CHAPTER - IX

NATIONAL SCENARIO OF OIL SEED PRODUCTION

India is one of the major producers of oilseeds in the world. Yet our vegetable oil economy is beset with the problems of shortage. The demand-supply gap in vegetable oils, once developed to fightening level necessitating massive imports of edible oils. During 1986-87 and 1987-88, the country imported edible oils to the extent of 15 lakh tonnes and 18 lakh tonnes respectively, while in 1988-89 and 1989-90 it came down to 3.70 lakh tonnes and 6.90 lakh tonnes respectively.

During the current oil years 1990-91, the availability of edible oils in India has been estimated at 49 lakh tonnes, which is higher than the estimate of 47.45 lakh tonnes in 1989-90. If the per-capita consumption is assumed at 6.5 kgs (including 5.3 kgs of liquid oils and 1.2 kgs of vanaspati) the total requirement of edible oils would be around 54.60 lakh tonnes in 1990-91 to feed about 850 millions of people. The per-capita consumption if however, taken at 7 kgs the total requirement of edible oils would be of the order of 58.80 lakh tonnes.

A recent exercise conducted at Krishi Bhavan reveals that the aggregate production of oilseeds during 1989-90 crop year would be in the neighbourhood of 186.6 lakh tonnes (88.6 lakh tonnes kharif and 80 lakh tonnes rabi) which indicates that the deficit in edible oils would be anything between 6 and 9 lakh tonnes in the current oils year.

9.1. OILSEEDS - NATIONAL SCENARIO

The importance of oilseeds in our national economy can hardly be over emphasized. Oilseeds crops are the principal sources of edible oils, forming an integral part of human diet. Besides, it constitutes important raw materials for a number of manufactured goods including soap, paint, lubricants and so on.

Next to foodgrains, oilseeds contribute significantly to the agricultural economy of the country. In India, oilseeds crops are cultivated in an area of 18 million hectares, accounting for about 12% of the total land under cultivation.

Oilseeds crops like groundnut, mustard/rapeseed, safflower, niger and sunflower were largely used for edible purposes while linseed and castor are pre-dominantly grown for industrial purposes. The production of cultivated oilseeds taken together touched a new peak of 179 lakh tonnes by the end of the seventh plan as against the target of 180 lakh tonnes.

Among the major oilseeds crops, groundnut and mustard/rapeseed account for about 80% of the total production of oilseeds in the country. Gujarat contributes about 30% of the area and outpur of groundnut while U.P. accounts for about 60% of the area and production of mustard/rapeseed in the country.

India is the third largest producer of oilseeds in the world. It ranks first in the production of groundnut and sesame and second in rapeseed and mustard. India's share in the world production of these oilseeds is as under :

TYPES	Per cent
Groundnut (Shelled)	37
Rapeseed and Mustard	19
Sesame	24
Linseed	20

The other two important oilseeds, i.e., soybean and sunflower are still to make a dent in the country. In spite of a large share in the world production, the per capita consumption of oil in India is very low about 5 kg as against the world average of 11 kg and the consumption of about 28 kg in the affluent countries.

According to the area and production, the oilseeds of the country are broadly divided into three catagories (Table IX-1). Area, production

Table IX -1. Area, production and productivity of different oilseed crops in the states

State		Groundnut	Rapeseed mustard	Sesame	Lineseed	Castor	Niger	Saflower	Sunflower
1		2	3	4	5	6	7	8	9
Andhra Pradesh	A	1,433.9	0.6	165.5	11.0	271.5	10.3	35.8	5.5
	P	1,407.3	0.1	26.6	2.0	54.1	3.6	7.3	2.9
	Y	981	167	161	182	199	350	204	527
	% Area	74.1	0	8.6	0.6	14.0	0.5	1.8	0.3
	% Prod.	93.6	0	1.8	0.1	3.6	0.2	0.5	0.2
Assam	A	-	224.0	12.6	5.5	2.0	-	-	-
	P	-	102.7	6.1	2.4	0.8	-	-	-
	Y	-	458	484	436	400	-	-	-
	% Area	-	91.8	5.2	2.3	0.7	-	-	-
	% Prod.	-	91.7	5.4	2.1	0.7	-	-	-
Bihar	A	5.4	75.3	18.3	97.2	2.1	45.8	0.3	1.0
	P	3.6	46.3	5.3	41.0	1.6	16.9	0.1	0.3
	Y	667	615	290	422	762	369	333	333
	% Area	2.2	30.7	7.5	39.6	0.9	18.7	0.1	0.4
	% Prod.	3.1	40.2	4.6	35.6	1.4	14.7	0.1	0.3

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
Gujarat	A	2,191.5	169.7	105.2	-	175.2	-	-	-
	P	2,145.3	78.3	40.2	-	196.9	-	-	-
	Y	976	461	382	-	1,124	-	-	-
	% Area	83.0	6.4	4.0	-	6.6	-	-	-
	% Prod.	87.2	3.2	1.6	-	8.0	-	-	-
Haryana	A	7.9	202.0	4.5	0.2	-	-	-	-
	P	7.4	141.0	1.9	0.2	-	-	-	-
	Y	937	698	422	1,000	-	-	-	-
	% Area	3.7	94.1	2.1	0.1	-	-	-	-
	% Prod.	4.9	93.7	1.3	0.1	-	-	-	-
Himachal Pradesh	A	1.5	6.5	8.2	5.3	-	-	-	-
	P	0.9	1.9	2.3	0.9	-	-	-	-
	Y	600	292	280	170	-	-	-	-
	% Area	7.0	30.2	38.1	24.7	-	-	-	-
	% Prod.	15.0	31.6	38.4	15.0	-	-	-	-

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
Jammu &	A	0.1	42.3	7.1	2.9	-	-	-	-
Kashmir	P	0.1	59.8	2.6	2.5	-	-	-	-
	Y	1,000	1,414	366	862	-	-	-	-
	% Area	0.2	80.7	13.6	5.5	-	-	-	-
	% Prod.	0.2	92.0	4.0	3.8	-	-	-	-
Karnataka	A	779.2	3.1	120.1	65.3	29.5	53.7	175.4	37.7
	P	618.0	0.9	38.4	14.3	17.0	9.3	89.0	19.7
	Y	793	290	320	219	576	173	507	523
	% Area	61.6	0.3	9.5	5.2	2.3	4.2	13.9	3.0
	% Prod.	76.6	0.1	4.8	1.8	2.1	1.2	11.0	2.4
Kerala	A	13.0	-	17.0	-	-	-	-	-
	P	11.2	-	4.4	-	-	-	-	-
	Y	862	-	259	-	-	-	-	-
	% Area	43.3	-	56.7	-	-	-	-	-
	% Prod.	71.8	-	28.2	-	-	-	-	-
Madhya	A	299.9	243.6	248.0	528.6	4.1	224.9	0.9	-
Pradesh	P	221.6	145.7	40.0	110.5	1.4	40.8	0.2	-
	Y	739	598	161	209	341	181	222	-

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
	% Area	19.3	15.7	16.0	34.1	0.3	14.5	0.1	-
	% Prod.	39.6	26.0	7.1	19.7	0.3	7.3	0	-
Maharashtra	A	823.8	4.6	178.2	251.6	4.2	101.0	542.2	142.7
	P	694.4	1.6	31.8	57.7	1.0	24.1	324.4	92.1
	Y	843	348	178	229	238	239	598	645
	% Area	40.2	0.2	8.7	12.3	0.2	4.9	26.5	7.0
	% Prod	56.0	0.1	2.6	4.7	0.1	2.0	26.4	7.4
Orissa	A	218.3	162.1	185.0	38.5	43.2	137.2	6.0	1.1
	P	297.8	72.4	79.3	16.6	22.5	57.6	2.8	0.4
	Y	1,364	447	429	431	520	420	467	364
	% Area	27.6	20.5	23.4	4.9	5.5	17.3	0.7	0.1
	% Prod	54.2	13.2	14.4	3.0	4.1	10.5	0.5	0.1
Punjab	A	92.0	108.0	19.4	1.3	-	-	-	-
	P	90.0	72.0	6.7	0.5	-	-	-	-
	Y	978	667	345	385	-	-	-	-
	% Area	41.7	48.9	8.8	0.6	-	-	-	-
	% Prod.	53.2	42.6	3.9	0.3	-	-	-	-

Table IX-1. (Contd.)

1		2	3	4	5	6	7	8	9
Rajasthan	A	160.7	651.3	429.1	84.7	5.6	-	-	0.6
	P	107.4	458.4	49.9	28.4	1.2	-	-	0.4
	Y	669	704	116	335	214	-	-	667
	% Area	12.1	48.9	32.2	6.4	0.4	-	-	0
	% Prod.	16.6	71.0	7.7	4.4	0.2	-	-	0.1
Tamil Nadu	A	1,44.6	1.0	137.0	20.1	-	-	30.6	
	P	1,368.6	0.3	40.7	-	5.8	-	-	9.6
	Y	1,196	300	297	-	289	-	-	314
	% Area	85.5	0.1	10.3	-	1.5	-	-	2.3
	%Prod.	96.0	0	2.9	-	0.4	-	-	0.7
Uttar Pradesh	A	270.7	2,258.0	748.3	636.3	0.3	-	-	6.3
	P	259.4	1,073	96.0	183.2	0.1	-	-	4.4
	Y	958	475	128	288	333	-	-	698
	% Area	6.9	57.6	19.1	16.2	0	-	-	0.2
	% Prod.	16.0	66.4	5.9	11.4	0	-	-	0.3
West Bengal	A	1.2	163.3	109.9	55.1	-	-	-	2.2
	P	1.1	94.7	48.8	13.6	-	-	-	1.1
	Y	917	580	444	247	-	-	-	500

Table IX-1. (Contd.)

1	2	3	4	5	6	7	8	9
% Area	0.4	49.2	33.1	16.6	-	-	-	0.7
% Prod.	0.7	59.5	30.6	8.5	-	-	-	0.7

A = Area ('000 ha.); P = Production ('000 tonnes); Y = Average yield (kg/ha) and productivity of different oilseed crops statewise (IX-1). That the cultivation of each oilseed is concentrated in different States of the country as given as follows :

1. Groundnut	:	Gujrat, Andhra Pradesh, Tamil Nadu, Maharashtra and Karnataka.
2. Rapeseed-Mustard	:	Uttar Pradesh, Rajasthan, Madhya Pradesh, Assam and Haryana.
3. Sesame	:	Uttar Pradesh, Rajasthan, Himachal Pradesh, Orissa, Maharashtra and Andhra Pradesh.
4. Linseed	:	Uttar Pradesh, Madhya Pradesh, Maharashtra, Bihar and Karnataka.
5. Castor	:	Andhra Pradesh, Gujarat, orissa and Karnataka.
6. Safflower	:	Maharashtra, Karnataka and Andhra Pradesh.
7. Sunflower	:	Maharashtra, Karnataka, Tamil Nadu and Uttar Pradesh.
8. Niger	:	Madhya Pradesh, Orissa and Maharashtra.

Even in these states the areas can be easily defined which are concentrated in specific zones.

Information on the average production of various oilseed crops in the country and scope of improvement per unit production is given in Table 9.2.

This table indicates that there is gap between the productivity in India as compared to the highest yields obtained in the world and thereby indicates the ample scope for further improvement.

The growth, production and yield per hectare of the oilseeds in the country over the years are given in Table 9.3.

One can see a large increase in the area sown under oilseeds, mostly of groundnut and rapeseed and mustard during the period from 1951-52 to 1982-83 reflecting the general increase in the area and production. This table also indicates that the country has made progress, although at a slower pace than expected.

Table IX-2. Productivity levels of Different of Oilseeds in India and abroad

Sl. No.	Crop	Average Yield of India (kg/ha)	Highest Yield in the world (kg/ha)
	MAJOR		
1.	Groundnut	756	5,784 (Israel)
2.	Rapeseed and Mustard	589	2,826 (FR Germany)
3.	Sesame	181	2,000 (Yugoslavia)
4.	Linseed	271	2,000 (New Zealand)
5.	Castor	605	384 (Philippines)
	MINOR		
6.	Safflower	493	-
7.	Sunflower	522	2,209 (Italy)
8.	Niger	236	-

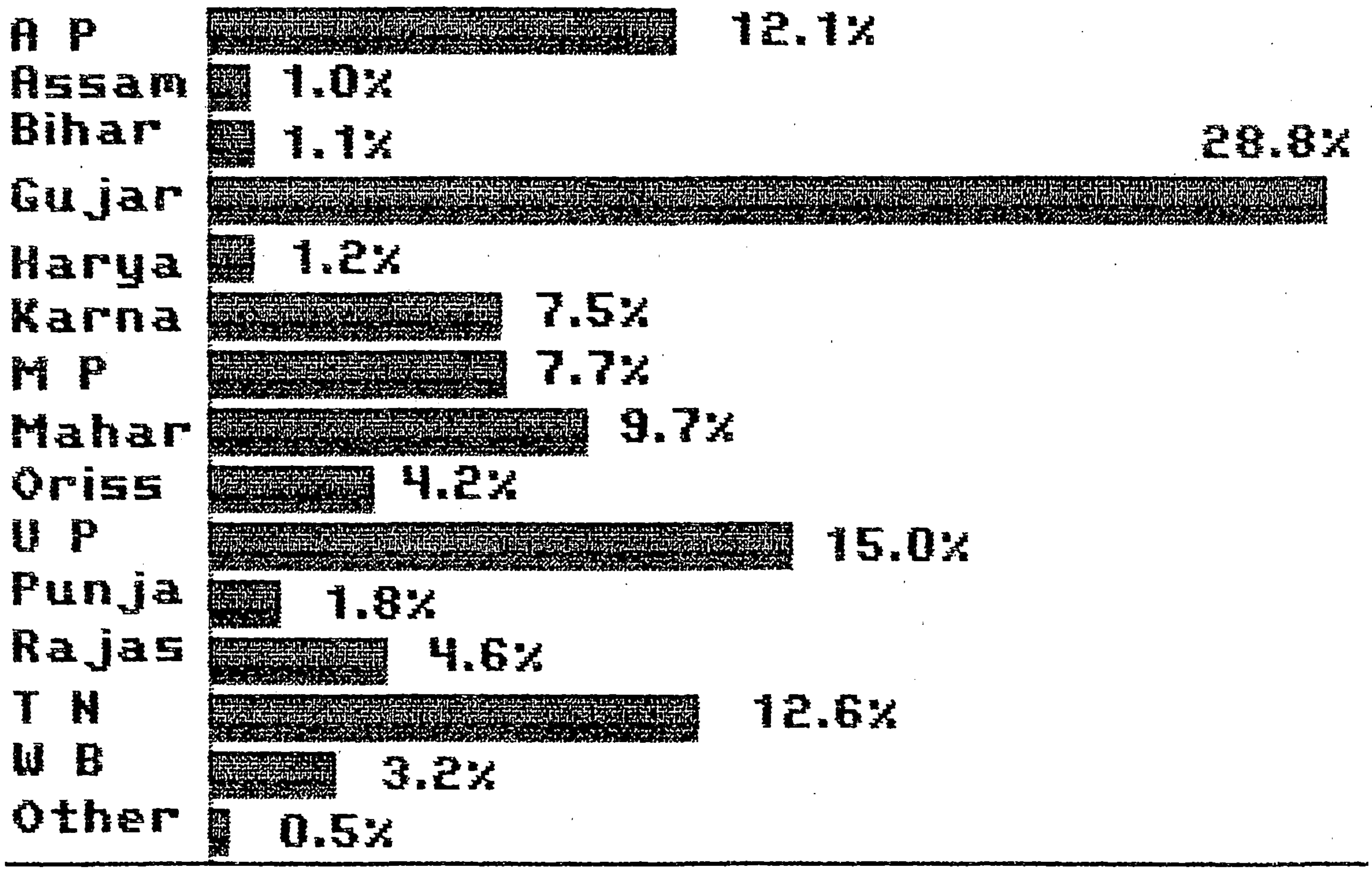
Table IX-3. Area, Production and Yield per hectare of Oilseeds
Area : '000 ha; Production : '000 tonnes; Yield : Kg/ha

Crop		1951-52	1982-83	Increase
Groundnut	Area	4,917	7,345	2,428
	Production	3,192	5,553	2,361
	Yield	649	756	107
Rapeseed	Area	2,401	4,194	1,793
Mustard	Production	943	2,472	1,529
	Yield	393	589	196
Sesame	Area	2,405	2,780	375
	Production	452	502	50
	Yield	188	181	-7
Linseed	Area	1,380	1,758	378
	Production	333	476	143
	Yield	241	271	30
Castor	Area	582	570	-12
	Production	108	345	237
	Yield	186	605	419
		1965-66		
Safflower	Area	462	755	293
	Production	69	371	302
	Yield	149	492	343
Niger	Area	522	501	-21
	Production	91	118	27
	Yield	173	236	63

(Data on Safflower and Niger available only from 1965-66)

Table IX-4. Share of States in the All India Area under Oilseed Crops and Production thereof in 1988-89

States	Area Under Oilseeds Crop (in %)	Share in the All India Production of Oilseeds (in %)
Andhra Pradesh	10.00	12.1
Assam	1.3	1.0
Bihar	1.5	1.1
Gujarat	13.8	28.8
Haryana	1.1	1.2
Karnataka	7.4	7.5
Madhya Pradesh	11.3	7.7
Maharashtra	11.1	9.7
Orissa	3.9	4.2
Uttar Pradesh	20.0	15.0
Punjab	1.3	1.8
Rajasthan	6.5	4.6
Tamil Nadu	6.6	12.6
West Bengal	1.5	3.2
Others	2.6	0.5
	100	100



Share of State in the All India
production of oilseeds (IN %)

9.2. GROUNDNUT

In West Bengal, groundnut is largely consumed as nut. In recent years refined groundnut oil has, however, entered into the kitchens of some afluent families of West Bengal but still then the quantity is negligible. The annual consumption of groundnut in terms of "nuts" in West Bengal is estimated at 50,000 tonnes which are largely imported from Western and Southern States. There is a not outflow of about Rs.35 crores from West Bengal to other States for meeting the consumption-demand for groundnut in the State. It is, however, encouraging that the cultivation of groundnut has been catching the imagination of the farmers of West Bengal. Generally groundnut is cultivated as a second crop after long duration Aman paddy in the mono-cropped area in the coastal areas and also in the high lands in the summer season. Since last two years the cultivation of groundnut in the districts of Hooghly, Midnapore, Purulia, Nadia, 24 Parganas, Cooch Behar and West Dinajpur has gathered momentum. The crushing of groundnut in West Bengal has, however, come to a grinding halt on account of various factors including high incidence of local taxes which has made the end-products quite uncompetitive.

