2012		2039- 2342	36.3- 38.9	Delhi, Haryana, Punjab, Jammu and Rajasthan	Superior oil quality
RH 0406	2013		2200- 2300	38-40	Delhi, Haryana, Punjab, Jammu and Rajasthan	Bold seeded lodging resistant

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
PBR-357	2011		1373- 3819	35.8- 41.5	Delhi, Haryana, Punjab, Jammu and Rajasthan	Timely sown irrigated conditions
PBR-378	2012		1228- 3484	37.7- 41.9	Delhi, Haryana, Punjab, Jammu and Rajasthan	Timely sown rainfed conditions
Raj Vijay Mustard-2 (JMWR 08-3)	2013		1276- 1874	37.1- 41.2	Delhi, Haryana, Punjab, Jammu and Rajasthan	Moderately resistant to white rust
44 S 01	2012		1109- 1429	36.9- 42.7	West Bengal, Bihar, Odisha and NEH region	Early maturity rainfed conditions
Divya-33	2013		1699- 3560	36- 40.7	Delhi, Haryana, Punjab, J&K and Rajasthan	Tolerant to high temperature
RH 0749	2013		2400- 2800	39- 39.5	Delhi, Haryana, Punjab, J&K and Rajasthan	Timely sown irrigated condition
RH 0119	2012	2009/2010	1047- 2156	38.5- 39.8	Haryana	Thermo-tolerant
PM 29	2013				Delhi, Haryana, J&K, Punjab and Rajasthan	
PM 30	2013				UP, Uttarakhand, MP and Rajasthan	
Giriraj	2013				Rajasthan and Haryana	
RRN 573	2013				Rajasthan	
Karan rai (<i>Brassica carinata</i>)						
Pusa Swarnim (IGC-01)	2003	IARI, Pusa, New Delhi	1567	42-43	Delhi, Haryana, Himachal Pradesh and Punjab	Suitable for irrigated and rainfed conditions
Pusa Aditya	2006	IARI, Pusa, New Delhi	1400	38.2- 41.2	Delhi	Suitable for rainfed conditions

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
Taramira (<i>Eruca sativa</i>)						
Karan Tara (RTM-314)	2001	SKN College Jobner	1050	34-35	Harayana, Punjab, Rajasthan and Uttar Pradesh	For rainfed areas
Narendra Tara (RTM- 2002)	2007	SKN College Jobner	1001- 1115	37-38	Rajasthan	For rainfed areas
Vallabha Taramira1 (PUT 93- 11)	2011	ZRS, Ujhani	616-1133	38-40	Uttar Pradesh	Moderately resistant to alternate blight and aphid
Vallabha Taramira2 (PUT 93-1)	2011	ZRS, Ujhani	500-1283	38-39	Uttar Pradesh	Resistant to white rust, moderately resistant to alternate blight and aphid
Brown sarson (<i>Brassica rapa</i> var <i>brown sarson</i>)						
	2001	SAREC, HP KVV, Kangra	900-1200	44	Himachal Pradesh	Resistant to white rust and tolerant to cold
Toria (<i>Brassica rapa</i>)						
Parbati	2001	OUA&T, Bhubaneswar	1380	42	Odisha	For rainfed areas
Anuradha	2002	OUA&T, Bhubaneswar	1460	44	Odisha	For rainfed areas
VL Toria-3	2007	VPKAS, Almora	769-1106	39-41	Uttarakhand Hills	-
Uttara	2010	GBPUA&T, Pantnagar	1000	42	Uttarakhand plains	Moderately resistant to white rust, downey and powdery mildew

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
Yellow Sarson (<i>Brassica rapa</i> var yellow sarson)						
Ragini (MYSL- 203)	2001	MAHYCO, Jalana, MS	1567	44	Bihar, Eastern Uttar Pradesh and West Bengal	Suitable for irrigated conditions
NRCYS 05-02	2009	DRMR, Bharatpur	1239-1715	38.2- 46.5	Yellow sarson growing areas of the country	Early maturity, medium height and high oil content
YSH 0401	2009	CCS HAU, Hisar	1273- 1651	43-45	Yellow sarson growing areas of the country	Bold seeded
PYS-1 (Pant Pili Sarson)	2010	GBPUA&T, Pantnagar	1050- 1163	42-44	Uttarakhand	For irrigated areas
Gobhi Sarson (<i>Brassica napus</i>)						
Hyola-401 (Hybrid)	2001/ 1997	United Phosphorus Ltd Bangalore	1200- 1640	42	Haryana, Himachal Pradesh and Punjab	Double low (low erucic acid, 0.8% and low glucosinolate content, 15 micromoles/g defatted seed meal)
Neelam	2001	ORS HPKVV Kangra	1570	43	Himachal Pradesh	Suitable for late sown conditions
GSC-5	2005/ 2007	PAU, Ludhiana	1719- 2390	37-43	Punjab	Low erucic (<2%) and low glucosinolate (26-41 micromoles/g defatted seed meal)
TERL- Uttam- Jawahar [TERI (00) R 9903]	2007	TERI, New Delhi	1619- 2685	43-45	Madhya Pradesh	Low erucic acid (<2%) and low glucosinolate (12.2 micromoles/g defatted seed meal)

Variety/ Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/region/ situations	Specific features/traits
GSC-6 (OCN-3)	2008	PAU, Ludhiana	1795	39.0	Punjab, Haryana and Jammu	Irrigated areas
NUDB-26- 11	2008	Mother Dairy Fruit & Veg- table Pvt Ltd, Noida, UP	984-1339	38-42	Himachal Pradesh and J&K	Low erucic and low glucosinolate content, suitable for irrigated conditions
Him Sarson 1 (ONK 1)	2008	SAREC, CSK HPKVV, Kangara	693-1789	38-42	Himachal Pradesh and J&K	Low incidence of <i>Alternaria</i> leaf blight and <i>Sclerotinia</i> stem rot, resistance to white rust and moderate resistance to downy and powdery mildew, wider adaptability
GSC 101	2013		1793- 2190	38.6- 42.0	Delhi, Haryana, Punjab, J&K and Rajasthan	Double low (Low erucic acid and low glucosinolate content)
Black mustard (<i>Brassica nigra</i>)						
Surya (LBM-428)	2003	ANGRAU, Lam, AP	1000- 1200	40-41	Andhra Pradesh	-