India is the 3rd largest producer of oil seeds in the world it ranks first in the production of groundnut. In spite of countries share in the world production of groundnut (Shelled) - 37% -
- India is now passing through a critical phase of edible oil shortage.

In West Bengal Repeseed - Mastard and Sesame are the two major oilseed crops grown in most of the districts and recently groundnut area is also increasing. The total area in the field out groundnut production in thousand hectare in only 19.00. Production 24.00 thousand tonnes. Yield kg/ha 1320.

Considering the localization of areas under major irrigation projects have been weighted in favour of rice, which is the main competition of oil seeds and specially groundnut during the rabi summer season. Even many light soil areas, which are eminently suitable for groundnut, were being used for rice cultivation, Localization of areas between wet crops and light-irrigated crops would now be done on the basis of soil types, desirable cropping patterns and optimum utilization of water. All light soils areas may be reserved for groundnut. Detailed surveys for minor irrigations or pipelines should be conducted to identify the areas for groundnut.

As far as possible, water supply during the rabi-summer season should be restricted to light-irrigated crops like groundnut.

Localization once done may be made effective for at least four to five years. This would help not only in long-term planning of cropping patterns and removing uncertainties but also in proper soil and water management.

Delays in the announcement of localization of areas, which are very common, are not conductive to planning of appropriate cropping patterns. Sometimes, the localization for rabi-summer is being announced as late as November-December. Consequently, farmers are not able to do advance planning of cropping patterns. It is therefore important that the announcement regarding localization of areas as between wet and dry crops both for the kharif and rabisummer seasons should be make well before the kharif season, i.e., by April-May. This would enable the farmers to make an appropriate choice of the rice variety in kharif, which would enable timely planting of groundnut in the rabi-summer season. This in turn would enable the farmer to get good yields from groundnut.

As far as possible localization may be done according to the distributary, as this would prevent groundnut being taken up by the side of rice, leading to problems of seepage and low yields of groundnut owing to excess moisture. The localization pattern announced should be enforced strictly.

The present system of field to field irrigation should be expeditiously replaced by individual field irrigation wherever not done, to facilitate proper water-management for the light-irrigation crops like groundnut and also improve water availability for these crops. Arrangements should also be made for the construction of proper drainage channels.

The schedules for running of distributary channels should be worked out to synchronizo with the crucial stages of the growth period of groundnut crop when irrigation is most required and beneficial.

Introduction of rotational supply of water will be useful with periodic closure of the channels to discourage rice cultivation and its replacement with groundnut during the rabi-summer season.

Arrangement of early release of water in the first week of June, which would permit early sowing and planting of rice during kharif and subsequently of during the rabi-summer season is another step.

Introduction of warabandi on a priority basis in the areas localized for groundnut would ensure timely and equitable distribution of irrigation water.

The extension workers must be goven through training, particularly in water management practices for light irrigated crops like groundnut as also in the use of fertilizers to enable them to effectively transfer this technology to the farmars. Programmes for the mass training of farmers should also be taken up.

Special awards and incentives may be introduced in the Command Areas for the farmers who give a lead in increasing the areas and productivity of ground-nut during the rabi-summer season.

9.2.1. Agronomic considerations

a) Plant Stand

Achievement and maintenance of optimum plant population is a prime requirement for obtaining good yields. Low plant population in the initial stages results from a number of factors like poor soil preparation, non-selection of seeds, no pre-sowing treatment of seeds with fungicides, defective sowing techniques and lack of adequate soil moisture. It is therefore very important that the extension staff should conduct vigorous campaigns to educate the farmers in all these aspects to achieve a good plant stand. It sufficient attention is given to these simple aspects, many farmers would be able to even reduce the seed rate and yet achieve an optimum plant stand.

b) Optimum Sowing Tiem

The optimum sowing time should be determined for those regions of the southern District for which specific data are not available, and conditions should be created wereby the farmers can take up timely sowing of the crop.

c) Method of Sowing

The most common method of sowing the crop is by dibbling behind the country plough. The use of seed drills or gorrue needs to be popularized on a much larger scale than hitherto so that the sowing is done at the recommended spacing and depth in the interest of better crop management. Farmers have yet to be educated in proper sowing techniques. Criss-cross sowing, whereever practised, should be discouraged and the farmers advised to raise an optimum plant stand with the use of selected seed, pre-sowing treatment of seeds and use of seed drills rather than use of a high seed rate and criss-cross sowing. The State Department of Agriculture may substantially intensify their programmes for supply of efficient bullock-drawn seed drills, at subsidised rates, if the situation so required.

d) Fertilizers

The importance of application of balanced doses of fertilizers in obtaining high yields cannot be over-emphasized. The states should carry cut detailed surveys of the areas identified for raising groundnut during the rabi-summer season, wherever not done, so as to identify the nutrient deficiencies and recommend appropriate fertilizer schedules for specific areas. Adequate attention should also be paid to micronutrients like zinc, magnesium, boron and molybdenum.

There is great scope for educating the farmers in the judicious use of fertilizers. While many do not use any fertilizer at all or apply only in low doses in some areas as in Midnapore district, many farmers use much higher doses of nitrogenous fertilizers and farmyard manure than required but not enough phosphatic fertilizers, which results in excessive vegetative growth.

Phosphorus application, which is very important in groundnut, has not yet caught up sufficiently. Same is position of gypsum and potassic fertilizers as also micronutrients like zinc, magnesium, boron and molybdenum, the use of which in identified areas needs to be popularized.

e) Interculture and Weeding

These aspects assume an added importance in Command Areas, particularly in those where field-to-field irrigation is practised. Farmers should be advised to take up timely interculture and weeding operations. Insufficient intercultiure and weeding are not conspicuously noticed in new areas. Studies have shown that the critical period for weed competition in bounch groundnut is 45 days from planting, and if the crop is kept free from weeds during this period the weeds that come up later to not reduce the yield. For proper interculture and weeding, the crop should have been sown in rows and criss-cross sowing should be done as earlier.

f) Pests and Diseases

The most important pest of rabi-summer groundnut is leaf miner or leaf webber, which has become a severe menace in areas where sowings are continued over a long period both during the kharif and rabi-summer seasons. The control measures are well known. What is required is what the sprayings should be taken up well in time and on an area and community basis without which it would not be possible to control the pest. The facilities of financial assistance available under different centrally sponsored and State Sector Schemes should be fully utilized.

Among diseases, mention may be made of tikka, bud necrosis and rust. Tikka assumes serious proportions even in the rabi-summer season wherever water management is not proper and the crop is over-irrigated.

Attention to these aspects is therefore very important apart from adoption of the recommended control measures. Bud necrosis is now becoming more prevalent in parts of Andhra Pradesh and Karnataka. Researches conducted at the ICRISAT Centre, Patancheru, district Medak, Andhra Pradesh, have shown that the disease is caused by the Tomato Spotted Wilt Virus and is transmitted by a thrip species. Two or three sprayings against thrips in the early stages of crop growth should help in checking the severity of the disease. Resistant varieties are not yet available.

Groundnut rust (Puccinia arachidis) has during the last few years spread at an alarming rate in Tamil Nadu, Karnataka and Andhra Pradesh.

Several rust-resistant lines have been identified at the ICRISAT and by the National Oilseeds Research Project of the ICAR, which are being used in their breeding programmes. The rust problem would be solved only when rust-resistant materials become available for commercial cultivation. Pending that, some of the recommendations for chemical control of groundnut rust may be mentioned here. In Karnataka, the recommendation is to spray the crop with Dithane M-45 (40 g mixed with 18 litres of water; 625 litres of the mixture being used per hectare) or dusting with sulphur @20.5 kg/ha, once every 15 days. According to Seshadri (1976) nickel chloride at 0.15% concentration (3 sprays at 10 days intervals commencing from 60 days after sowing) was significantly superior to other chemicals. Pre-sowing treatment with Thiram or capitan (0.3%) followed by 2-3 sprays with Dithane Z-78 or Dithane M-45 (0.3%) at interval of 10-15 days when the disease appears, have also been recommended. Durairaj and Mohan (1978) reported that application of Dithane M-45 (0.2%) was most effective followed by sulphur dust (25 kg/ha) and Kocide (0.1%) significantly increased the yield. Raomackers and Preston (1977) reported from Zambia that fungicides tested for cercospora arachidicola were also effective when both rust and leaf-post occurred and yield increased up to 120%; the most effective chemicals were Chlorothalonil, Mancozeb + Bonomyl, and a mixture of Mancozeb, Benomyl and Fentin.

g) Seed Production

Good-quality seed is a basic input required for high yields. The programmes for production and multiplication of breeder's foundation and certified seeds must be strengthened and the certified seed made available to thefarmers in sufficiently large quantities at subsidized rates to encourage them to replace the seed at least once in five years.

Since the states hesitate to enter into large scale production and distribution of groundnut seeds because of the large amount of funds involved and fear of losses resulting from drying and price fluctuations, there is an urgent need for seeting up a risk fund or price-stabilization fund to absorb any losses in procurement and distribution of quality seeds of groundnut.

In coastal districts where rabi groundnut sowings start from the first week of October, there is a problem of arranging timely supply of seeds. Kharif crop is not grown in these rice-growing districts. Even the produce from the kharifcrop grown in other districts of the state becomes available only in November and December. The farmers in the coastal districts have therefore to depend largely on the seed procured from other states.

Another problem is that due to the high atmospheric humidity, it is very difficult to keep the seed from the rabi crop viable till the next rabi season. The state should therefore explore all possibilities of raising an early kharif crop in any available uplands of the coastal districts for meeting the seed requirements of the rabi crop. At the same time, research efforts should be intensified to work out appropriate seed-storage technology for the rabi produce.

The greater part of the area in these states is under rainfed conditions where groundnut is cultivated. Due to this reason the yields are comparatively low. Facrors responsible for low yields are discussed below.

Groundnut breeders have been making efforts to evolve bunch varieties having high yield, high oil content, dormancy and short duration, ignoring the requirements of various industries like baby food, confectionary and exportable H.P.S. varieties. Except 'TG 17' evolved by the BARC, there is no other bunch variety with dormancy of 20-30 days. There are no large-scale seed multiplication programmes in the country to cover even with these improved seeds. The total area under improved seeds, though claimed to be high, does not touch the frings of the problem. Instead of insisting upon very short-duration varieties, efforts should be made to screen Virginia types which have inherent dormancy. Instead of making a general approach to induce dormancy into Spanish bunch tyoe, we may take advantage of a chemical approach to break the dormancy in the Virginia types and fit them into the cropping pattern.

Owing to the completion of the various irrigation projects, lack of proper drainage is resulting in the extensive areas becoming saline--alkaline. With this rapid progress in saline-alkalinity of the soils, choice of selection of crops and varieties thus becames limited. We may have to re-orient our breeding programme with varieties whose calcium requirements pre relatively low by using suitable physiological indices.

Next to seed, management plays a very vital role, since there is no break-through in the production of high-yielding varieties. Recent surveys conducted in Andhra Pradesh on the causes of declining yields indicated that many packages of practices recommended are either not followed, or followed only partially by an insignificant minority.

Seed treatment with effective chemicals coupled with optimum seed rate not only ensures disease-free seedlings but also optimum plant population.

Use of Rhizobium culture is not in vogue in a majority of the areas where groundnut is cultivated. It is not used extensively even in the newly brought areas under groundnut and under irrigated lands. The effectiveness of the cultures supplied at present is not known both to the supplier and to the farmer and there are no agencies to varify the efficacy of the cultures supplied. Work in this direction is to be organized and accelerated.

Similarly, the full complement of the recommended fertilizer does not reach the soil, thereby yields decline greatly. Groundnut being a leguminous crop, responds to application of single superphosphate compared with complex fertilizers, as single superphosphate supplies sulphur and calcium also as nutrients. Continuous cropping of groundnut years after year depletes the micro-nutrients notably zinc, molybdenum and boron. This type of imbalance is leading to reduction in quality and quantity of the pods. It is suggested that a preparation incorporating many micronutrients should be made readily available to the groundnut growers.

Weeds have become a major menace and with accent on food crops the quantum of investment on inputs given to the groundnut crop is relatively very low, and cultivators are unable to apply weedicides which have been found to be quite effective in controlling weeds. Not only their cost has become prohibitive for the groundnut grower but also their ready availability is a problem to reckon with.

Irrigation plays a vital role in boosting up the productivity of the crop. The water requirement of groundnut though relatively low, is quite exacting. A single protective irrigation at the critical stages, either at the flowering or pod-filling stage, increases the yield by 50-60%. Hence all efforts should be made to educate the farmer to put in maximum efforts to irrigate the crop by any available cource instead of diverting the entire water source to the food crops alone.

Rust on groundnut caused by Puccinia arachidis Speg. is being recorded in a virulent form. Cheap and effective prophylactic and control measures are to be evolved and farmers are to be educated in these operations. Similarly, bud necrosis virus (BNV) caused by the tomato spotted wilt virus (TSWV) results in reduction of yield even up to 80% (Gibbone, 1979). We may have to develop an integrated system of controll, including tolerance to the virus, resistance to the vector and biological and insecticidal control of the vector.

Large-scale multiplication of the presently available potential yielders should be taken up to cover significant areas under improved seeds. This could be achieved by taking up multiplication for seed purpose under irrigated conditions in the project areas and under tube wells. The entire produce should be procured, processed and redistributed for the kharif season as a short-term measure on a large scale.

9.2.ii. Possibilities of groundnut in different agro-climatic zone (W.B.)

a) Red Laterite and Gravelly Undulating Region

* Extension of Kharif groundnut as substitute to low yielding direct seeded paddy.
* Extension of groundnut as intercrop in Arahar

b) Gangetic Alluvial Region

* Extension of area under summer groundnut.

c) Vindya Alluvium

* Extension of groundnut with bunch type varieties as summer irrigated crop.

9.2.iii. Scenario of Groundnut

Area	-	0.121 lakh hectare
Production	-	0.143 lakh tonnes
Imported groundnut oil	-	0.3 lakh tonnes

Figure refer to 1986-87.
(These figures refer to figure supplied by AE).

The following are the varieties of groundnut seeds used in the state for common aggricultural practices in different districts.