ANNEXURE-VII

POTENTIAL DISTRICTS OF SESAME

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
West Bengal										
1	Midnapur (W)	63459	60278	61278	29771	44487	61349	469	738	1001
2	Hooghly	30830	26572	29742	21268	21704	28677	690	817	964
3	Nadia	22618	20595	20529	23801	21764	21829	1052	1057	1063
4	Murshidabad	17955	15946	17707	16539	16888	14400	921	1059	813
5	Bankura	28070	21661	17403	14951	12417	12450	533	573	715
6	Bardhaman	20204	18552	16934	9729	13119	13032	482	707	770
Rajasthan										
1	Pali	141969	146665	107074	31594	2022	47049	223	14	439
2	S. Madhopur	39125	61356	32523	15777	20629	11119	403	336	342
3	Tonk	47502	72821	41855	18142	6736	16021	382	93	383
4	Kota	16297	21591	53696	6242	12299	17448	383	570	325
5	Karoli	11093	28756	17723	7749	17145	8332	699	596	470
6	Baran	6776	10114	36444	2763	5873	17934	408	581	492
7	Bundi	18575	15967	36413	6225	3712	15408	335	232	423
8	Bhilawara	34619	28957	27652	7724	2964	12913	223	102	467
9	Jodhapur	43562	36066	29577	10482	360	12666	241	10	428
10	Nagaur	28072	18811	23223	8579	321	9001	306	17	388
11	Jaipur	11649	27527	16511	5634	5030	5860	484	183	355
12	Jalore	24634	25281	17368	3855	6067	5622	156	240	324
13	Ajmer	25703	25449	21321	6173	535	8130	240	21	381
14	Dausa	8664	15787	12346	4408	5560	3585	509	352	290

Sl. No.	District	Area (hectares)		Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
15	Sirohi	11289	16004	16144	1603	790	142	49	490
Madhya Pradesh									
1	Chhatarpur	58300	72700	48000	20300	24300	349	334	335
2	Datia	19700	41900	44900	8100	22900	408	546	523
3	Tikamgarh	33900	38300	22800	14700	18200	434	475	467
4	Gwalior	15800	24100	25000	7900	14300	498	592	802
5	Sheopur Kalan	19600	27600	32400	8400	11100	430	400	467
6	Panna	11100	25700	26400	7600	11500	684	449	451
7	Shivpuri	13300	12700	13000	7800	7100	587	560	718
8	Singroli	11500	12200	13000	4500	5700	388	464	532
Gujarat									
1	Surendranagar	76600	60700	51900	23400	20300	306	334	414
2	Kutch	24900	39200	48300	9200	19500	371	499	381
3	Bhavanagar	25600	24300	23800	12100	7300	471	300	664
4	Rajkot	16600	19700	29300	5600	8000	337	407	307
5	Amreli	18600	16300	20000	7900	4000	422	246	450
6	Junagadh	2200	1500	38100	700	500	316	354	507
7	Banaskantha	19700	18200	19300	5700	5100	288	278	461
8	Jamnagar	10600	8800	21100	6100	4200	577	476	441
Uttar Pradesh									
1	Jhansi	33165	105226	76589	5671	4735	171	45	315
2	Jalaun	33327	50539	49714	6799	5104	204	101	166

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
3	Hardoi	14869	25934	25644	3167	3527	5283	213	136	206
4	Lalitpur	9846	11485	14489	1694	3503	3898	172	305	269
5	Mahoba	17961	31435	26755	1832	1477	3558	102	47	133
6	Hamirpur	5838	37855	34529	618	1780	2969	106	47	0.86
7	Banda	1998	15146	15170	312	712	2715	156	47	179
Andhra Pradesh										
1	Vizianagaram	18999	19261	15200	1985	4793	2900	104	249	191
2	Prakasham	4274	11807	39950	2156	2400	4925	504	203	123
Karnataka										
	Gulbarga	7677	12108	15782	2305	1288	5278	316	112	352

ANNEXURE-VIII

DETAILS OF VARIETIES OF SESAMUM RELEASED AFTER 2001

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha) Rainfed	Recommended states/ regions/situations	Specific features
Sekhar	2001	CSAUT, Kanpur (UP)	50-53	750-800	<i>Kharrif</i> ; Uttar Pradesh	Duration 85-90 days, White seed, Resistant to phyllody, leaf curl, powdery mildew, Moderately resistant to Phytophthora blight, Macrophomina
RT-127	2001	ARS, RAU, Mandore (Rajasthan)	50-52	750-850	<i>Kharrif</i> ; Rajasthan	Duration 82-86 days, White bold seed, Tolerant to Macrophomina, bacterial leaf spot, powdery mildew
JTS-8	2001	ZARS, JNKVV, Tikamgarh (MP)	50-53	650-700	<i>Kharrif</i> ; MP, UP, Raj. Maharashtra, Gujarat, and adjoining parts of AP and Karnataka	Duration 82-85 days, White seed, Moderately resistant to Macrophomina, Alternaria leaf spot, Phytophthora blight
AKT-64	2001	PDKV, Agril. College, Nagpur (MS)	48-52	700-750	<i>Kharrif</i> ; Vidharbha region of Maharashtra	Duration 85-90 days, White seed, Tolerant to Macrophomina, Phytophthora
AKT-101	2002	PDKV, Agril. College, Nagpur (MS)	50-53	750-800	Summer, Vidharbha region of Maharashtra	Duration 88-90 days, Moderate resistant to Macrophomina, bacterial blight
Pragati (MT-75)	2002	CSAUT, Kanpur (UP)	48-52	700-750	<i>Kharrif</i> ; UP, Haryana, Rajasthan Bihar, Chhattishgarh, Andhra Pradesh, Karnataka, Maharashtra and Gujarat	Duration 85-90 days, White seed, Resistant to leaf curl, powdery mildew, Moderately resistant to Phytophthora blight, Macrophomina
Nirmala (OS-Sel-164)	2002	Ouat, bhubaneswar (Odisha)	42-45	650-700	<i>Kharrif</i> ; Odisha	Duration 84-88 days, White seed, Tolerant to wilt, Resistant to bacterial leaf spot, powdery mildew, Moderately resistant to stem/root rot, Alternaria leaf spot