B-30 - Derived from A.K. - 10 (M.P.)
B.31
M.H-2
A.K.-12-24 (Bunch type)
J.L.-24 [Derived from E.C. 94943 (Bunch type)]

Junagarh - 11 (Bunch type)

J-11

Polachy - 1

9.3. SUNFLOWER

There are several favourable points for sunflower cultivation in the state. Short maturity duration and its photo-insensitivity make the crop suitable for being fitted into existing cropping systems. Its relative resistance to drought and saline conditions would encourage its cultivation in the problem areas. Comparatively high oil content (45-50%) in the seed, relatively high amount (60%) of poly-unsaturated fatty acids and ease of oils extraction by country method make this crop suitable for adoption by the Indian peasant farmer. However, the reaction of farmers has not been as enthusiastic as was expected because of several reasons, chief amongst which are its susceptibility to bird attack (specially parrots), non-uniform grain-filling specially in the centre of the capitulum and lack of availability of good-quality seed.

9.3.1. Agronomic - considerations

a) Seed Treatment

Poor germination is one of the problems of sunflower cultivation. Apart from improperly filled seed, fungal attack during the seed germination impairs the germinability of the seed. Experiments cunducted at Vellayani in Kerala have shown that fungicides like Captan, Thairam or Brassicol (Quintozene) increased the germination of the seed (Abraham et al., 1976). The untreated seed lot showed germination of 73% while the germinability of the treated seed was 88%. Soaking the seed in water for 24 hr followed by treatment with Brassicol (2 g/kg seed) yielded 4 q more than the untreated seed. In the soaking process most of the unfilled seeds float to the surface and can be easily removed. Sowing depth of 5 cm is optimum for this corp.

b) Seeding Time

Sunflower as a photo-insensitive crop can be shown throughout the year. Under rainfed conditions, however, best results are obtained by sowing the crop with the onset of monsoon rains.

When the crop is raised under irrigated condition the best time for sowing the north-west parts of the country is the middle of October. Delay in sowing beyond the end of October progressively reduced the yield. Lowest yields were recorded (Chandra, 1974) when the crop was sown in February (Table 9.5).

For Berniput conditions of West Bengal, highest seed and oil yields were obtained by sowing the crop in the last week of November or mid-December (Bhattacharya et al., 1975). In the cropping sequence this crop can therefore follow mid and long-duration aman rice. A delay in sowing beyond the middle of December decreased the yield of the crop substantially. For the tarai belt of Himalayan foothills (as represented by Pantnagar conditions), optimum time for spring-summer crop was reported by Yadav and Singh (1974) to be the second week of March. A progressive reduction in grain yield occurred as the sowing was delayed. Very low yield was obtained when sown in April-July. Yield again improved by sowing in the middle of September (Table 9.6).

c) Planting Geometry and Plant Population

Under dryland conditions of plateau region of the country, as represented by Hyderabad conditions, a yield of approximately 900 to 1,300 kg seed/ha was obtained over a population range of 18,000 to 32,000 plants/ha and 56,000 to 98,000 plants/ha respectively. For dryland conditions a population of 60 to 75 thousand plants/ha at a row spacing of 35 to 60 cm is recommended (Vijailakshmi et al., 1975).

For the irrigated crop a row spacing of 45 to 50 cm and intra--row spacing of 20 to 25 cm is recommended. The irrigated conditions at a plant population of 50,000 plants/ha gave maximum yield (Hukker and Sharma, 1975).

d) Fertilizer Use

Experiments conducted on black cotton soil have shown that 25 kg N/ha was the optimum for this crop (Table 9.7). There was no response to P application on these soils (Girase et al., 1975).

Table IX-5. Yield (tonnes/ha) of Sunflower Varieties as Influenced by Seeding dates at IARI under Irrigated Condition

Seeding date	Sunflower Variety			
	'Sunrise'	'EC 69874'	'EC 68413'	Mean
October	2.80	2.11	2.77	2.56
November	2.35	1.85	2.31	2.17
December	2.31	1.54	2.47	2.07
January	2.25	1.60	2.40	2.08
February	1.71	1.71	1.96	1.79
Mean	2.29	1.72	2.34	
CD (P=0.05)				
Varieties	0.09			
Dates of	0.20			
V X D	0.28			

Table IX-6. Effect of Seeding Dates on the Seed Yield of Sunflower under Tarai Conditions

Date of Seeding	Seed Yield (tonnes/ha)
March	3.19
April	2.80
May	1.45
June	0.21
July	0.15
September	2.74
CD (P=0.05)	0.25

At Pantnagar a recommendation of 40 kg N and 13 kg P/ha was found optimum for a rainy season sunflower crop (Singh et al., 1973). For the spring season crop a fertilizer application of 60 kg N/ha is recommended (Table 9.8). No significant response to P was noted in the spring season. For Delhi conditions, Hukkeri and Sharma (1975) have recommended 50 kg N/ha as optimum for this crop.

e) Irrigation Requirement

Singh et al. (1973) conducted experiments on the effect of irrigation at different times, and noted that saturating the soil profile with 7 to 9 cm of water is sufficient to sustain the crop till maturity during the winter season. For the spring season crop one pre-sowing irrigation followed by 2 to 3 irrigations - the first one 3 weeks, the second one 10 weeks and the third one 14 weeks after sowing gave good yields (Table 9.9). Hukkeri and Sharma (1975) have reported for Delhi conditions that irrigation at flowering stage is more critical than at the seed-development stage.

9.3.ii. The current situation of sunflower crop

The development of high oil sunflower varieties in Soviet Union has stimulated worldwide interest in the commercial exploitation of this crop. Sunflower crop which was once ranked very low in the world, now occupies second place after soybean as a source of edible oil.

The commercial cultivation of sunflower crop was started in India during 1972-73 with few imported varieties from USSR and Canada. Among all the sunflower varieties tried, EC-68414, EC-68415 and Morden were found adaptable to various agro-climatic conditions and different croping systems. Varietal Renovation Programme initiated in 1977 helped in stablisation of yield and oil content in these varieties. Due to the intensive Research and Development Programme, the crop has now assumed importance as an oil seed crop in Indian agriculture. Rapid expansion of production and wide interest shown by farmers suggest that sunflower may become a major crop in India. At present, the crop

Table IX-7. Response of Sunflower to N and P fertilization at Jalgaon (Maharashtra)

Level of N (kg/ha)	Seed Yield(tonnes/ha)		Level of P_2O_5 (kg/ha)	Seed Yield(tonnes/ha)	
	1973	1974		1973	1974
0	0.81	1.04	0	0.96	1.27
25	0.96	1.34	25	0.99	1.23
50	1.01	1.30	50	0.91	1.26
75	1.00	1.35	75	0.92	1.27
CD(P=0.05)	0.08	0.13		NS	NS

Table IX-8. Sunflower Seed Yield as Affected by N and P Fertilization at Pantnagar

Level of N(kg/ha)	Monsoon season	Spring season	Level of P_2O_5	Monsoon season	Spring season
0	1.46	3.01	0	1.61	2.57
20	1.75	2.69	13	1.98	2.68
40	2.06	2.79	26	2.06	2.80
60	2.26	3.18	-	-	-
CD (P=0.05)	0.23	0.34		0.17	NS

Table IX-9. Irrigation requirement of Spring-Sunflower

Treatment	Seed Yield (tonnes/ha)
No Irrigation	1.42
One Irrigation (4-6 leaf stage)	1.88
Two Irrigations (4-6 leaf and flowering)	2.14
Three Irrigations (4-6 leaf, flower Bud initiation and flowering)	2.05

is being cultivated in 7 to 7.5 lakh ha in the country either as entire or mixed and inter-crop. The early duration variety Morden maturing within 70 to 75 days is found to be more suitable for mixed and inter--cropping. A high yielding and early maturing hybrid BSH-1 was developed. It has greater degree of self-compatibility, more stability in yield, uniformity in stand and resistance to rust. Hence, seed production in BSH-1 sunflower hybrid was initiated.

The sunflower crop can be grown during all the seasons kharif, rabi and summer.

However, higher yields are obtained during summer. It is observed that sunflower crop has more potential for the farmers and it is replacing some of the crops like kharif groundnut, rabi jowar and durum wheats which are less remunerative to the farmers. Hence, the area under sunflower is on the increase and it is gaining importance as one of the potential oilseed crops. At present, as the crop is newly introduced, it is not having major pests and disease. However, in certain localities, it is affected by the diseases - Alternaria, Rust and selerotania. During 1983, the Heliothis insect damage was also observed. It is found that the crop is comming up well in saline soils also. So, it is contemplated to introduce this crop in saline-affected areas like Bhal area in Gujarat and Sundarbans in West Bengal. In Uttar Pradesh, the crop can be successfully cultivated, after the havest of potato crop. The crop may also be cultivated with available residual moisture in paddy fallows after the harvest of paddy, crop.

9.3.iii. The achievements and progress made by the Sunflower research centres in the country

1) In the year 1980, a sunflower hybrid BSH-1 was released for commercial cultivation. A few open pollinated varieties like Surya and CO-1 have been developed and released for commercial cultivation in Maharashtra and Tamil Nadu State, respectively. S-55, an early maturing variety with a duration of 60 to 65 days has been developed at Akola. The work on developing new hybrids

and open pollinated varieties is in progress. The work on incorporation of male sterility and restoration characters into new promissing inbred lines is under way.

2) Some of the defects such as instability in yield, low oil content and low seed filling ability, the crop had in the initial stage, have been minimised. The seed filling ability, which was to the extent of 60 to 65 per cent only in the mid-seventies has been raised to 80 per cent by Varietal Renovation Method. The oil content in the commercial varieties has been raised by 4 per cent.

3) Due to the intensive Research and Development Programme, the crop has now assumed importance as an importance as an important oilseed crop in the Indian agriculture. Rapid expansion in production and wide interest shown by farmers suggest that sunflower may become one of the major oilseed crops in India.

4) The package of practices for cultivation of the crop has been developed and supplied to the farmers.

5) The critical stages of the crop have been identified. During these critical stages, i.e., bud, flowering and seed filling, irrigating the crop is necessary depending upon the soil moisture status to obtain higher yields.

6) Dithane M-45 and Zeneb fungicides have been indentified for control of leaf spot and rust diseases. Endosulphen (0.05 per cent) helped in controlling Jassids and Heliothis.

7) In the absence of bees during flowering, hand pollination in the morning hours (10 to 12 A.M.) on alternate days for five to six times during flowering, results in increased yield to the extent of 15 to 20 per cent. Growing niger crop along with sunflower, as a mixed crop, helps in attracting honey - bees and thereby, obtaining higher seed yield.

8) Split application of nitrogen was found to be better than single basal application.

9) Mixed cropping of sunflower with groundnut, ragi and blackgram in 2:6 proportion was found to be remunerative to the farmers.

10) In the maximisation trials, it was observed that a fertilizer does of 40:60:40 kg/ha gave 22 per cent higher yield with that of half the recommended dose.

11) Keeping plots weed-free up to 45 days helped in getting 35 per cent more yield over unweeded plots.

12) The sunflower seeds were found to have the dormancy period of 45 days. Ethrel (25 ppm) was found to be the effective chemical to break the dormancy.

13) Seed viability studies indicated that seed stored in tin containers were found to retain viability for more than nine months. Short term seed hardening treatment using water on six months old seeds revealed that treated seeds showed viability even ten months after the treatment.

14) It was observed that growing one crop of sunflower after another reduces the yield ability of the crop. Hence, crop rotation should be followed. Among the rotations tried, sunflower was found to come up well after groundnut, rabi jowar and avena crops.

15) It is important that the sowing date should be adjusted in such a way that flowering period should not synchronise with continuous rains.

16) The seed production centres initiated in 1977 have produced nearly 14 tonnes of breeders and 400 tonnes of foundation seeds. These quality seeds were supplied to the State Departments of Agriculture, N.S.C. and other agencies.

9.3.iv. Deficiencies/constraints in research and development of sunflower crop

1) The crop is developing fast in the country. Hence, to cater to the needs of research under varied agroclimatic conditions, it is better to have more number of research centres.

2) At present, the research and seed production centres do not have sufficient lands with irrigation facilities. It is necessary to have these to advance the generations of the breeding material quickly and hasten research programmes.

3) As area under this crop is on the increase, the demand for quality seeds is also increasing. So, to cater to the needs of farmers for quality seeds, it is essential to have more number of seed production centres.

4) To screen the germplasm collections against disease and pests under laboratory conditions, there should be green-house facilities.

5) Sunflower crop is mostly cultivated under rainfed conditions. Hence, there should be inter-projects. This may help in reducing the number of years of trials and understanding the crop cultivation aspects.

6) There should be closer liaison between research and extension agencies. This would help in imparting the research results to the farmers effectively. This interaction is particularly necessary in the development of a newly introduced crop like sunflower.

9.3.v. Prospects of sunflower crop in India

1) At present 8 to 10 a/ha sunflower seed yields are being obtained. This is not at per with the yields obtained in other countries like Romania, U.S.A. and U.S.S.R. Hence, there is a scope for further improvement in the yields. However, this crop can make important contribution to the income of dryland farmers and at

the same time help to reduce the edible oil shortage in the country. Since it is having a low seed rate (10 kg/ha) and high seed multiplication ratio (1 to 100), rapid spread of the crop is possible.

2) Taking sunflower as an inter-crop is groundnut or in ragi in 2:6 proportion was found to bring higher returns. Under unfavourable weather conditions, groundnut may fail but sunflower gives at least some return, while under favourable conditions, sunflower and groundnut in 2:6 proportion gives higher returns as compared to a single crop. The short duration variety Modern was found to be most suitable for inter-cropping in groundnut and also for double or multiple cropping.

3) Introduction of sunflower crop in new areas like Ladakh in Srinagar valley. Koraput district in Orissa, Sundarbans in West Bengal and Bhal regions in Gujarat will help in increasing seed production in the country.

4) In Saurashtra region in Gujarat state, wide spacing in groundnut crop is adopted. If early variety like Modern is taken as an inter-crop in widely spaced groundnut crop, it would help in increasing the production of oilseed crop.

5) In southern State like Karnataka and Maharashtra, herbacium, arborium cottons, durum wheats and bajra crops are very low yielders. The farmers are already replaceing the low yielding crops with sunflower in Gulbarga, Bidar, Bijapur, Raichur and Bellary districts in Karnataka State and Solapur, Osmanadbad and Parbhani districts in Maharashtra State.

6) The crop is fairly tolerant to salinity. Hence, it can be introduced in saline-affected areas and increase the production of sunflower crop in the country.

7) Growing of early duration varieties like Morden in paddy follows would help to a great extent in increasing the production of the crop.

8) If sowings of groundnut crop are delayed due to late receipt of rains (i.e., beyond second fortnight of July), as a mid-season correction, cultivation of sunflower crop in such areas would be economical.

9) It is observed that under dryland agriculture, cultivation of sunflower is more economical than cultivation of groundnut and sesame crop during kharif season.

9.3.vi. Major thrust required indeveloping sunflower crop in the country

1) Collection, evaluation and utilisation of germplasm material from major sunflower growing countries, especially collection of wild species for imparting disease and pest resistance in the commercial varieties is necessary.

2) More emphasis should be placed on the development of high yielding sunflower hybrids, populations and composites suited to different agroclimatic conditions.

3) Effective and quick disseminetion of research findings is necessary to reduce the gap between the yields obtained in the experimental stations and in the farmers' fields

4) Production of early maturing and high yielding verieties for use in different cropping system.

5) Studies on viability of sunflower seeds.

6) Some of the non-monetary inputs like soaking of seeds, use of renovated seeds, optimum time of sowing and time of harvesting would enhance the productivity and production of the crop.

9.4. Factors limiting safflower production in India

Safflower (Karad, Kusum) is a traditional crop of India, Safflower cultivation in India has been primarily for edible oil extraction or for the preparation of vegetable dyes from the petals. Bulk of the crop is grown under drylands as border rows or as a mixture with other crops. It also thrives well when irrigated.

Although safflower is a traditional crop of India and accounts for 49% of the world area, its yield per unit area is one of the lowest (Table 9.10).

The main causes of low yields are: (i) lack of genetically improved cultivars with high oil content and resistance to rusts and aphids, (ii) lack of spineless cultivators for adoption in not-traditional areas, (iii) lack of awarences of quality of oil, and (iv) lack of proper marketing facilities and price structure to enthuse farmers to grow the crop in solid stands.

Some efforts have recently bean made to improve the genetic base of safflower, and as a result the following varieties (Rajan, 1974) have been recommended for the different climatic zones of the country.

State	Improved varieties
Tamil Nadu	'K1' or 86503'
Karnataka	'17-3-3'
Andhra Pradesh	'7-13-3'
Maharashtra	'N 62-8' or '116-42'
Gujarat	'N 62-8'
Madhya Pradesh	'N 62-8'
Rajasthan, Haryana	'A 300', 'N 62-8'
West Bengal	'N 62-8'
	'6503'

It is now established that by adopting suitable agronomic technology like seedbed preparation for proper moisture conservation, appropriate seeding time and fertilizer practices, yield of the crop can be

Table IX-10. Area, Production and Yield of Safflower in Different Countries of the World

Continent/Country	Area ('000/ha)	Yield (kh/ha)	Production ('000 tonnes)
Africa	64	391	25
North-Central America	499	1,433	715
South America	8	789	6
Europe	56	404	23
Oceania	44	637	28
USSR	11	467	5
India	668	325	217
World	1,356	754	1,023

Table IX-11. Effect of planting methods on performance of Safflower

Methods of Planting	Plant height (cm)	Seeds/ fruit	Branches/ plant	1,000-seed weight (g)	Seed yield (tonnes/ha)
Broadcast	119	25.9	7.4	35.9	1.09
Row sowing	126	28.6	8.0	77.4	1.12

increased several folds under dryland conditions. When irrigated at appropriate stages of growth, yields of almost 5 tonnes/ha have been realized. Some of the production practices are discussed below.

9.4.i. Production practices

Depth of Seeding and Treatment of Seed :

Under dryland conditions, where the crop is sown in the post--monsoon season, depth of seeding plays an important role. Daulay et al. (1974) have shown that seeding at a depth of 3 to 5 cm depth. They have recommended soaking the seed before sowing.

Since the moisture is found below the 5 cm depth under dryland conditions, the seed should be sown deep (8 to 9 cm), keeping the furrows open forrapid germination.

Planting Method :

Line sowing has been found better than broadcast sowing for this crop (Eunus et al., 1975). The crops grown in row produced higher seed yields, plant height, seeds per capitulum and thousand-seed weight than the broadcast sowing of the crop at the same seed rate (Table 9.11).

a) Seeding Time and Planting Geometry

Safflower is primarily a crop of the drylands. The seeding time and population pressures play important role in the yielding ability of the crop. Because of climatic (mostly temperature) variations, the optimum time of seeding is different under north and peninsular Indian conditions. It should be sown in the middle of October when the mean daily temperatures are around 26°C (Table 9.12). Because of high diurnal temperatures, earlier sowings make the seedlings weak. When sown after mid-October, flowering process is adversely affected. For peninsular India, Girase et al. (1975a) have recommended first week of October as the optimum time for sowing under Jalgaon conditions (Table 9.13).

Table IX-12. Seed Yield of Safflower as Influenced by Seeding Dates and Planting Density in Drylands of North-Western India

Seeding data	Seed Yield (tonnes/ha) 1975-76	1976-77	Planting density ('000 plants/ha)	seed yield (tonnes/ha) 1975-76	76-77
III week of Sep.	1.44	0.56	1.66(30x20cm)	1.64	1.29
II week of Oct.	1.92	1.85	1.11(45x20cm)	1.41	1.30
I week of Nov.	1.59	1.70	0.86(60x20cm)	1.18	1.02
III week of Nov.	0.69	0.70			
CD (P = 0.05)	0.32	0.14			

Table IX-13. Effect of seeding dates of the seed yield of safflower in the drylands of peninsular India

Seeding date	Seed Yield (tonnes/ha)	Seeding date	Seed Yield (tonnes/ha)
Early Sept.	1.28	Early Nov.	1.09
Middle Sept.	1.34	Middle Nov.	0.56
Early Oct.	1.47	Early Dec.	0.14
Middle Oct.	1.12	Middle Dec.	0.05
CD (P=0.05)			

A population of 111,000 plants/ha at a rectangular planting geometry of 45 cm x 20 cm was found optimum for dryland conditions, while Sounda (1975) recommended a population of 1,28,000 plants/ha for partially irrigated conditions.

For an irrigated crop 75,000 to 80,000 plants/ha were found optimum (Sharma and Hukkeri, 1973). Apparently the indeterminate flowering habit of the safflower plant enable it to adjust the population variations under adequate soil-moisture regimes by adjustment in the secondary and tertiary flower nodes (Table IX-14).

b) Fertilizer Use :

Rajan (1974) reported the recommendations on the quantity of fertilisers to be used in safflower for different states (Table IX-15).

For the irrigated conditions of north India, Sharma and Hukkeri (1973) have recommended 50 kg N/ha as optimu, while Sounda (1975) have found 80 kg N/ha to be optimum for the crop (Table IX-16).

c) Irrigation Use

Though safflower crop is primarily grown under dryland conditions, experiments conducted by Dastane et al. (1971) have shown that safflower and sunflower were the most remunerative crops when grown either with or without irrigation (Table IX-17). The monetary returns from safflower were highest amongst the crops tested by them, which included wheat, Bengal gram, linseed, sunflower and rapeseed.

According to these workers the irrigation given at 4-6 leaf stage, branching, flowering and capsule formation recorded seed yield of 4.8 tonnes/ha. Of these growth stages, 4-6 leaf stage and initation of branching phase appeared to be the most critical (Table 9.18).

9.4.ii. Safflower in the Plateau Region

The plateau region of Bihar comprising the districts of Palamau, Gumla, Lohardaga, Ranchi, Singhbhum, Hazaribagh, Giridih, Dhanbad, Deoghar, Godda, Dhamuka and Sahebganj accounts for nearly 46 per cent

Table IX-14. Effect of Plant Population on Yield of Irrigated Safflower

Plant Population ('000 plants/ha)	Seed Yield (tonnes/ha)
50	1.89
75	2.03
150	2.12

Table IX-15. State wise Recommendation for Fertilizer Use

State	N	:	P_2O_5	:	K_2O
Andhra Pradesh	50	:	25	:	25
Gujarat	40	:	30	:	20
Karnataka	30	:	15		
Maharashtra	40	:	30	:	20
Madhya Pradesh	20	:	10	:	0

Table IX-16. Response of Safflower to N Fertilization under limited Irrigation conditions

Rate of N (kg/ha)	Seed yield (tonnes/ha)
0	1.50
50	2.20
100	2.34
CD (P=0.05)	0.26

Table IX-17. Comparison of Rabi Crops to Irrigation levels

No. of Irrigations	Gross Income (Rs./ha)				
	Wheat	Bengal-gram	Sunflower	Mustard	Safflower
0	-	3,030	3,210	2,700	3,190
1	2,520	2,490	4,155	3,980	4,290
2	3,340	3,960	5,210	3,720	4,800
3	3,460	3,880	5,460	4,370	4,800
4	3,740	3,750	4,380	4,420	5,580

Table IX-18. Response of Safflower to Irrigation

Stages of Plant Growth for Irrigation				No. of Irrigation	Seed Yield (tonnes/ha)
4-6 leaf	Branching	Flowering	Capsule formulation		
-	-	-	-	0	2.75
-	X	-	-	1	3.22
X	-	X	-	2	4.14
X	X	-	X	3	4.14
X	X	X	X	4	4.81
CD (P=0.05)					

X = Irrigation applied, - = Irrigation not applied

Table IX-19. All India Index Number of Area Production and Yield, 1959-60 to 1980-81
(Base Year: Trinnium ending 1969-70 = 100)

	1959-60	1962-63	1964-65	1967-68	1970-71	1973-74	1976-77	1979-80	1980-81
Area	87.2	87.2	87.2	92.1	105.6	110.2	121.8	130.8	129.5
Production	71.0	71.0	71.0	74.3	147.1	182.6	208.2	265.0	322.5
Yield	82.1	82.1	82.1	82.3	140.4	167.0	170.9	202.6	249.0

Table IX-20. Average Yields of Safflower, Linseed and Rapeseed-Mustard in the Varietal Evaluation Trials at Ranchi

Crop/Varieties	Average Yield (q/ha)	Range of Yield (q/ha)
1. Safflower		
Annigeri-1	9.65	6.75 to 12.22
APRH -1	8.85	6.01 to 12.68
A. 300	8.77	6.58 to 12.70
2. Linseed		
T. 397	6.04	4.17 to 8.15
S.S. 2	6.02	3.78 to 9.08
3. Rai		
Varuna	2.62	1.67 to 3.05
4. Torai		
BR 23	2.10	0.78 to 4.04

of the land area of Bihar State. It is characterised by undulating topography and non-flow-perennial river systems. Although the mean annual rainfall is high (1,210-1,480 mm in different districts), the distribution is highly lopsided. About 82 per cent of the rainfall is received between the months of June and October. Year to year variation is also high and there are long and short gaps during the monsoon months making the crop vulnerable even during the Kharif season. Assured irrigational facilities are available to less than 5 per cent of the cultivated area. All these factors lead to a low cropping intensity.

The undulating topography results in definite toposequences with hills and hillocks at the top, gravelly, skeletal, light textured soils at the higher levels of topography (upland), followed by loamy sands to sandy loams at intermediate level (medium land) and sandy clays as the lowest element (lowland). Out of approximately 3 m ha under cultivation, uplands and medium lands account for nearly 60 per cent of the area. These are the land situations which are suitable for cultivation of oilseeds in general.

Life behalf in West Bengal Safflower per cultivation may be introduced in the State. As this crop is suitable in any type of soil.

As the horizontal extention is limited in the State due to the lack of agricultural line Safflower may be introduced in the saline shown of Sundarban or in the red latrite or in the gravelly soils of Purulia and Bankura. But though it has draught resistance capability still it is a neglected crop in the state.

The uplands soils are light textured, highly permeable, acidic, low in nitrogen and available phosphate and have low moisture holding capacity. In absence of irrigation, only Kharif crop is grown. Apart from a number of cereals and pulse crops, Kharif oilseeds like groundnut, sesame and niger (late Kharif) are currently being grown; these soils are also eminently suitable for soybean.

The medium lands are relatively heavier in texture, slightly acidic to neutral in reaction, and have better moisture holding capacity. These lands are mostly sown with rice in the Kharif season. The medium lands though able to support a good Rabi crop are mostly kept fallow, except for some portions of the medium upland which came under rapeseed-mustard, linseed, barley and bengalgram. These crops together cover hardly 30 per cent of the medium lands which have distinct potential for swquence cropping with suitable crop and varietal adjustment during the preceeding Kharif season. Sunder such a land situation, safflower is a potential crop.

Despite a pronounced drought resistance capability safflower has been a neglected crop until recently. As evident from All India Index Number for crops, it is only in the seventies that this crop started showing a rising tendency in area, production as well as productivity (Table 9.19), and by 1980-81 this rise in area was matched only by rapeseed-mustard, while in production and in yield the magnitude was unmatched by any other oilseed crop.

a) Prospects of safflower in the plateau region

Safflower is not a traditional crop of this region. With the inception of AICRP for dryland agriculture, work was started on this crop in 1971-72. Regular varietal varietal evaluation work commenced from 1972-73 and studies on its agronomic requirements were initiated in 1974-75.

Safflower was found eminently suitable for the plateau region. It is evident from the average yield over five years give in Table 9.20 along with those of linseed, toria and rai (B. juncea) grown under similar experimental conditions. Safflower varieties gave average yields of 8.77 q/ha (A-300) to 9.65 a/ha (Annigeri-1), linseed varieties gave an average of 6.04 q/ha (T.397) and 6.02 q/ha (L.S.2) while toria (BR 23) and B. juncea (Varuna) averaged 2.1 q/ha and 2.62 q/ha, respectively. On an average safflower varieties gave more yield by 151 per cent over linseed, 347 per cent over rai (B. Juncea) and 433 per cent over toria. This clearly establishes the suitability of safflower for the plateau region.

The markedly superior performance of safflower as compared to other Rabi oilseeds crops in this region is because of the fact that the safflower is in complete consonance with the climatic rhythm of the area. The Rabi seeding starts just after the cessation of monsoon rains around 10th of October, with usually a full moisture profile unless there is a failure of late monsoon rains. There are some rains in November too, while in December it is less than 5 mm. The rainfall again picks up around middle of January, February receives the highest amount of Rabi rainfall which continues in March as well. An early maturing crop like toria is not able to take any advantage at all of winter rains, mustard and linseed are able to take partial advantage, while safflower capitalises fully. Unlike other crops, safflower passes the major part of the period in the rosette stage when the crop has to depend on stored soil moisture and grows under an under a receding soil moisture regime. However, during this period it develops a rood system which is able to tap moisture from the deeper layers wee it is not deficient. Soon after its entry in the elongation phase, the regular winter rains arrive and are available in small quantities until the maturity of the cro. Its long duration of 160-170 days is thus turned to distinct advantage.

The diseases and pests are also not much of a problem in this region. Alternaria leaf spots mostly occur in very low intensity to cause any serious damage, rusts count be a problem in some of the years, but them resistant varieties like APRR-1 and APRR-2 are available. Black aphids do infest the crop, the hardly cause any palpable damage.

The comparison made here between the safflower and other Rabi oil-seed is only meant to establish the credentials of this crop, for there is enough land available not only for oilseeds, but for other Rabi crops as well. Out of a total of around 0.8 m ha of medium land, less than 20 per cent is being cropped at the moment. There is enough land to go round.

9.4.iii. Constraints/problems

a) Lack of systems approach in corp planning

The medium land is predominantly cropped with either direct seeded or transplanted rice. Most of the rice varieties under cultivation are of comparatively longer duration and consequently land does not become available in the early part of October. Hence planning for a Rabi crop in the medium land has to start in Kharif itself with sowing/ transplanting of rice varieties maturing in 110 to 120 days. A good number if such rice varieties are available. Lands which become available towards the end of September can go to rapeseed-mustard, those becoming available in October to safflower, linseed bengalgram and lentil and those available in early part of November can becropped with linsed, bengalgram, lentil and barley.

Since the crop has to grow on a receding soil moisture regime supplemented with meagre later October and November rains it has to be sown within four to five days of the harvest of the Kharif crop to enable it to make full use of available moisture. This is usually not followed and moisture depletion from top layer makes the germination of Rabi crop patchy.

b) <u>Lack of technical know-how among the farmers</u>

Since safflower is a now crop for the region, not only the farmers, but many of the extension functionaries particularly at the lower level, are not aware of the proper technology for raining the crop. An intensive training programme for the various levels of extension functionaries and farmers, coupled with an extensive programme of demonstrations is required for introducing the crop in a big way.

As a corollary, it follows that this programme must be back up with adequate arrangements for supplying seeds of proper varieties (A. 300, Annigen-1, APRR-1).

c) <u>Lack of adoption of proper seeding methods/devices</u>

Proper stand establishment of Rabi crops is a general problem in this area, but it is much more so incase of safflower which has a hard and thick seed coat. It takes seven to ten days for emergence. Hence the seed bed is required to maintain adequate moisture level during this period. If the sowing is shallow, the depletion of moisture from the seed zone levels the seed high and dry. This problem is accentuated, if proper precautions for moisture conservation are not taken after the harvest of the Kharif crop and during land preparation. If the sowing is done too deep, the soil overburden impedes germination. Hence the sowing needs to be done deep (8-10 cm) with less of soil overburden (4-5 cm). This can be achieved with indigenous seed tubes (Pora or Chonga) or seed drills developed at Birsa Agricultural University to suit the low draught power of the local bullocks. By the large, even the use of indigenous seed tubes is limited to only a part of Palamau district, the seed drills are yet to reach the general farmers.

d) Problem of stray cattle grazing

Since practically very little crop is grown during the Rabi season in this region, the cattle are let loose for free grazing after the harvest of the Kharif crop. Even the spiny varieties of safflower are valnerable to cattle grazing during this period since they do not develop spines for about two months. During the prolonged rosette stage, the field does not give a "cropped look" to the farmers who are not used to safflower and leads to a sort of psychological apathy which does not induce them to make extra efforts for warding off the stary cattle. Thus the social problem of stray cattle grazing gets compounded with a psychological attitude of apathy. Once the spines develop, it is largely left alone by the cattle but not by the goats.

e) Difficulties imposed by spiny leaves

While the spines, once they develop, act as a deterrent to cattle grazing they make inter-culturing, harvesting and threshing operations bothersome. But this is largely a problem of adaptation.

f) Problem of oil extraction

Inefficient oil extraction by village "ghanis" (expellers) because of hard seed coat makes the crop less attractive. Power expellers are generally not available in the interiors. Thn hulled varieties with higher oil content would be preferred in this context. Efforts need to be intensified in this direction.

g) <u>Lack of marketing facilities and remunerative prices</u>

Since efficient expellers are not available in the villages and also since safflower oil is not preferred largely due to unfamiliarity, marketing facilities assume an added importance. Proper marketing facilities should go a long way towards popularising the crop and exploitation of the vast potential both in terms of area and yield/unit areas.