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha) Rainfed	Recommended states/ regions/situations	Specific features
Prachi	2002	OUAT, Bhubaneswar (Odisha)	42-45	700-750	<i>Kharif, Rabi</i> , Odisha	Duration 85-90 days, Black seed, Moderately resistant to <i>Macrophomina</i> stem/root rot, phyllody
Gujarat Til-10	2002	ARS, GAU, Amreli (Gujarat)	48-52	700-800	<i>Kharif</i> , Gujarat	Duration 88-92 days, Black seed, profusely branched, flower colour pinkish white, Resistant to powdery mildew
JCS-94 (Chandan)	2002	RARS, ANGRAU, Jagtial	45-48	<i>Kharif</i> 550-600 Summer 1000-1100	<i>Kharif, Rabi</i> and semi- <i>Rabi</i> , Andhra Pradesh	Duration 84-88 days, Brown seed, Tolerant to bacterial blight
Tarun	2005	CSAUT, Kanpur (UP)	52-55	700-750	<i>Kharif</i> , UP, Rajasthan, MP, AP, KK and Bihar	Duration 90-95 days, White seed, Moderately resistant to diseases
VRI (SV)-2	2006	TNAU, Coimbatore (TN)	50-52	700-800	<i>Kharif</i> rainfed and Irrigated, Tamil Nadu	Duration 80-85 days, Reddish brown seed, Indeterminate, glabrous, mixed in phyllotaxy, basal branch habit, profuse branching, Moderately resistant to phyllody and root rot
Hima (JCS-9426)	2006	RARS, Jagtial (AP)	48-50	<i>Kharif</i> 700-750 Summer 1100-1200	<i>Late Kharif, Rabi</i> and semi- <i>Rabi</i> , Andhra Pradesh in chalka and light black soils	Duration 75-80 days, Shiny white seed, field tolerance to <i>Alternaria</i> leaf spot
Amrit [OSC-24 (95)2-1-3]	2006	OUAT, Bhubaneswar (Odisha)	43-46	750-850	<i>Kharif</i> rainfed, <i>Rabi</i> summer irrigated, AP, TN, CG, WB and MP	Duration 80-85 days, Light brown seed, Tolerant to major diseases
Gujarat Til-3	2006	ARS, GAU, Amreli (Gujarat)	48-52	750-800	<i>Kharif</i> , Saurashtra region of Gujarat	Duration 84-88 days, White bold seed

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha) Rainfed	Recommended states/ regions/situations	Specific features
Jawahar Til PKDS-11 (Venket)	2006	ZARS, JNKVV, Powarkheda (MP)	46-50	650-700	<i>Kharrif</i> ; Punjab, Haryana, Gujarat, MS, UP, HP, MP, WB, AP and Jharkhand	Duration 82-85 days, Dark brown, Tolerant to Macrophomina stem/root rot
TKG-306	2006	ZARS, JNKVV, Tikamgarh (MP)	49-52	750-800	<i>Kharrif</i> ; Madhya Pradesh	Duration 86-90 days, White seed, seed weight 2.8 g. Resistant to Phytophthora blight and Moderately resistant to Macrophomina, Cercospora, powdery mildew, Alternaria leaf spot
Thilak	2006	RRS, KAU, Kayamkulam, Kerala	48-50	600-650	<i>Kharrif</i> ; Onattukara region of Kerala (Summer rice fallows)	Duration 85-90 days, Blackish brown seed, Tolerant to moisture stress
Thilathara	2006	RRS, KAU, Kayamkulam, Kerala	48-52	600-650	<i>Kharrif</i> ; Onattukara region of Kerala (Summer rice fallows)	Duration 84-88 days, Blackish brown seed, shy branching, Resistant to powdery mildew
Thilarani	2006	RRS, KAU, Kayamkulam, Kerala	46-50	700-750	<i>Kharrif</i> ; Onattukara region of Kerala	Duration 82-86 days, Dark brown seed, Resistant to powdery mildew
SWB-32-10-1 (Savitri)	2008	ORS, Berhampore. (WB)	48-52	1200-1500 Summer	<i>Rabi</i> ; Summer, West Bengal	Duration 84-88 days, Light brown seed, Tolerant to Macrophomina
Jawahar Til-12 (PKDS-12)	2008	ZARS, JNKVV, Powarkheda (MP)	48-52	700-750	Summer, Madhya Pradesh	Duration 82-85 days, White seed, Moderately resistant to Macrophomina stem/root rot
Jawahar Til-14 (PKDS-8)	2008	ZARS, JNKVV, Powarkheda (MP)	50-53	700-750	Summer, Madhya Pradesh	Duration 82-85 days

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha) Rainfed	Recommended states/ regions/situations	Specific features
RT-346	2009	BAU Bikaner	49-51	750-850	<i>Kharif</i> , Rajasthan Haryana, Punjab, Himachal Pradesh, Gujarat, Uter Pradesh and Maharashtra	Duration 82-86 days, White seed, Resistant to leaf curl, Moderately resistant to Macrophomina, Alternaria, Cercospora
PKV-NT-11	2009	PDKV, Agril. College, Nagpur (MS)	50-53	800-850	Summer, Vidharbha region of Maharashtra	Duration 88-92 days, White seed, Moderately resistant to root rot, bacterial blight
DSS-9	2009	UAS, Dharwad	48-50	600-650	Zone I & II of Karnataka	Duration 85-90 days, White bold seed, early maturing
JLT-408	2010	Oil Seeds Research Station MPKV Jalgaon	51-53	700-800	Assured rainfall zone of Khandesh and adjoining areas of Vidharbha, Marathwada region	Duration 80-85 days, White seed
RT-351	2011	ARS, RAU, Manodre (Raj)	48-50	700-800	Resistant to Macrophomia, Leaf curl, Phillody, Moderately resistant to cercospora & capsule borer	Rajasthan, Gujarat, UP, Maharashtra, Haryana, Punjab, HO, KK & J&K
TKG-308	2010	ZARS, JNKVV, Tikamgadh	48-50	700-750	Madhya Pradesh (<i>Kharif</i>)	Moderately resistant to Macrophomia, Cercospora, Bacteria leaf spot, Leaf curl, Tolerant to capsul borer