Practically most of the common type of soil arrives as classified in soil chapter are suitable for safflower cultivation. From the plotau resions of West Bengal to the full fill of Himalaya and in the postal salayin soil of the state. In any aggroclimatic condition safflower may be cultivation with a best afficient approach. So far experiment done on seed varities C.T.S. 7803, N62-8, A-1 and A.P.R.R-1 are the most suitable seeds in the state yielding variety.

As the horizontal areas in the gangetive alluviun of the state are mainly covered by paddy pulses and other crops it is difficult to convince the farmers introduce safflower. As due to the lack of market and scarcity of Ghanies and other source of extracting oils from the safflower seeds turned the situation difficult. Other chemical technology for processing the same oil is not very much popular even among the industrials who are involve in the same field. As mustard oil is the most common and popular cooking midium in the state. It is very difficult the introduce safflower oil in the state of West Bengal. For the above reason with vast opportunity of producing safflower in the state it become difficult for the specilist in this field to make the farmers aware are necessary were market thus not prevail. Thus we loose a great protentiality for producing safflower in the state of West Bengal.

Cyanogen compounds, Bitter and cathartic factors are the main toxic constituents in safflower oilseeds though there is the present of amono acid content are not negligible but the chemical processing methr-

9.5. Soybeans

The soybean area in the world rapidly increased to 49 m.ha. in 1983, of which 21% was in Asia contributing about 16% of the world's total soybean production of nearly 78 m tonnes. This amounts to a conspicus increase by 11.3 m ha and 20 m tonnes of world areas and production of soybean, in less than a decade (1974-76 to 1983). Approximately 14 and 15% of increased production and area respectively, was in Asia. From the view point of global oil production, soybean ranked at the top, both in area and edible oil production in the world.

9.5.1. Soybean in India

Although soybean is not new to India, commercial cultivation of yellow seeded soybean is comparatively recent origin. Earlier, low yielding black seeded shattering type of soybean were conventionally grown under different names in hills and scattered pockets in plains. Initiation of efforts to popularies yellow soybean in early sixties faced considerable controversies about its usefulness in India which undoubtedly retarded the progress of commercial exploitation of this maracle gift of nature. While usefulness of soybean to mankind was recognised and its commercial exploitation in developed world resulted a record increase in the area to 43.39 m ha in 1977 to 78; at the same time the apathy and detraction in yester-years for utilisation of soybean in India was ironical particularly when the country was faced with acute shortage of edible oil, high protein food and feed. However, with time various apprehensions against the crop have been proved to be unfounded and soybean cultivation has taken a modest start in the country.

The area under soybean in India rose from 0.0003 mha in 1968 to 1 m ha in 1983. This feat had been possible due to ingenuity of Indian farmer and outcome of soybean research and development efforts in the country. Although, presently Madhya Pradesh and Uttar Pradesh with about 0.8 and 0.1 m ha, respectively, are the major soybean producers in the country, other States like Rajasthan, Himachal Pradesh, Bihar, Maharashtra and Karnataka also provide bright prospects for soybean production Table 9.21. The targets of 1.8 m ha are aimed for 1984-85.

Table IX-21. Identified/released varieties of soybean for different agro-climate zones

Agro-climatic zone	Variety	Day to maturity	Yield q/ha
Northern Hill Zone	Bragg	120	20-25
	Punjab-1	110	20-25
	Shilajeet	105	20-25
	DS-74-20-2	110	25-30
Northern Plain Zone	Bragg	120	20-25
	Ankur	130	25-30
	Alankar	120	25-30
	Shilajeet	105	20-25
	PK-327	110	25-30
	PK-262	125	30-35
	PK-308	115	25-30
	DS-73-16	120	30-35
	DS-75-22-4	120	30-35
Central Zone	Bragg	115	20-25
	Ankur	120	25-30
	JS-2	105	20-25
	Gaurav	110	25-30
	MACS-13	110	25-30
	Durga	110	25-30
Southern Zone	Hardee	110	15-20
	KHSb-2	115	20-25
	DS-74-40	110	20-25
	Improved Pelicon	110	15-20
Davis	Davis	110	15-20
	PK-74-292	110	20-25
	CO-1	115	20-25

9.5.ii. Possibilities of Soyabean Cultivation

The prospect of soyabean cultivation in West Bengal is indeed very great. Soyabean is essentially a Kharif crop maturing within 90 to 105 days. It is, however, distressing that the vultivation of soyabean in West Bengal has not received adequate attention it deserves. Presently, the cropped area of soyabean is only 300 hectares, producing about 200 tonnes of soyabean. The yield per hectare is around 670 kgs. It is stated that a farmer can make a net profit of Rs.3000 to Rs.4000 per acre of soyabean cultivation. There are quite a number of solvent extraction units in and around. Burdwan where soyabean can be cultivated by the farmers profitably. This year the association has taken a programme to grow soyabean in a small plot of land on an experimental basis in the district of Burdwan for which necessary foundation seed has already been procured. The cultivation of soyabean in the districts of Burdwan, Murshidabad, Midnapore and Purulia deserves special attention of the Department of Agriculture, West Bengal.

Although soyabean contains 18 to 22% oil and 38 to 42% protein, its importance could be realised more during the World War-II as a source of edible oil and also as a compact form of nutritious food for armed forces. Since then, area has grown over ten times and now soybean stands first in the world in contribution of edible oils. According to FAO estimate for 1986-87, 198 million tonnes of oilseeds including cotton seed was produced in the world. Of this, crop-wise production (million tonnes in parenthesis) of major oilseeds were: soyabean (98), cotton seed (29), groundnut (22), rapeseed and mustard (20) and sunflower (19) etc.

Therefore, analyses certain constraints, which need to be overcome in order to boost soybean production. Before this, a brief highlight on the prospect of area expansion in coming years under soybean have been discussed.

9.5.iii. Prospects of Area Expansion

Soyabean has shown tremendous growth during the last fifteen years particularly in the black-soils of the central India. Besides, area is also increasing in the eastern region of the country. Also, soybean researchers have shown the possiblities of soybean cultivation during rabi and summer seasons particularly in the southern India. It is, therefore, important to figure out, atleast roughtly, the area that might come under soyabean in the coming years. The potential area for soyabean in various part of country has been given briefly below:

a) Use of fallow-lands

The experience of area expansion in the black-soils in Madhya Pradesh, which earlier remained fallow, indicated that success story of Madhya Pradesh can be reported in the black-soils of other states as well which mostly remains fallow in kharif season. There are no data available as to how much kharif fallow-land is available in the black--soils. The senior author made some approximation for the year 1983-84 (a very good rainfall years) of the suitable soybean districts having black-soils. He estimated that about 7.11 million hectare of kharif fallow-land in the various states (fallow area in lakh ha in parenthesis) are; Andhra Pradesh (8), Gujarat (3), Karnataka (16), Madhya Pradesh (34), Maharashtra (29), Rajasthan (3), Tamil Nadu (5), Uttar Pradesh (10), etc. Besides, approximately 8-12 lakh ha of up-land kharif-fallow suitable for soybean are available in Bihar and north-eastern states.

The major soybean producing countries in the world in 1985-86 (with their percentage share of world production) were: USA (58), Brazil (18.3), China (9.2), Argentina (6.5), India (0.9) and rest (7). According to an ad-hoc estimation in 1958, about 17,200 ha was under soybean in India which produced about 6000 tonnes of soybean. The area under soybean started moving up after the introduction of yellow-seeded varieties from USA, establishment of All-India Co-ordinated Research Project (AICRP) on Soybean and Intensive Soybean Development Programme during seventies. The area which was about 32.3 thousand hectares in 1970-71 rose to 1392 thousand hectares in 1986-87. The corresponding production values were 13.1 and 835.3 thousand tonnes, respectively with the maximum production of 1024 thousand tonnes in 1985-86. Though, it is grown in many states of the country, Madhya Pradesh alone is producting amount 80% of total production of the country, which is followed by Uttar Pradesh (about 15%), Rajasthan (about 2.5%) and remaining 2.5% of production is made by other states.

Although, it showed tremendous expansion in area, the yield level is still very low in India as compared to many other countries of the world. The average yield (Q/ha) in 1985-86 was 23 for USA, 181 for Brazil, 7.6 for India, 12.7 for Asia and 19 for world. The policies have to be changed and constraints removed so that yield level is increased as this crop has great potential in India. It is because that this crop known as "gold of the soil" has many advantages such as easy cultivation, higher cost-benefit ratio, less requirement of nitrogenous fertilisers and labour, beneficial effect on following crop, soil conservation, relatively better suitability for black-soils etc.

Since the black-soils are suitable for soybean, much of fallow lands in this category can be deviated to to soybean. In the high rainfall areas of eastern regions, soyabean in upland fallow is among the crop giving profitable return, where as upland-paddy gives very poor yield. With allocation of 30% of such fallow land for soybean, an additional 30 lakha area can be added to the present area under soyabean.

The soyabean can also be grown in rabi/summer seasons. Some data indicate that it can be grown in rabi/summer in the southern India, eastern parts of India and even during spring in north India. The cultivation in rabi/summer, however, depends on the availability of water for irrigation. The vast fallow-lands after the harvest of kharif paddy are available in southern and eastern parts of country. The area that could be diverted to soybean is difficult to assess at this stage, when cultivation of soybean during rabi/summer is at the initial stage and, perhaps, it may not exceed 10 lakh ha. This also includes area in north India, where soybean, groundnut and sunflower can be grown in spring season in the land vacated by toria, potato, sugarcane etc.

b) Replacement of low-yield/remunarative crops

Various crops in rainfed as well as inadequately irrigated areas show poor yield or are less profitable. Soyabean, as compared to some crops in one or another zone appears to be promissing under above suitations. In the low-to-medium rainfall regions the rainfed crops such as paddy in Madhya Pradesh, Gujarat, Uttpar Pradesh, Maharashtra and Rajasthan: cotton in Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Gujarat and some pulses in Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh and Rajasthan can be replaced by soybean as it is applicable to in West Bengal.

In the high rainfall zones, the low-yielding rainfed crops such as paddy, small millets, pluses etc. in the parts of Orissa, West Bengal, Bihar, north-eastern states can be replaced by Soybean. Areas with water stagnation for some days, where Soybean has relatively more tolerance than maize, sorghum etc. or areas with inadequate water supply for water-intensive crops like paddy, sugarcane etc. can be switched over to soybean.

c) Area expansion through inter-cropping

Intercropping, in general, has been proved more beneficial than raising pure crop against erratic rainfall conditions. According to the reports of AICRP on Soybean, it can be inter-cropped with many crops with a increased return.

9.5.iv. Constraints

The productivity of soybean in India is very low, which could be due to various reasons including poor plantstand, low input application to erratic rainfall. The failure to expend the area under soybean in some regions of the country could be mainly due to lack of marketing facilities. Such constraints are required to be analysed and removed through research and developmental efforts so that not only area under soybean can be enhanced rapidly, but also to generate good income to the growers through increased productivity. Some of the constraints faced presently area presented below :

1. High seed cost

Unlike other oilseed except groundnut, seed-rate in soybean is high due to large seed size, low vability etc. The seed rate of 75 to 100 kg per hectare is a heavy initial input for the farmers particularly when yield per hectare is low. Consequently farmers are either using low seed-rate or are reluctant to buy expensive quality seeds. This is one of the important factors for poor plant stand in the field which leads to low yield.

The following lines of work may be useful in this regard :

a) Reducing seed-size.

b) Increasing seed-viability.

c) Changing the plant-type in order to increase spacing.

d) Developing storage techniques and facilities so that viability can be maintained during storage.

e) Multiplying soybean for seed purpose during rabi season in Southern India and during kharif in the hills of Northern India.

2. Varieties

a) Number of varieties

About 23 varieties have been released during the last two decades i.e. on an average one variety has been released every year. Many are old, absolute and have become susceptible to diseases. Thus, there are very few good varieties available for varying climatic regions of India. Though, there is always need of high-yielding varieties with resistance to diseases drought etc. the state Governments have great responsibilities for the popularisation and adequate supply of seeds of improved varities.

It has been noticed that some states are given indent for breeder seeds of varieties which are either low yielders of have become highly susceptible to one or another pathogen. In this context, it is important that information on diseases and pests, pre-planned seed production programme of improved varieties in right quantities, use of specific variety in the specific climate must be followed scrupulously in order to increase yield, reduced cost on disease/pest control, slow-down the spread of disease/pests etc.

b) Disease and pests

There is considerable damage in some years or zones by diseases, mainly mosaic, leaf blights, bacterial pustule, etc. and pests like girdle beetle, stem fly, Bihar-hairy catter-pillar, leaf miner etc. For many diseases, seeds are carrier, which cause seedling mortality. It has been observed that mostly farmers do not control disease and pests and seldom practice seed treatment. There reasons could be many including lack of purchasing power of farmers to buy pesticides. In the long-term basis, the breeding of varieties resistant to diseases and pests appears to be the best choice. The present day varieties are often susceptible to one or other disease. Gram-plasm collection, careful use of diverse and many genes for resistance, proper deployment of genes or their combination in different regions etc. are needed in order to slow-down disease development and its spread.

The losses by disease and pests can be reduced by concerted efforts under developmental programmes through increased awareness for seed treatment, quick diagnosis of diseases/pests and their control at the very begining, timely and adequate supply of quality chemicals etc.

(c) Germination and plant stand

Soybean is mostly grown under rainfed conditions in the uncertain rainfall areas of the country. The fluctuation in yield level over years and wide gap between yields under rainfed and irrigated conditions may indicate that the level of drought resistance is low in the present varieties and needs to be incorporated. Soybean shows poor emergence wherever there is heavy rainfall immediately after sowing particularly in black soils. Also under such soils, it is difficult to sow following heavy rainfall. The requirement that seeds should be 3-5 cm deep in the soil, poses a problem i.e., sowing after light rain is again risky as the soil moisture during hot days of June/July at upper 3-5 cm may dry up before seed germinates and result in poor plant stand.

d) Early maturity

Many of the present-day varities mature between 100-130 days. In major soybean growing areas of the country. 80-90% of annual rainfall occurs before the end of August and the long duration varieties usually face moisture-stress during the seed-filling stage (very sensitive stage to moisture-stress). Though, few early maturing varieties are available for some zones, more concerted efforts are needed for the breeding of early maturing but high yielding varieties to fit in as a pure crop, inter-crop and sequence crop.

Such varieties are also required in the farming situation where after taking soybean, farmers would like to conserve residual moisture for the sowing of rabi crop. Thus, the development of varieties with the maturity of 80-90 days will accelerate the area expansion.

3. Inter-cropping

Soybean has been advocated for intercropping with other crops particularly in low-to-medium rainfall areas. Besides additional returns, soybean adds nitrogen to soil (i.e., to companion and following crops), checks soils crosions supresses weed growth etc. Inspite of various advantages, inter-cropping is not popular and reasons for its slow or negligible adoption needs to be studied and analysed.

4. Date of sowing

Generally soybean is sown between 15th June to 15th July. In the West Bengal there is heavy rain in July and the farmer may like to sow in June or towards end of May. Also, the onset of monsoon in some regions or years may not be in time, as happened during the last three years in one or other part of country. Farmers are not sure as to which variety is recommended for such situations. Thus, it is suggested that besides complete package of practices for the sown conditions for each zone, will be of great help for realising maximum benefit from the varieties.

5. <u>Increase in the number of soybean zones</u>

At present the area under soybean cultivation has been divided into 4 agro-climatic zones viz. Northern Hills, Northern plains, Central and Southern. Looking at varying climatical conditions under which soybean is grown in India, the above four zones may not be sufficient for the realisation of optimum yield. It is known that soybean varieties show high environment - varietal interaction. A review on this aspect is need. A tentative soybean zones could be as below :

a) Northern Hills

The Hills of Himachal Pradesh, Uttar Pradesh and Jammu & Kashmir

b) The North Eastern State

The states of Assam, Sikkim, hills of West Bengal, Meghalaya, Arunachal Pradesh, Manipur, Nagaland, Mizoram and Tripura.

c) Nothern Plains

Pubjab, Haryana, parts of Jammu & Kashmir, Uttar Pradesh (except hills and Bundelkhand area), Northern Rajasthan.

d) Eastern Plains

Bihar, West Bengal (except hills), Orissa, Eastern Madhya Pradesh.

e) Central

Bundelkhand area of Uttar Pradesh, Madhya Pradesh (except Eastern area), Eastern Rajasthan Vidharba, and Marthwada region of Maharashtra.

f) Western

Rajashthan (except northern and eastern area) and Gujarat.

g) Southern

Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Kolapur region of Maharashtra.

6. Technology for home-utilisation

Though recipies are available for the preparation of multitude of soybean products, the awareness among people about the utility of soybean and the methods for its consumption at home etc. are lacking. Lately, about 5-7 lakh tonnes of soya meal is exported, which though is the highest foreign-exchange earner among oilseed meals, is a big drain of valuable protein. It could have been used for crores of people with mal-nutrition, particularly when prices of pulses are going up. The creation of such indigenous demand of soybean and its products, will accerlerate its development.

7. Technology adoption by the farmers

Some studies in the M.P. (Anonymous, 1987) for example showed that most of the farmers do not control diseases. Very few are applying fertilisers or rhizobium culture and many do not apply the required seed rate. This kind of district of zone-wise studies to know the real problems faced by the farmers in the adoption of new technology are important in order to make suitable strategies for the faster development of soybean in the country.

8. Marketing

Soybean is not consumed locally except by few people in the hills. Thus, most produce has to be marketted. Though, marketing facilities through the establishement of processing plants have been the one among main factors for the development in some states, but the lack of such infrastructure in other potential area have been hinderance for its growth. The processing plants are needed, for instance, in north-eastern, northern Karnataka regions of the country.

9. Extension and input service

Agrigultural extension is an important medium in transfering technology to the farmers. Though it is good in some states, adequate in others while very poor in remaining. This needs strengthening so that maximum yield can be obtained from the crop. Some years or places, production suffers due to inadequate and or poor quality of seed, pesticides, fertilisers, rhizobium etc. The improvement in these services including credit supply will increase area and yield of soybean.

9.5.v. Effect of sowing datas and fertility levels on the grain yield of soybean

Soybean (Glycine max L.) is an important legume crop rich in protein (42%) and oil (22%). Since it is a new introduction, the production technology for optimum yield of soybean under agroclimatic conditions is not perfectly available. Hence, the present investigation was taken upto find out the optimum time of sowing and fertilizer requirement for the newly released soybean varieties.

A field experiment was conducted during kharif seasons of 1983 and 1984 at Jawaharlal Nehru Agricultural University, Campus CSR Project, Indore. The climate of the area is substropical having temperature range 23°C to 41°C in summer and 7°C to 29°C in winter season. The amount of rainfall during the cropping period was 987.51 mm in 1983-84 and 863.24 mm in 1984-85. The soil of the experimental site was medium black cotton soil, having 246.0, 14.0 and 1036 kg/ha of available N, P_2O_5 and K_2O respectively. The experiment was laid out in the split plot design with four replications having sowing dates in main plots, four fertility levels in sub plots whereas varieties were assigned to sub-sub plots. Nitrogen, phosphorus and potas were applied through urea, single superphosphate and muriate of potash respectively. Full dose of N, P_2O_5, and K_2O was applied basally.

The results reveal that sowing of soybean in the first week of July in both the years of experimentation. The yield increase in the first date of sowing of soybean was 37.09% end 128.80% higher than the second data of sowing during both the years.

Application of fertilizers @ 10:20 of $N:P_2O_5:K_2O$ kh/ha has produced significantly higher yield over control in the year 1983-84. However, the optimum dose was found to be 20:40:20 N, P_2O_5 and K_2O kg/ha. Agrawal and Narang (1975) reported that application of 20 kg N

Table IX-22. The Salient Production Technology of Soyabean for Different Agro-climatic Zones in India

Iteam	Northern Hill Zone	Northern Plain Zone	Central Zone	Southern Zone
Variety	Bragg, Lee, Shilajeet, Pb-1	Bragg, Ankur, Shilajeet, PK-327 PK-262	Bragg, Ankur, JS-2 Grurav, Durga	Davis, KHSb-2, Haridee, Co-1, Improved, Pelican
Planting time	Beginning of June to middle of July	Last week of June to middle of July	Middle of June to middle of July	Middle of June to middle of July (Kharif crop) 1st week of Oct. to November (Rabi crop)
Planting distance	Row to row 45 cm, seed to seed 5 cm	45-60x5 cm	30-45x cm5	
Depth of seedling	3-5 cm	3-5 cm	3-5 cm	3-5 cm
Fertiliser	20:40:40 NPK + Bacterial culture	20:40:40 NPK	20:40:40 NPK + Bacterial culture	20:40:40 NPK Bacterial culture
Seed rate (kg/ha)	75	75	75	75
Seed treatment and Irrigation	Thiram 3 gm/kg seed during flowering and pod filling stage, if drought			
Plant Protection	2-3 sprays of 0.1% thiodan + 0.1% met asystox if needed			

Table IX-22. (Contd.)

Iteam	Northern Hill Zone	Northern Plain Zone	Central Zone	Southern Zone
Harvesting	When leaves day and fall, approx. 14% moisture			
Threshing	By wheat or any other modified thresher with reduced cylinder speed			
Seed drying and storage	12% moisture, stores in moisture proof bags			
Weedicide	Basalin 2 litre/800 litre water/ha. Pre-sowing incorporation in soil.			
Mixed cropping	Maize	Cotton		

Table IX-23. Performance of some Promising Advanced Breeding Lines as Soybean Developed in India

Breeding line	Pedigree	Developed at	Suitable Zone	Days to maturity	100-seed wt.(g)	Yield potential (q/ha)	Reaction to diseases		
							Yellow mosaic	Bacterial pustules	
PK-374	M-534XPK-71-39	Pantnagar	Hill Zone	120	15.3	25-28	HT	R	MR
Himso-107	Sel. from PK-74-260	Palampur	Hill Zone	125	13.2	28-30	MR	MR	NA
N-23A	-	Ranchi	Northern	121	13.5	20.24	-	T	-
Himso-352	Bienvile	Palampur	Hill Zone	124	15.8	24-29	-	M	-
PK-429	(M-534XS-38) Bragg X Bragg	Pantnagar	Hill Zone	120	12.8	26-30	T	R	MR
PK-416	(M-534XS-38)	Pantnagar	Plain Zone	115	12.5	30-35	R	R	S
PK-486	(GFXBragg)XBragg	Pantnagar	Plain Zone	115	11.2	28-30	R	R	S
DS-76-1-37-1	BraggXJawa-16	Delhi	Plain Zone	120	11.3	28-32	S	R	MR
DS-76-1-29	BraggXJawa-16	Delhi	Plain Zone	116	10.6	21-27	S	S	-
PK-308	T-31XHardee	Pantnagar	Plain Zone	115	12.5	25.28	T	R	MR
JS-76-259	-	Jabalpur	Central Zone	108	14.3	22-28.	-	T	-
PK-472	HardeeXB-1	Pantnagar	Central Zone	105	14.9	25-30	R	R	NA
N-19	-	Ranchi	Central Zone	101	14.1	24-28	-	-	-
DS-74-62	SemmesX8-3	Delhi	South Zone	95	13.6	25-30	MR	R	NA
JS-72-185	-	Jabalpur	Southern Zone	94	14.3	26-33	-	T	-

Table IX-24. Targetted and Actual Cultivation (ha) as well as Production (tonnes) in India under the Centrally Sponsored Scheme for Soybean Development

State	1978-79		1979-80		1980-81		1981-82		1982-83		1983-84	
	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production
Madhya	2,32,562	2,32,000	4,14,341	N.R.	4,47,600*	3,50,000	6,47,711	5,00,000	5,84,000	3,58,600	8,09,000	6,00,000
Pradesh	(2,00,000)	(2,11,400)	(4,00,000)	(51,400)	(4,80,000)	(3,74,000)	(6,00,000)	-	-	-	(11,00,000)	(9,50,000)
Uttar	68,689	60,326	75,866	36,121**	1,31,747	84,200	1,41,196	1,00,000	1,57,200	1,17,400	1,02,000	1,05,500
Pradesh	(1,30,000)	(76,400)	(1,37,000)	(70,400)	(1,75,000)	(1,06,400)	(2,13,000)	-	-	-	(2,75,000)	(1,50,000)
Karnataka	1,181	588	1,296	N.R	-	-	-	-	-	-	-	-
	(3,000)	(2,400)	(3,000)	(2,400)	-	-	-	-	-	-	-	-
Bihar	665	500	N.R.	N.R.	157	77	111	N.R.	-	-	6,000	5,000
	(3,000)	(2,400)	(3,000)	(2,400)	(5,000)	(4,000)	(6,000)	-	-	-	(8,000)	(5,000)
Himachal	4,000	N.R.	244	N.R.	4,000	6,000	N.R.	N.R.	400	Neg.	N.R.	5,000
Pradesh	(3,000)	(2,400)	(3,000)	(2,400)	(6,000)	(4,800)	(8,000)	-	-	-	(12,000)	(5,000)
Rajasthan	-	-	-	-	12,500	6,250	13,000	11,950	9,800	6,500	3,000	10,000
	-	-	-	-	(2,000)	-	(10,000)	-	-	-	(15,000)	(5,000)
Gujarat	-	-	-	-	-	-	-	-	11,000	4,500	N.R.	5,000
	-	-	-	-	-	-	-	-	-	-	(6,000)	(5,000)
Total	3,07,087	2,93,414	4,91,747	36,121	5,96,008	4,46,329	8,02,018	6,11,975	7,67,900	4,90,000	10,00,000	73,00,000
	(3,39,000)	(3,95,000)	(5,56,500)	(1,39,000)	(6,68,000)	(4,90,000)	(8,37,000)	-	-	-	(14,19,000)	(11,20,000)

Figures in parentheses indicate targetted acreage and production

*However, the State has taken up a coverage of 6,000 ha during 1980-81.

**Due to drought the yield and total production have gone donw. The production figures are communicated by the Director of Agriculture and the concerned State.

N.R. - Not received

Source: Directorate of oilseeds Development, Ministry of Agriculture, Govt. of India.

with 80 kg p 205/ha gave maximum average seed yield of soybean. Rehman et al. (1978) observed that maximum seed yield of soybean was recorded from N40+P_2O_5 40+K_2O 40 kg/ha. In the year 1983 the varieties JS 72-44 and Punjab-1 were comparable in grain yield, but in 1984 the variety JS 71-05 which was not tested in the previous year gave the highest grain yield of 16.9 q/ha, thus showing its superior performance over the rest.

9.6 COCONUT PLANTATION/COPRA

Coconut ranks first among the perennial oilseeds. Coconut/copra is one of the most important sources of vegetable oils, yielding upto 55% of oil. Coconut is grown widely in the country but the plantation has come to stay in the Coastal areas. The production of coconut, milling copra and coconut oil in the country can be gleaned from the following table (N. 9.25).

Table IX-25. Estimated production of Coconuts, Milling Copra and Coconut Oil

Year	Area under Coconuts in 000 ha.	Production of Coconuts (Million Nuts)	Production of Milling Copra (in lakh tonnes)	Production of Coconut Oil (in lakh tonnes)
1983-84	1,165.6	5,807.9	2.72	1.72
1984-85	1,183.3	6,912.8	3.56	2.24
1985-86	1,225.6	6,770.3	3.48	2.19
1986-87	1,231.2	6,376.8	3.18	2.00
1987-88	1,428.7	7,562.3	3.82	2.41

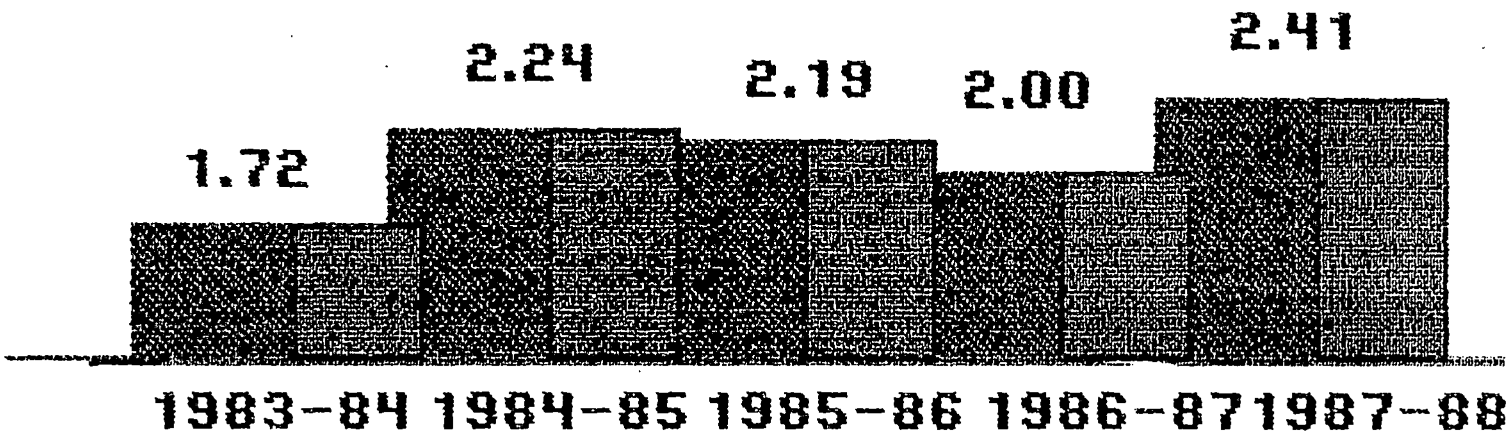
Though India is one of the biggest producers of coconut in the world, the per capita availability of coconut is 11 nuts per annum as against 220 nuts in Philippines and 230 nuts in Sri Lanka. The State wise production of coconut can be gleaned from the following table :

All India final estimate of coconut 1988-89

State/U.T.	Area (thousand hactares) 1987-88 (Revised)	Area (thousand hactares) 1988-89	Production (million nuts) 1987-88 (Revised)	Production (million nuts) 1988-89
Andhra Pradesh	48.8	52.0	480.3	511.2
Assam	9.1	9.3	79.9	65.9
Goa	23.2	23.2	106.9	107.2
Karnataka	213.1	219.5	1,096.5	1,129.4
Kerala	775.4	866.5	3,346.0	8,841.0
Maharashtra	7.8	7.8	88.9	103.0
Orissa	27.1	27.1	113.7	113.7