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha) Rainfed	Recommended states/ regions/situations	Specific features
Shubra	2012	OUAT, Bhubaneswar, Odisha	48-52	800-900	Odisha (<i>Kharif</i> , summer)	Golden yellow bold seed, delayed shattering, synchronous maturity
Smarak	2012	OUAT, Bhubaneswar, Odisha	46-50	800-900	Odisha (<i>Kharif</i> , summer)	White seed, tolerant to leaf curl, phyllody, macrophomina, cercospora and capsule borer
Gujarat til-4	2012	ARS, JAU, Amreli	47-49	750-800	<i>Kharif</i> , North Saurashtra Zone IV of Gujarat	White seed, tolerant to leaf spot
DS-5	2012	USA, Dharwad	49-51	600-700	<i>Kharif</i> summer, Karnataka	White bold seed

ANNEXURE-IX

POTENTIAL DISTRICTS OF SUNFLOWER

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Karnataka										
1	Raichur	162826	132138	56116	60591	29463	34118	372	235	608
2	Bagalkot	88433	60584	35440	46310	24551	29559	524	427	834
3	Gulbarga	134365	114959	32724	52016	31298	12652	387	287	387
4	Bijapur	142801	119522	59598	41349	26514	24158	290	234	405
5	Bellary	93229	67595	40449	36826	25251	29117	395	393	720
6	Koppal	91178	83434	39951	28628	18978	27535	314	239	689
7	Gadag	78710	55276	39673	28675	14872	24116	364	283	608
8	Belgaum	42405	31673	20869	28160	14874	15782	664	494	756
9	Chitradurga	42153	29751	13659	17285	11323	9736	410	401	713
10	Davanagere	16717	12239	4721	11083	10069	4216	663	866	893
11	Hassan	14748	15295	6809	8238	8136	6099	559	560	896
12	Chamarajanagar	16866	16181	12343	11154	3415	5662	661	222	459
15	Dharwad	16626	8297	10220	6135	3785	6542	369	480	640
16	Chikmangalur	13951	13675	4845	5956	6242	2972	427	480	613
Andhra Pradesh										
1	Kurnool	144534	140629	78213	113086	84432	63375	782	600	810
2	Kadapa	93468	53688	74025	38470	59819	17716	412	1114	239
3	Prakasham	39982	23750	18503	40780	23312	22870	1020	982	1236
4	Anantpur	42268	55286	17615	26305	33503	14072	622	606	799
5	Mahabubnagar	24279	24340	10833	17355	16387	7739	715	673	714
6	Medak	15637	14820	8362	28187	20154	12464	1803	1360	1491
7	Nizamabad	29054	16170	5934	35702	12613	5673	1229	780	956

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Maharashtra										
1	Osmanabad	63300	56500	50900	39800	31300	29900	629	554	587
2	Latur	43100	34200	25300	24100	17000	17900	559	497	708
3	Solapur	23900	24400	17900	14300	11400	9000	598	467	503
4	Akola	18700	8100	8200	10300	4000	6500	551	494	793
5	Amravati	17400	12600	2900	10100	7600	2600	580	603	897
6	Parbhani	11500	10800	9800	6700	5600	6500	583	519	663
7	Beed	16600	11000	6000	8500	6400	3400	512	582	567

ANNEXURE-X

DETAILS OF VARIETIES/HYBRIDS OF SUNFLOWER RELEASED AFTER 2001

VARIETIES

Variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/ regions situations	Salient features/traits
DRSF-108	2004	DOR, Hyderabad	900-1800	36-39	All India	High oil
CO-5	2005	TNAU Coimbatore	1000-1700	39-42	Tamil Nadu	-
TAS-82	2005	PDKV Akola	800-1200	40-42	Maharashtra	Black seeded variety
LSF-8	2006	Latur, Maharashtra	100-1400	36-39	Maharashtra	Tolerant to downy mildew, rust and <i>Alternaria</i>
DRSF-113	2007	DOR, Hyderabad	1000-1500	36-39	All India	High yield
Phule Raviraj	2009	MPKV, Rahuri	1795	34	Western Maharashtra	Tolerant to Necrosis, <i>Alternaria</i> and Capitulum borer
RSFV-901 (Kanthi)	2012	RARS, Raichur	1200-1400	-	Karnataka	Tolerant necrosis

HYBRIDS

Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/ regions situations	Salient features/traits
KBSH-41	2005	UAS, Bangalore	1300-1500	39-41	Karnataka	Tolerant to moisture stress
KBSH-42	2002	UAS, Bangalore	1300-1500	38-41	Karnataka	Tolerant to moisture stress
PSFH-118	2002	PAU Ludhiana	1400	40	Punjab	Resistant to stem and head rot
KBSH-44	2003	UAS Dharwad	1400-1600	36-38	All India	Resistant to downy mildew

Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/ regions situations	Salient features/traits
LSFH-35 (Maruti)	2003	Latur, Maharashtra	1400-1500	39-41	Maharashtra	Resistant to downy mildew
NDSH-1 (NDSH-15)	2003	ANGRAU, Nandyal	1400	40	Andhra Pradesh	Early maturing hybrid
RSFH-1	2004	UAS Raichur	1300-1500	39-41	Karnataka (Zone 2 and 3)	High oleic hybrid
HSFH-848	2005	HAU Hissar	1800-2400	41-42	Haryana	Dwarf hybrid
DRSH 1	2006	DOR Hyderabad	1300-1600	42-44	All India	High oil
KBSH-53	2009	UAS, Bangalore	1700-2700	42-44	Karnataka	Resistant to powdery mildew
PSFH-569	2009	PAU Ludhiana	2232	40	Punjab	High oil, early hybrid
Suryamukhi	2010	PAU, Ludhiana	2000-2200	40	Punjab	
RSFH-130	2012	RARS, Raichur	1200-1500	40	Karnataka	Tolerant to necrosis
CO-2	2012	TNAU, Coimbatore	1900-2200	38-40	Tamil Nadu	Moderate resistant to Alternaria leaf spot, rust & tolerant to thrips and leaf hopper
Olisun 3794 (PAC-3794)	2013	Advant India Ltd.	1594	38	Maharashtra, TN, Karnataka and AP	For both rainfed/irrigated & <i>Kharif/Rabi</i> , Resistant to downy mildew

POTENTIAL DISTRICTS OF SAFFLOWER

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Maharashtra										
1	Parbhani	36600	37000	34900	22000	22900	16200	601	619	464
2	Osmanabad	28300	30600	28900	14200	16500	16900	502	539	585
3	Hingoli	22700	20500	25700	11600	13800	17200	511	673	669
4	Latur	22600	22300	15400	11600	8800	10300	513	395	669
5	Jalna	13000	11800	7600	9600	7000	4900	738	593	645
Karnataka										
1	Bidar	10804	11412	11398	13394	15408	14174	1305	1421	1309
2	Gulbarga	14355	14679	9877	9101	10949	5968	667	785	636

ANNEXURE-XII

DETAILS OF VARIETIES/HYBRIDS OF SAFFLOWER RELEASED AFTER 2001

VARIETIES

Variety	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/ regions situations	Salient features/traits
Parbhani Kusum (PBNS-12)	2001	MAU, Parbhani	1900	29	All India	Spiny
Phule Kusuma (JLSF-414)	2003	MPKV, Solapur	1200-1500 I 2000-2200 (I)	29	All India	Spiny
JSF-97	2004	RVSKVV, Indore	1500-1600	30	Madhya Pradesh	Non-spiny, Moderately tolerant to <i>Alternaria</i> , wilt and aphids
JSF-99	2004	RVSKVV, Indore	1100-1200	28-29	Madhya Pradesh	Semi-spiny, Moderately tolerant to <i>Alternaria</i> , wilt and aphids
PBNS-40	2006	MAU, Parbhani	1500	27	Madhya Pradesh	Non spiny
AKS-207	2006	PDKV, Akola	1200-1400	27	Maharashtra	-
NARI-38	2007	NARI, Phaltan	2038	28	All India	Resistant to wilt
SSF-658	2009	MPKV, Solapur	1430	28	All India	Tolerant to wilt and aphids
SSF-708	2012	MPAU, Solapur	1300-2200	29	Western Maharashtra	Moderately tolerant to aphid
PKV-Pink (AKS-311)	2013	SRS, Oilseeds, PDKV, Akola	2200-2500	33	Vidharbha region of Maharashtra	Moderately tolerant to wilt

HYBRIDS

Hybrid	Year of release	Releasing Centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/ regions situations	Salient features/traits
NARI-NH-1 (PH-6)	2002	NARI, Phaltan	1936	31	All India	Non spiny hybrid, moderately resistant to <i>Cercospora</i> leaf spot, wilt; tolerant to <i>Alternaria</i> and aphids
NARI-H-15	2005	NARI, Phaltan	2200	29	All India	-
MRSA-521	2006	MAHYCO, Jalna	1000-1500 (R) 2200-2500 (I)	27	All India	Resistant to wilt; tolerant to <i>Alternaria</i> and aphids
NARI-H-23	2013	NARI, Phaltan			Maharashtra, Karnataka, MP, Chhattisgarh, Rajasthan and WB	Suited for Irrigated and assured rainfall

ANNEXURE-XIII

POTENTIAL DISTRICTS OF NIGER

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Madhya Pradesh										
1	Dindori	25600	25600	34100	4800	4800	6200	1890	1820	1820
2	Betul	22700	19400	18900	5900	4900	4900	2580		2580
3	Chhindwara	14900	14300	15300	3200	3300	3500	2130	2280	2280
4	Anuppur	9900	10900	11700	2700	2100	1800	2770	1880	1500
Odisha										
1	Koraput	41920	38590	38140	16090	9800	16550	384	254	434
2	Rayagada	12660	13110	11450	4050	3890	5280	320	297	461
3	Keonjhar	15630	12270	12920	3980	4100	3270	255	334	253
4	Phulbani	12060	12400	11220	3710	3530	3570	308	285	318
Chhattisgarh										
1	Sarguja	23390	30000	38000	4860	6450	8360	208	215	220
2	Jashpur	21760	23910	24020	4350	6260	6610	200	262	275
3	Jagdalpur	19250	19090	18790	4830	5540	5540	251	290	295
Maharashtra										
1	Nasik	16300	13800	12300	4900	3000	1800	301	217	146

DETAILS OF VARIETIES OF NIGER RELEASED AFTER 2001

Variety	Year of release	Releasing centre	Oil content (%)	Potential Yield (kg/ha) rainfed	Recommended states/ regions/situations	Specific features
N-5	2001	PDKV, Akola (MS)	36-39	600-650	Bihar and Maharashtra	Duration 95-100 days, Small black and sickle shaped seed
Gujarat Niger-1	2001	Niger Res. Stn., Vanarasi, Gujarat.	35-38	600-650	Gujarat	Duration 95-100 days, Black seed
JNC-6	2002	ZARS, JNKVV, Chhindwara (MP)	37-38	650-700	MP; Bihar, MS, Karnataka and Rajasthan	Duration 95-100 days, Shining dark black seed
NRS-96-1	2003	Niger Res. Stn., Vanarasi, Gujarat.	35-38	650-700	All niger growing states	Duration 90-95 days, Black seed
Birsa Niger-2 (BNS-8)	2005	BAU, Ranchi (Jharkhand)	35-38	600-650	All niger growing states	Duration 95-100 days, Black seed
Jawahar Niger Composite-1	2006	ZARS, JNKVV, Chhindwara (MP)	38-40	650-700	MP, MS, Bihar, Rajasthan and Karnataka	Duration 90-100 days, Black seed
JNS-9 (JNC-9)	2006	ZARS, JNKVV, Chhindwara (MP)	38-40	650-700	All niger growing states	Duration 95-100 days, Black seed