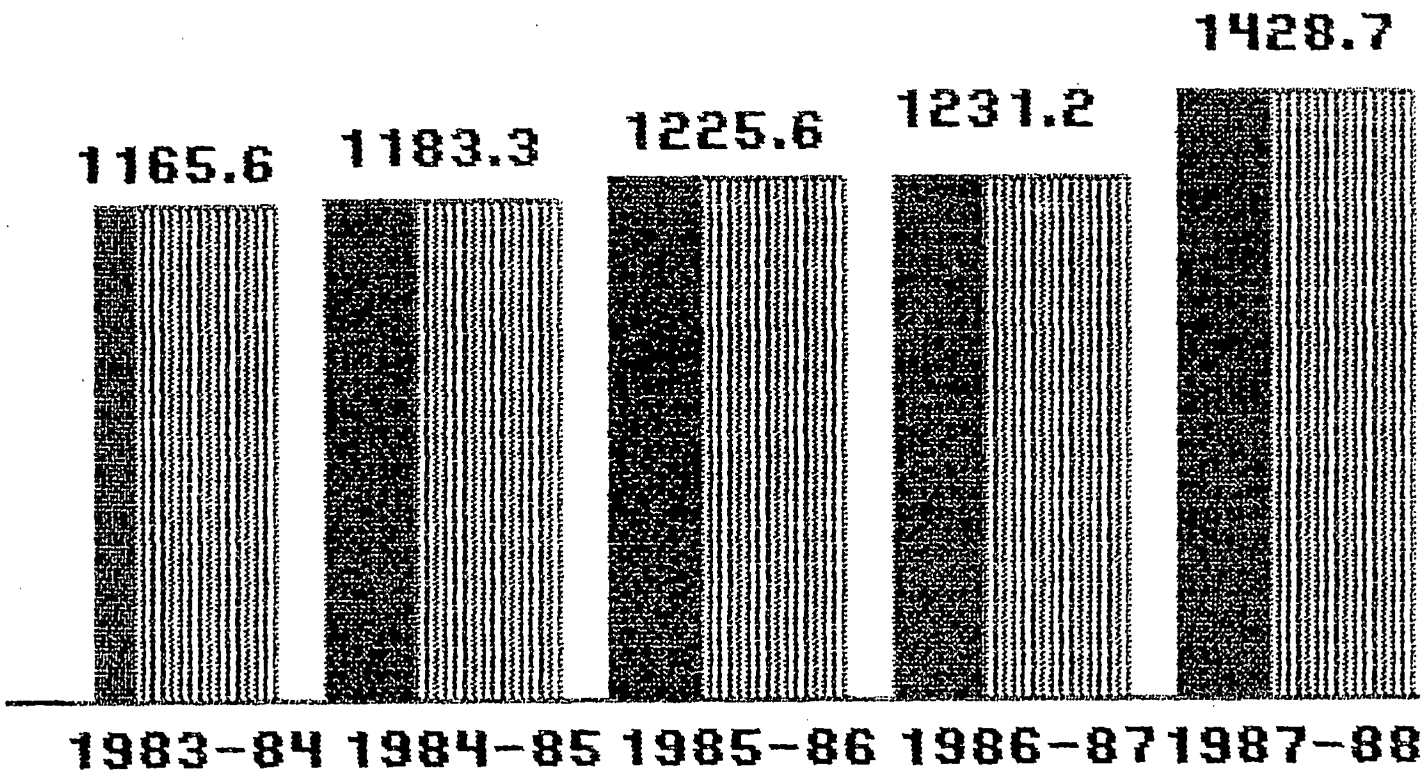
Production of Coconut Oil

(In lakh tonnes)



Estimated production of coconuts milling Copra and Coconut Oil

(Area under Coconuts in 000 Ha)



Estimated production of coconuts milling Copra and Coconut Oil

State/U.T.	Area (thousand hactares) 1987-88 (Revised)	1988-89	Production (million nuts) 1987-88 (Revised)	1988-89
Tamil Nadu	189.5	214.2	1,578.3	1,917.8
Tripura	5.6	5.6	3.3	3.3
West Bengal	19.1	19.8	248.5	238.5
Andaman & Nicobar Islands	22.8	23.3	80.0	81.4
Lakshadweep	2.8	2.8	24.8	25.2
Pondicherry	1.7	1.7	22.8	23.2
	1,346.0	4,272.8	7,269.9	8,160.8

9.7 L I N S E E D

India, due to reasons of regional preferences and history, grows largest varieties of commercial oilseeds, unlike other countries which produce only few varieties of oils and fats. India enjoys a premier position in the world, being the largest producer of groundnut, rapeseed-mastard and sesame. It is second in respect of castor seed production, third in coconut production, fourth in cotton seed and fifth in linseed. India grows linseed on an area of about 20 lakh ha, which is about 10.8 per cent of the total area under lilseeds, producing around 5 lakh tonnes of seed, contributing about 4.3 per cent of the total oilseed production in the country. Madhya Pradesh, Uttar Pradesh and Maharashtra are the important linseed growing States of India, contributing about 75 per cent of the area and production of linseed seed in the country. Statewise area, production and productivity are presented in Table IX-26.

The most flagrant features of linseed is a high degree of instability in production from year to year as evident from Table IX-26. This is primarily because most of the linseed area is unirrigated. Adding to instability in linseed production is the fact that entire linseed area comprises marginal lands. Main cause for the low productivity of linseed and inadequate growth rates are that linseed, like any other oilseed crop is energy rich crop but it is cultivated under conditions of energy starvation. Hardly any area receives fertiliser. Further, diseases, pests and weeds cause heavy losses both in the early stages of plant growth and also at the stage of maturity.

Linseed is an important oilseed crop of India and has a wide range of uses. The seed has been a supplementary food in the ancient times and is still being so used in certain parts of the country. It yields a valuable drying oil used largely in the manufacture of paints and varnishes, oilcloth, etc. The by-product in the extraction of linseed oil is the linseed meal or cake which is a rich source of protein for cattle feeding.

Table IX-26. State-wise distribution of area, production and average yield per hectare of linseed

State		1976-77	1977-78	1978-79	1979-80	1980-81
Andhra Pradesh	A	6.5	8.9	14.2	12.1	10.9
	P	1.5	1.7	2.5	3.4	2.2
	Y	231	191	176	281	202
Assam	A	4.7	4.5	5.1	5.9	6.1
	P	2.0	1.9	2.2	2.5	2.6
	Y	-	-	-	-	-
Bihar	A	94.3	106.7	99.5	88.3	97.2
	P	39.9	40.1	37.9	37.7	41.0
	Y	423	376	381	427	422
Himachal Pradesh	A	6.3	6.2	5.6	5.8	5.8
	P	0.3	0.3	0.3	2.1	2.1
	Y	-	-	-	-	-
Jammu & Kashmir	A	3.4	3.9	3.1	2.4	2.4
	P	2.7	2.7	1.1	1.4	1.4
	Y	-	-	-	-	-
Karnataka	A	80.4	72.0	73.1	68.3	56.4
	P	17.6	12.5	21.3	15.4	11.0
	Y	218	174	291	225	195
Madhya Pradesh	A	652.5	741.2	770.6	444.0	555.9
	P	102.5	179.4	173.4	49.8	122.3
	Y	157	242	225	112	220
Maharastra	A	269.6	282.9	281.0	261.2	248.5
	P	55.5	67.6	60.2	58.2	52.2
	Y	206	239	214	223	210
Orissa	A	17.7	27.6	32.8	34.4	36.3
	P	16.5	11.3	14.2	13.6	16.0
	Y	367	409	433	395	441
Punjab	A	1.0	1.0	1.9	1.5	1.6
	P	0.5	0.5	1.0	1.0	1.0
	Y	-	-	-	-	-
Rajasthan	A	78.4	86.7	101.2	79.7	42.7
	P	24.6	31.1	38.1	16.7	14.4
	Y	314	359	376	210	337
Uttar Pradesh	A	630.2	607.6	634.6	557.0	578.4
	P	153.2	158.0	164.4	53.5	141.7
	Y	243	260	259	96	245

Table IX-26 (Contd.)

State		1976-77	1977-78	1978-79	1979-80	1980-81
West Bengal	A	43.1	60.2	68.3	52.6	67.8
	P	11.8	19.4	18.3	13.8	19.4
	Y	274	322	268	262	286
All India	A	1,999.4	2,009.9	2,091.5	1,613.6	1,710.4
	P	418.8	526.8	535.1	269.3	427.5
	Y	222	262	256	167	250

A, area in '000 ha; P, production in '000 tonnes and Y, yield in kg/ha.

The stem of flax gives one of the most important textile fibre from which linen is made. Linseed straw, which usually goes waste in this country can also yield fibre of utility and efforts are being made to tuilise the fibre economically for a variety of purposes. Attempts are also being made by Indian Scientists to improve the linseed fibre by hybridising linseed with flax and to evolve dual purpose cultivars.

The available classification of linseed, L usitatissimum (Tammes, 1916; Howard and Khan, 1924; Jeswani, 1953; Jeswani and Guglani, 1963) are based mainly on morphological characters without an indication of the type of their variability. The varied ecological conditions in which the genus Linum is distributed, augmented by human selection for widely different purposes namely, for fibre and oil, appear to have contributed to the enormous divergence between populations. With a view to supplement morphological classification with quantitative assessment of the degree of the diversification between individual populations and groups of populations, Jeswani, Murty and Mehra (1970) implied multivariate analysis to measure divergence between biological populations in a world collection of Linum. Jeswani et al. (1970) reported marked phenotypic diversity in Linum usitatissimum, unlike other crops under cultivation, due to prolonged selection in different directions, namely for fibre and for oil. Although the centre of origin of Linum is considered to be south-west Asia (Vavilov, 1935), its cultivation has extended to diverse agro-ecological conditions, such as tropical and sub-tropical regions of India, Argentina, Afghanistan and Asiatic parts of Russia, where it is grown for oil and temperature regions, including Germany, France, Sweden, Greece, U.S.A., Canada, European region of Soviet Russia and Australia, where it is grown for fibre. Within India itself, two distinct ecological types have been recognised: (1) Small to medium seeded Indi-Gangetic alluvial types with shallow and abundant root system, and (2) the blold seeded, deep-rooted peninsular types. Both these types are apparently the result of adaptation over long periods to the physical environment in the regions of their distribution. Even among the peninsular types, there is substantial diversity for several character. This could be due to wide soil and climatic differences in this region. Thus, the linseed crop in India has been subjected to selection pressures in several directions.

9.8 OIL PALM

Recent experience of imported palm oil has shown that it is readily acceptable in the Indian market. Being a perennial tree crop, oil palm can stabilise the production of oil for serval decades to come.

For the successful cultivation of oil plam the climatic conditions should be favourable for its growth and development. A mean maximum temperature of 28-30°C, mean minimum temperature of 22-24°C, a minimum of five hours sunshine a day and well distributed rainfall of about 2000 mm per annum and the absence of marked dry seasons are essential. It can also withstand higher rainfall as well as three to four months of drought with out drastic reduction in yield. The oil palm has been reported to the growing well up to 900 m, but an altitude below 450 m is considered the best. It can grow on a variety of soils but moist deep loamy soils rich in humus with good water permeability suit the palm best. These conditions are prevalent in Andaman Nicobar Islands and some parts of southern Kerala where the crop is grown as a rainfed crop. In other states like Karnataka, Tamil Nadu, Andhra Pradesh, Goa, Maharashtra, Orissa, West Bengal and Assam this crop can be grown under irrigated conditions since the other climatic conditions except adequate rainfall are available.

At present the only large-scale plantation available is at Anchal (Kerala) managed by Oil Palm India Ltd. planted over an area of 3000 ha. Another 500 ha is in Andamans (Central Forest Dev. Corporation), 20 ha at Palode and 25 ha at Thodupuza (Kerala). Except these there are few palms planted in Orissa, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu.

9.8.i) Technical Knowhow

One of the serious handicaps in successful oilpalm plantation as of now is the lack of reach information under Indian conditions. This has been partially overcome since the ICAR intiated research work on oil palm from 1975. Tenera seed required for commercial planting in this country was being imported till recently. We have now the know-how to produce up to 2 lakhs of seeds per year using indigenous dura and pisifera parents which is sufficient to cover about 1000 ha/year. Trials are underway to maximise the yield potential of the indigenously produced teneras. An oil yield of one tonne per hectare was obtead by the seventh year from tenera hybrids grown under rainfed conditions in Kerala which is expected to increase to two to three tonnes of oil per hectare when the palms stabilise in yield by the twelfth year. Fertiliser recommendations have been made based on nutritional studies made at the CPCRI research centre and it is now known that NPK at 800, 400, 1800 g respectively per palm per year are required for maximum production of fresh fruit banches. There is clear evidence from the few palms grown in a valley at the Palode research centre that an oil yield of five tonnes/ha/year of oil is possible. The favourable location particularly from the point of view of moisture availability appeared to be responsible for this high yield.

9.8.ii) Constraints

There are two oil palm mills now in operation one in Oil Palm India at Bharathipuram and the other in the Department of Agriculture, Kerala at Thodupuzha. A plantation of 200 ha will be required to produce sufficient raw material for these mills.

The main problem in the cultivation and development of oil palm is its requirement of a larger area for an economically viable unit for extracting the oil. Though small-scale extraction units are possible with hand-operated hydraulic press, maximum efficiency is obtained only through mechanically operated mills, for which a steady supply of fresh fruit bunches is to be ensured. The fruits should be processed as soon as they are harvested (preferably within three to four hrs) because of the low keeping quality of the oil palm fruits. Processing involves streilisation, stripping of fruits, fruit digestion, pressing of the pulp and clarification of oil. It therefore appears that developing a small-scale mill for processing requires priority attention as this would enable extension of oil palm cultivation to small holders.

Another alternative is to set up cooperative agencies to collect fresh fruit bunches from small holders and deliver to the nearest factory. Till such time technology for small-scale processing on arrangements for extraction on cooperative basis in large factories are developed, oil palm cultivation has to be restricted to large-scale plantations and to small holders in and around estates with processing facilities.

9.8.iii) Future Research and Development Strategy

Considering the scope of the crop in initiating the vegetable oil deficit, ICAR has given added emphasis in gathering research information which will be essential to maximise its yield and resultant economy.

The first and foremost aspect is the improvement of the tenera hybrids by testing a large number of dura X piscrosses and indentifying the best among them.

Tissue culture techniques are available outside the country for multiplication of high yielding palms. Work in progress at BARC and CPCRI on the vegetative propagation of oil palm through tissue culture technique, has given encouraging results.

Though there are a number of serious pests and diseases affecting the crop elsewhere certain maladies like bunch failure and leaf yellowing are now know to reduce the yield under Indian conditions.

In Malaysia, cultivation of oil palm under irrigation has given a yield of 8.5 tonnes per ha/year. Since the importance of irrigation is recognised, ICAR is planning research work on this aspect in Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu. Oil palm research work is proposed to be intensified under an All India Coordinated Programme of ICAR during the Seventh Plan.

As mentioned earlier, lack of technology for small-scale processing of the oil palm fruits is the main handicap in popularising the crop. Efforts have to be made to devise low cost mini mills. Oil palm is virtually a new crop in India, but if adequate efforts are made in the proper direction, India should be able to produce a large quantity of palm oil in addition to the traditional coconut and other oils. If some area having irrigation facilities in the mainland could be brought under oil palm with good management practices it should be possible to produce 2 lakh tonnes of palm oil annually.

There are only two major avenues for attaining self-sufficiency in oil seeds sector.

(a) Improvement in yield/hectare of present oil bearing crops.

(b) Introduction of new sources of oil bearing crops giving high oil yield per hectare.

The prospects of improving oil yield in the traditional crops are not bright due to the fact that oil seed crops are cultivated under rainfed conditions. Large scale investment and long term planning are required to provide irrigation wherever oil seed crops are cultivation has very high prospects.

Oil palm is the highest oil yielding crop with about 3-6 tonnes of oil per ha per year depending on the climatic and other environmental factors. Other oil seed crops grown in India are annuals except Coconut. In fact, the two perennial oil seed crops cultivated in the tropics are Coconut and Oil Palm. A comparative statement of the yield of oil crops is given below:-

	Average oil yield per ha
1. Oil Palm	3 to 6 M.T.
2. Coconut	1 Tonne
3. Ground-nut	376 kg/ha
4. Rape/Mustard	200 kg/ha
5. Sesame	225 kg/ha
6. Sunflower	208 kg/ha
7. Soyabean	134 kg/ha

The commercial variety of oil palm Elaeis Guineensis Jacq is grown in Africa. Equitorial America, South East Asia and the South Pacific. Though the ancestral home is doubted either as Africa or America, there are sufficient fossil, historical and linguistic evidences that the ancestral home of Oil Palm is West Africa. The American Oil Palm is called Elaeis Oleifera. There are short palms mainly used for breeding purposes at present.

The Oil Palm is a monoecious plant and the female flower gives fruits commonly referred to as fresh fruit bunches (FFB). The trees grow to a height of 15 m. It has an unbranched habit and produces a single trunk which bears a crown of fronds, having 25 to 40 large pinnate fronds. The root system is fibrous. Thousands of primary roots arise from the bole and spread horizontally or descend into the soil. Secondary roots descend or ascend from the primary roots. Tertiary and quaternary roots form a dense mat in the upper 30 cm of soil. The roots spread horizontally upto 19 m. Each tree is capable of bearning about 10 to 12 bunches per year. The number of fruits per bunch varies from 1000-3000 in mature palms and the everage weight of each bunch can vary between 20-30 kg. The economic life of the palm is around 20-30 years. The Oil Palm is quite unique in producing Kernel Oil from the seed and Palm Oil from the mesocarp.

The palm fruit is a drupe and consists of leathery exocarp, fleshy mesocarp from which palm oil is extracted and a stony endocarp (shell) which encloses the kernel. There are three fruit types :

(1) Nigrescens : (Black when unripe-red when ripe with part of the top half black in colour).

(2) Virescene : (Green when unripe, light reddish orange when ripe with a greenish tip).

(3) Albescens : (White when unripe, pale yellow when ripe)
Three fruit forms exist, based on sheel thickness.