Variety	Year of release	Releasing centre	Oil content (%)	Potential Yield (kg/ha) rainfed	Recommended states/ regions/situations	Specific features
IGPN-2004-1, (Phule Karala-1)	2010	ZARS, Igatpuri (MS)	39-41	650-700	<i>Kharif</i> season in MS and Karnataka (High rainfall areas of Maharashtra)	Duration 95-100 days, Shining black seed, Resistant to Alternaria, powdery mildew
BNS-10 (Pooja-1)	2009	BAU, Ranchi (Jharkhand)	36-38	650-700	All niger growing states	Duration 95-100 days, Shining black seed, Resistant to pests, diseases
KBN-1	2009	UAS, Bangalore			Karnataka	Moderately resistant to alternaria leaf spot
Birsa Niger-3 (BNS-11)	2010	BAU, Ranchi (Jharkhand)			Jharkhand, Chhattisgarh, MP, Odisha, Maharashtra, AP, WB and Kerala	Early maturing variety 85 days, drought tolerant
Utkal Niger-150	2011	RRTS, OUA&T, Semiliguda (Odisha)	38-40	650-700	Odisha	Duration 105-110 days, Black seed, Tolerant to Alternaria, Cercospora, cuscuta
DNS-4	2012	USA, Dharwad	39-41	500-600	<i>Kharif</i> , Karnataka	Shining Black seed, robust growth habit

ANNEXURE-XV

POTENTIAL DISTRICTS OF LINSEED

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Madhya Pradesh										
1	Balaghat	16800	15700	20600	7000	8100	8900	418	518	424
2	Rewa	13100	14200	11700	4100	4500	2700	315	316	232
3	Seoni	10000	10100	10000	3800	4000	3000	377	401	300
Chhattisgarh										
1	Sarguja	13400	13570	9100	4880	5600	3870	364	413	425
2	Rajnandgaon	16350	10100	10550	5590	3750	4010	342	371	380
3	Janjgir	8080	11690	12610	3090	4860	5370	382	416	426
Odisha										
1	Mayurbhanj	11450	12430	7480	4910	5710	3430	429	459	459
Maharashtra										
1	Chandrapur	13200	10500	9800	3000	3100	3000	227	295	306

ANNEXURE-XVI

DETAILS OF VARIETIES OF LINSEED RELEASED AFTER 2001

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha)	Recommended states/ regions/situations	Specific features
Parvati	2001	CSAU, Mauranipur AICRP Centre	42.00	1600(S), 1020(F)	UP (Excl. Bundelkhand), Bihar, West Bengal and Rajesthan (Kota)	Blue flowered, brown seeded moderately resistant to rust and PM
Sheela	2001	CSAU, Kanpur	41.00	1379(R)	Himanchal Pradesh, Punjab, Haryana and J&K	Erect deep blue flower, shiny brown seeded, resistant to rust, wilt and moderately resistant to AB and BF
Shekhar	2001	CSAU, Kanpur AICRP Centre	43.00	1555(I), 920(R)	UP (Excl. Bundelkhand), Bihar, West Bengal and Assam	Violet blue flower, shining brown seeded, resistant to PM, rust, wilt and moderately resistant to AB and BF
NL-97	2001	PDKV, Nagpur, AICRP Centre	42.00	641(R)	Bidarbha Region of Maharashtra	Blue flowered, early maturing, moderately resistant to bud fly, AB, PM & tolerant to wilt
RL-914	2002	MPUA&T, Kota AICRP Centre	41.10	1617(I)	Kota Command Area of Rajasthan	Tall in height, brown seeded, resistant to rust and wilt
Suyog (SLS -27)	2004	JNKV, Sagar AICRP Centre	41.43	1509(I)	Rajasthan, UP, MP, Maharashtra, CG, Odisha, AP and Karnataka	Medium in height, white flower, light brown seeded, moderately resistant to rust, PM and BF
Binwa (KL-210)	2005	CSK HPKV, Palampur AICRP Centre	40.00	1142(I)	Haryana, Punjab, Himanchal Pradesh and J&K	Medium in height, blue flower, yellow seeded, resistant to rust
Baner (KL-224)	2005	CSK HPKV, Palampur AICRP Centre	39.70	511(U)	Haryana, Punjab, Himanchal Pradesh and J&K	Medium in height, purple flower, brown seeded, resistant to rust

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha)	Recommended states/ regions/situations	Specific features
Kartika (RLC-76)	2005	IGKV, Raipur AICRP Centre	42.93	1078 (R)	Rainfed areas of Chhattisgarh	Dwarf in height, light brown seeded, moderately resistant to wilt, PM and BF.
Indira Alsi-32	2005	IGKV, Raipur AICRP Centre	39.18	780 (R)	CG, Maharashtra, Karnataka and Odisha	Dwarf in height, blue flower, dark brown seeded, resistant to PM
Sharda (LMS-4-27)	2006	CSAU, Mauranipur AICRP Centre	41.32	762 (R)	CG, Maharashtra, Karnataka, Andhra Pradesh & Odisha	Dwarf, early duration, white flower, brown seeded, moderately resistant to wilt, PM & BF
Pratap Alsi-1 (RLU-6)	2007	MPUA&T, Kota AICRP Centre	41.08	1997 (S), 834 (F)	Rajasthan Kota command areas	Tall in height, erect, funnel shaped, white flowered, light brown seed, moderately resistant to wilt, PM, AB & BF, tolerant to rust
Deepika (RLC 78)	2007	IGKV, Raipur AICRP Centre	41.39	1272 (I)	Partially irrigated as well as <i>Urena</i> situation of Chhattisgarh State	Medium in height & early, blue flower, brown seeded, resistant to PM
LC-2063	2008	PAU, Ludhiana AICRP Centre	41.00	1200 (I)	Irrigated areas of Punjab State	Tall plant, medium maturity, blue flower, dark brown seed, moderately resistant to BF
Azad Alsi-1 (LMS 9-2K)	2008	CSAU, Mauranipur AICRP Centre	39.92	1610 (I)	Bundelkhand of UP, MP and Rajasthan	Disk shape violet blue flower, dark brown seed, resistant to rust, wilt, PM and bud fly
Himani (KL-214)	2008	CSK HPKV, Palampur AICRP Centre	36.40	583 (U)	HP, J&K, Haryana and Punjab	Blue flowered, small brown, seeded moderately resistant to rust and PM
PKV NL 260	2009	PDKV, Nagpur AICRP Centre	37.67	963 (R)	Maharashtra	Medium height, early, light violet funnel shaped flower, moderately resistant to AB, PM, BF

Variety	Year of release	Releasing centre	Oil content (%)	Average Yield (kg/ha)	Recommended states/ regions/situations	Specific features
SLS 67 (Shival)	2010	JNKV, Sagar AICRP Centre	40.16	1252 (R)	Bundelkhand of UP, MP and Rajasthan	Dwarf star shaped white flower, early maturity, light brown seed, moderately resistant to PM & rust
Bhagsu (KL-215)	2010		36.38	428(U)	Himachal Pradesh, J&K, Uttarakhand, Punjab and Haryana	
Jawahar Linseed-66, (SLS-66)	2010		42.80	1200 (R)	Rainfed areas of MP	
Ruchi (LCK-5021)	2011		39.84	1366(S) 1055(F)	UP (Except BKD), Bihar, JKD, W/B, Assam and NEH Region	
MAU Azad Alsi-2	2011	CSAUT, Kanpur			Chhattisgarh, Maharashtra and KNK, Odisha	Early to medium duration variety
JLS-73	2011	JKVK, Jabalapur			MP, Rajasthan, UP, Gujarat, Maharashtra	Early duration
NDL 2004-05	2011		42.00	1800 (I & R)	UP	
NDL-2002	2011		43.00	1800 (I)	UP	
Jawahar Linseed-41, (PKDL-41)	2012		40.00	1600 (I)	MP limited irrigation facility	

POTENTIAL DISTRICTS OF CASTOR

Sl. No.	District	Area (hectares)			Production (tonnes)			Yield (kg/ha)		
		2008-09	2009-10	2010-11	2008-09	2009-10	2010-11	2008-09	2009-10	2010-11
Gujarat										
1	Banaskantha	82700	90800	78200	178400	214300	185700	2157	2360	2375
2	Mehsana	58200	45700	60400	116200	96000	119100	1995	2101	1970
3	Kutch	63900	46600	75400	105600	72600	133200	1653	1558	1766
4	Sabarkanth	48000	54500	73400	90000	92800	125700	1876	1705	1712
5	Surendranagar	28000	32600	39700	76600	58200	103800	2738	1785	2615
6	Patan	42100	46800	48900	68300	67900	90600	1623	1450	1854
7	Gandhinagar	29900	23400	30300	64400	50700	66900	2153	2167	2212
8	Ahmedabad	15900	19400	28000	28500	26800	54200	1792	1376	1936
9	Rajkot	4600	14800	12900	10700	54700	22400	2344	3697	1730
10	Vadodara	18200	15600	14800	27900	25400	26100	1534	1973	1770
11	Kheda	14400	8500	9100	20800	13500	12900	1448	1583	1426
Rajasthan										
1	Jalore	59409	52220	55348	100447	72388	110131	1691	1386	1990
2	Sirohi	35988	29127	31943	53264	7467	57851	1480	256	1811
3	Barmer	23725	22185	25427	18880	14659	20471	796	661	805
4	Jodhapur	18810	20101	25673	11239	3591	12722	598	179	496
Andhra Pradesh										
1	Mahabubnagar	90413	84106	83957	43669	34988	46513	483	416	554
2	Kurnool	15055	36210	71168	11337	18032	62414	753	498	877
3	Nalgonda	27065	9133	12206	8634	1945	2636	319	213	216

DETAILS OF VARIETIES/HYBRIDS OF CASTOR: RELEASED AFTER 2001

VARIETIES

Variety	Year of release	Releasing centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/ regions situations	Salient features/traits
Haritha (PCS-124)	2002	ANGRAU, Palem	1400-1600 (R)	49	Light soils of Southern Telangana, Rayalaseema and Prakasam District	Resistant to wilt
Kiran (PCS 136)	2002	ANGRAU, Palem	1200-1500 (R)	51	Rainfed areas of AP and also late sown <i>Kharif</i> conditions with one or two irrigations	Tolerant to Botrytis
Jwala (48-1)	2007	DOR, Hyderabad	1000 (R) 1800 (I)	50	All castor growing areas under both rainfed and irrigated	Resistant to <i>Fusarium</i> wilt; tolerant to <i>Botrytis</i> , salinity
GC-3	2009	JAU, Junagadh	2340 (I)	49	Irrigated areas of Gujarat	Resistant to wilt
Chandra Prabha	2009	CSAU&T Kanpur			Uttar Pradesh	Suitable for intercropping
DCS-107	2011	DOR Hyderabad	1500-1700	49	Identified for both rainfed and irrigated areas of the country	Resistant to wilt & tolerant to leaf hopper
JL-273(GC-3)	2012	ORS, JAU, Junagadh	2340	49.6	Irrigated areas of Gujarat	Resistant to wilt, tolerant to Macrophomina root rot

HYBRIDS

Hybrid	Year of release	Releasing centre	Yield potential (kg/ha)	Oil content (%)	Recommended states/ regions situations	Salient features/traits
PCH-1	2001	ANGRAU Palem	1500 (R) 2000 (I)	-	Rainfed areas of AP	Tolerant to wilt resistant to Jassids
DCH-519	2006	DOR Hyderabad	1500 (R) 2200 (I)	49	Both rainfed and irrigated castor growing areas of the country	Green, triple bloom, resistant to <i>Fusarium</i> wilt
GCH-7	2006	SK Nagar Gujarat	2450 (I)	49	Irrigated areas of Gujarat	Resistant to nematode-wilt complex
YRCH-1 Arandi	2009 2011	Yethapur, TN	1861 (R)	49	For Tamil Nadu	

ABBREVIATIONS

AB	Alternaria Blight
AGMARKNET	Agricultural Marketing Information Network
ai/ha	Active Ingredient/Hectare
AP	Andhra Pradesh
AICRP	All India Coordinated Research Project
ANGRAU	Acharya N.G. Ranga Agricultural University
AMP	Average Market Price
APEDA	Agricultural and Processed Food Products Export Development Authority
BBF	Broad-Bed and Furrow
BC	Before Crist
BC ratio	Benefit Cost Ratio
BS	Breeder Seed
BSP	Breeder Seed Production
Ca	Calcium
cal kg ⁻¹	Calorie/Kilogram
CaO	Calcium Oxide
CIAE	Central Institute of Agricultural Engineering
GNP	Gross National Product
cm	Centimetre
CMS	Cytoplasmic Male Sterility
CO ₂	Carbon-di-Oxide

CPO	Crude Palm Oil
°C	Degree Centigrade
DAC	Department of Agriculture & Cooperation
DAP	Di-Ammonium Phosphate
DAS	Days After Sowing
DGR	Directorate of Groundnut Research
DOC	De-Oiled Cake
DOR	Directorate of Oilseeds Research
DRMR	Directorate of Rapeseed & Mustard Research
°E	Degree East
EC	Emulsifying Concentration
ELS	Early Leaf Spot
EP	Expected Production
ETL	Economic Threshold Level
FAQ	Fair Average Quality
Fe	Ferrous
FFBs	Fresh Fruit Bunches
FLDs	Front Line Demonstrations
FP	Farmers Practice
FYM	Farm Yard Manure
G	Granule
GM	Genetically Modified
GMS	Genetic Male Sterility
GoI	Government of India
ha	Hectare
HP	Himachal Pradesh
HPS	Hand Picked Selection
HSM	Hundred Seed Mass
ICAR	Indian Council of Agricultural Research

ICRISAT	International Crops Research Institute for the Semi-Arid-Tropics
INM	Integrated Nutrients Management
IOPEA	Indian Oilseed and Produce Export Promotion Council
IPM	Integrated Pests Management
ISOPOM	Integrated Scheme of Oilseeds, Pulses, Oil Palm & Maize
IT	Improved Technology
IW/CPE ratio	Irrigation Water/Cumulative Pan Evaporation Ratio
J&K	Jammu & Kashmir
K	Kernel
K ₂ O	Potassium Oxide
kg	Kilogram
l/ha	Litre/Hectare
LE	Liquid Emulsion
MgO	Magnesium Oxide
MgSO ₄	Magnesium Sulphate
mm	Millimetre
MPKV	Mahatma Phule Krishi Vidyapeeth
MSP	Minimum Support Price
MT	Metric Tonne
N	Nitrogen
NAFED	National Agricultural Cooperative Marketing Federation of India Limited
NSC	National Seed Corporation
NATP	National Agricultural Technology Project
NDDB	National Dairy Development Board
NEH Region	North-Eastern Hilly Region
NFSM	National Food Security Mission
NAY	National Average Yield
NPK	Nitrogen, Phosphorous, Potash

NPV	Nuclear Polyhedrosis Virus
NSKE	Neem Seed Kernel Extract
°N	Degree North
O/L ratio	Oleic/Linoleic Ratio,
OPAE	Oil Palm Area Expansion
OPVs	Open Pollinated Varieties
P	Phosphorous
P ₂ O ₅	Phosphorus Pentoxide
P x P	Plant x Plant
PPI	Pre-plant Incorporation
PAU	Punjab Agricultural University
PBND	Peanut Bud Necrosis Disease
PE	Pre-emergence
PFA	Prevention of Food Adulteration Act
PM	Powdery Mildew
POE	Post Emergence
PP Chemicals	Plant Protection Chemicals
PSB	Phosphorus Solubilising Bacteria
PSS	Price Support Scheme
qtls	Quintals
R lines	Restorer lines
RDF	Recommended Dose of Fertilizer
RH	Relative Humidity
R x R	Row x Row
RKVY	Rashtriya Krishi Vikas Yojana
₹	Rupees
S	Sulphur
SAUs	State Agricultural Universities

SAY	State Average Yield
SC Formulation	Suspension Concentrate Formulation
SEA	Solvent Extractors Association of India
SND	Sunflower Necrosis Disease
SOPA	Soybean Processors Association of India
SRR	Seed Replacement Ratio
TN	Tamil Nadu
TE	Triennium Ending
TBOs	Tree Borne Oilseeds
TMO	Technology Mission on Oilseeds
TMOP	Technology Mission on Oilseeds & Pulses
TNAU	Tamil Nadu Agricultural University
US	United State
USA	United States of America
USAID	United States Agency for International Development
USDA	United States Development Agency
USSR	Union of Soviet Socialist Republics
VPKAS	Vivekananda Parvatiya Krishi Anusandhan Sansthan
W/V	Weight/Volume
W/W	Weight/Weight
WP	Wettable Powder
WS	Water Soluble
WUE	Water Usage Effectiveness
YMV	Yellow Mosaic Virus
Zn	Zinc
2,4-D	2,4-Dichlorophenoxyacetic acid

► NOTES



सत्यमेव जयते

OILSEEDS DIVISION

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