(1) Dura - having thick shell, most common in wild groves.

(2) Pisifera - having little or no shell.

(3) Tenera - a hybrid between Dura and Pisifera having a thin shell with a larger fleshy pericarp containing 20% Palm Oil (of FFB). Kernel gives 40% Kernel Oil or 2% Kernel Oil (of FFB). This variety is commercially cultivated the world over.

9.8.iv) How Oil Palms are Raised?

150 seedlings are required for planting a ha. Germinated seeds are raised in poly bags of size 37.5 x 50 cm. and 10-11 months old seedlings are planted in the field in pits of size 80 x 80 x 80 cms. The planting distance is 8.7 m in a trangular pattern. The palms will start bearing 32 months after planting.

9.8.v) Insect Pollination

Assisted Pollination of female flowers is done to ensure fertilization of a majority of flowers. Now-a-days pollination is done by insects called Elaidubious Kamerunicus. Insects ensure 100% pollination which has resulted in a green revolution in Oil Palm production.

Harvesting of fruits is done at intervals of 7 to 10 days. During the 1st 5 years of harvesting, ripe bunches are harvested by means of a wide chisel and as the palms grow taller a sickle attached to a long bamboo or aluminium pole is used.

Oil Palm fruits have to be processed within 24 hours of harvesting failing which the quality of oil will be deteriorated due to increase in free fatty acid content.

9.8.vi) What is Palm Oil/Palmolein?

Palm Oil is a semi-solid edible oil extracted from the pulpy portion (mesocarp) of the fruit wall of the Oil Palm. Palolein is the fractionated liquid portion of Palm Oil after removing the hard fat stearin.

9.8.vii) Where are Oil Palms Grown Successfully?

Oil Palm is now grown in several parts of the tropics, generally within 10° of the Equator. Besides the West African Countries, Oil Palm is grown in Malaysia, Indonesia, Papua New Guinea and other countries in Far East and to a lesser extent in Brazil, Columbia, Ecuador, Panama and Costa Rica. Better yields (5 to 6 Tonnes oil per ha) are obtained in areas of evenly distributed rainfall throughout the year with a mean minimum and maximum temperatures of 22°C-24°C and 29°C-30°C.

If the distribution of rainfall is good throughout the year as in Malaysia and soil conditions are highly favourable, some estates give even upto 5-6 tonnes of oil per ha. But all factors should be favourable to get such a good yield. The soil must be physically fit, chemically balanced and biologically active. Flat or gently undulating land is preferable.

9.8.viii) Rainfall and Yield in Selected Countries

The answer is Yes. Kerala and Andaman Nicobar Islands are having favourable climates. If areas with good soil are selected 3 to 4 Tonnes of oil per ha could easily be achieved. But in Kerala, due to high density of population and intensive cropping the prospects are limited unless the diseased coconut trees are replanted with Oil Palm. In Andaman-Nicobar, though the climate is ideas, the forests cannot be cleared due to fear of enclogical imbalance.

<u>Which are the other areas?</u>

Large tracts of irrigated lands now cultivated with paddy and sugar cane in Karnataka, Andhra Pradesh and Maharashtra might be suitable provided irrigation water is made available for 10-11 months in an year. But in some of these areas day temperatures go upto 41°C and the photosynthetic efficiency will be very much reduced due to closure of stomata in the leaf, limiting production. However, 3 tonnes of oil per hectare are easily achievable. It is estimated that 2.5 to 3 lakh hectares are available for oil palm cultivation in the above States which can produce about 1.2 million tonnes of edible oil.

In Kerala, Oil Palm India Ltd. a Joint Venture Undertaking of kerala Government and Government of India has raised about 3705 ha of oil Palm plantations whereas in Andaman Nicobar Islands, Forest and Plantation Development Corporation has raised 1595 he till now. There are also two Oil Palm Research Stations in Kerala - one at Thodupuzha - a 40 ha station under the control of Department of Agriculture and the other at Palode near Trivandrum under the control of Central Plantation Crops Research Institute. The Research Station at Thodupuzha is a seed producing centre producing 4 lakh Tenera hybrid seeds per year. A few palms were raised in Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu both as ornamental and for experimental purpose in the past. Results are encouraging.

9.8.ix) Constraints and Prospects

The constraints could be summarised as given below :

1. Though not ideal, suitable climatic zones are limited to Kerala and Andaman Nicobar Islands, where availability of suitable land is a constraint for oil palm development.
2. Large tracts of irrigated land are available in karnataka and Andhra Pradesh where either paddy or sugarcane are grown. A change in cropping pattern is required and the farmers are to be convinced of the economic gains.
3. Minimum economic size for setting up of a modern palm oil factory of 100 M.Ts of FFB per day is 2000 ha and minimum size of a planatation for setting up a small scale factory is 200 ha.
4. There is a need for processing the fruits within 24 hours to avoid spoilage of the oil.

5. The forest Conservancy Act of 1980 preventing further release of land for oil palm cultivation is yet another constraint.

Prospects

1. The estimated shortage of edible oil in 2000 A.D. is 2.3 million tonnes. Oil Palm, being the highest oil producer per ha, has a big role to play. It is proposed that oil palm should be grown in 3 to 4 lakh ha in the regions mentioned above which can produce a minimum of 1.2 million tonnes of edible oil. The deficit of 1.1 million tonnes should be made up by improving the productivity per ha of various existing oil seed crops by the improved package of practices.

2. It should be seriously considered to plant 20% of some of the island in Andaman Nicobar islands with Oil Palm which will not have any adverse impact on ecology. Millions of ha of forests are being cleared in Indonesia and Columbia for planting oil palms as a National Policy.

3. Planting Oil Palms in about 2½-3 lakh ha in Andhra Pradesh, Kernataka and wherever irrigation facilities are available, (except of course climatic zones where there is serious temperature variation) should be systematically programmed.

4. Oil Palm should be exampted from land ceiling and should be considered as a Plantation Crop.

5. The rich experience of Oil Palm India Ltd. should be utilized in organising plantations elsewhere in the country.

6. India has professional experties in Oil Palm Plantation Management and Processing Technology. The most modern Palm Oil factory is being established by Oil Palm India Limited.

7. The farmers should be organised on a co-operative system of management and should be given all incentives.

9.8.x) Economics of Oil Palm Cultivation

The economics of oil palm cultivation are indeed very promising for the farmer. If we assume 3 tonnes of oil per ha about Rs.13,000/- per tonne of Crude Oil, the gross income per ha is about Rs.39,000/- per annum. The cost of harvesting, transport and processing will be about Rs.8,000/- per ha. The net income from one ha plantation is thus estimated at Rs.31,000/-. The estimated cost estimates for raising one ha of plantation till maturity (5 years) is approximately Rs.21,628/-. Thereafter the annual maintenance expenditure including cost of weeding, mulching, manuring, harvesting and processing is about Rs.8,000/-.

Under irrigated conditions and proper cultural operations 5 tonnes of oil could be obtained and the revenue per ha will be correspondingly high. In the case of rubber, the net income per ha will be only Rs.10,000/- while net income from coconut cultivation is about Rs.20,000/- Paddy cultivation is much less profitable with about Rs.4,000/- per ha for two crops.

From the above informations, it is clear that Oil Palm cultivation is much more profitable than any other crop in the proposed areas for Oil Palm Cultivation.

Table IX-27. Rainfall and Yield in selected Countries

	Total rainfall mm	Dry Months with less than 100 per month	Yield of oil per ha (tonnes)
AFRICA			
1. Nigeria	2409	4	2.0 - 2.5
2. Ivory Coast	1920	5	1.8 - 2.7
3. Camernoon	2641	3	1.6 - 2.0
4. Sierra Leone	2762	3	2.5
5. India (Kerala)	2178	5	2.5 - 3.0
AMERICA (South and Central)			
6. Columbia	2786	2	3.0
7. Honduras	2860	2	3.0 - 4.4
SOUTH EAST ASIA			
8. Malaysia	2393	0	3.6 - 4.4
9. Indonesia	1939	1	3.4

9.9 RICEBRAN OIL - INCREASING AVAILABILITY AND IMPROVING QUALITY

9.9.i) Introduction

In recent years the shortage of edible oils in our country has reached alarming levels. The expenditure in foreign exchange is estimated to be over Rs.1,000 crores in the current year only on account of imports of edible oil to meet the demand gap. In a span of just two decades our country has turned around from being a net exporter to an importer of oils. The grave situation is being approached on a priority level by the government as well as several research institutions in the country. Due credit must be given to the industrial users of natural oils. The Industrial users have gradually switched over to non-edible oils for applications such as soaps, paints, lubricants, etc. This has resulted in reducing the burden on edible oils to a considerable extent. An all round effect is being concentrated on increasing the productivity and acreage for cultivation of oil seeds and significant results have been obtained through sustained efforts. In this paper the emphasis is given on ricebran oil which is already existing in the country but is not available for use due to the lack of technology and infrastructure.

9.9.ii) Increasing Availability of Ricebran Oil

India produces nearly 800 lakh tonnes of paddy per annum. On an average basis of one per cent oil content, the total potential availability of ricebran oil (RBO) is 80 lakh tonnes. However, production of RBO in the country is only around 1.5 lakh tonnes of which only 10-15 per cent is of edible grade. The main reason for the significantly lower production than the potential is the status of milling operations in the country.

It is estimated that nearly 10-15 per cent paddy produced in the country is processed through hand pounding. Out of the rest, the major protion goes for milling through the huller mills. The relative distribution of the three different kinds of mechanical milling units is shown in Table IX-28. It is observed that the huller mills outnumber the sheller and modern rice mills by nearly an order of magnitude. It is estimated that huller bran containing nearly 4.5 lakh tonnes of oil

Oilseed Production

Table IX-28. Rice Milling Statistics

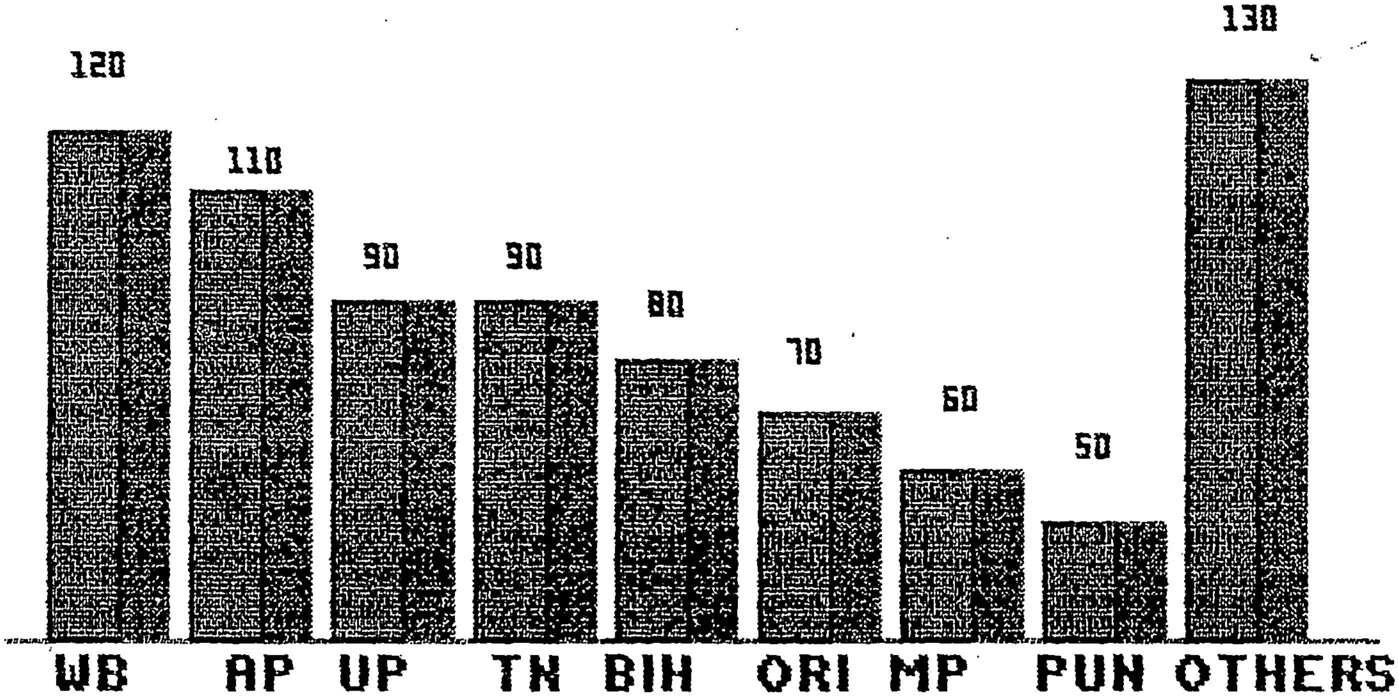
Sl. No.	State	Paddy produced, lakh tonnes	No or rice mills		
			Huller	Sheller	Modern
1.	West Bengal	120	1,200	200	160
2.	Andhra Pradesh	110	6,000	5,300	4,840
3.	Uttar Pradesh	90	5,700	700	1,220
4.	Tamil Nadu	90	5,800	650	1,130
5.	Bihar	80	4,800	100	50
6.	Orissa	70	3,000	250	670
7.	Madhya Pradesh	60	3,100	450	100
8.	Punjab	50	4,400	1,000	170
9.	Others	130	36,000	6,350	4,660
	Total	800	80,000	15,000	13,000

is being produced in the country. Since the bran is of poor quality in terms of oil content, and it is uneconomical to conduct solvent extraction on this bran, currently it is being consumed after incorporation in home made animal feed. In the past, major efforts have been put in to convert the huller mills to sheller mills through Government legislation and through improvements in the existing machines, but the progress has been extremely slow.

In order to expedite the recovery of oil from huller bran, a project has been undertaken at Hindustan Lever Research Centre to ascertain the status and problems of huller mill operators with an objective to develop a simple and practical technology for its ready acceptance.

Paddy production,

Lakh tonnes



9.9.iii) Status and Infrastructure of Huller Mill Operations

The huller mill is an inexpensive unit which costs around Rs.10,000 to Rs.15,000 to install for a capacity of 500-1000 kg/hr. The operations are simple and can be handled by one operator. The huller mill owners belong to the relatively lower income group bracket and operations are usually confined to the backyard of the residential premises. Paddy is passed through the huller mill in two passes two passes and the bran and busk are removed simultaneously. Due to the presence of husk, silica and crude fibre content of the bran are high and the oil content is of the order of 4-5 per cent. The analysis of bran is shown in Table IX-29 as compared to the desired specifications. In comparison, the bran from sheller and modern mills where the husk and bran are removed separately, in different operations, the oil content is around 14-18 per cent with silica and fibre in extracted bran matching the specifications. With the quality of huller bran currently available it is not feasible to extract the oil economically.

Table IX-29. Quality of Ricebran Extractions

	% Silica	% Fibre
ISI Specification		
Grade I	6	14
Grade II	10	16
Exports		
Grade I	8	16
Grade II	9	16
Grade III	8-12	-
Huller bran	15-25	20-35

An estimation of the oil price with respect to the bran cost and extractions price is shown in Table IX-30.

Table IX-30. Cost of Oil on Direct Extraction of Huller Bran

Bran Rs./tonne	Extractions, Rs./tonne					
	200	300	400	500	600	700
200	11,300					
300	13,800	11,450				
400	16,300	13,950	11,600			
500	18,800	16,450	14,000	11,750		
600	21,300	18,950	16,600	14,250	11,900	
700	23,800	21,450	19,100	16,750	14,400	12,050

The conversion of huller machines to sheller or modern mills has been extremely slow, primarily due to two reasons, Firstly, the cost of a sheller mill is nearly ten times as compared to the huller mill of the same capacity. Secondly, the huller mills serve a very important function in the village community. They provide a service to the farm labour and other households in processing small quantity of paddy ranging from 20 to 100 kg. If all the huller mill are converted to sheller operations, these consumers will be forced to move towards hand pounding which will result in total loss of bran. Thus it is imperative that the huller mills will continue to operate in out country for a considerable future. Hence the utmost urgency is to improve the quality of huller bran through modifications which are feasible and acceptable to the operator, at the same time no disturbance should be caused in the existing functionality to the village community.

9.9.iv) Objectives and Targets For Huller Bran Upgrading

The infrastructural constraints were considered while setting objectives for the huller bran improvement programme. The objectives were formulated in order to develop a scheme which could be implemented immediately at village level. The targets set were as below:

(a) The oil content in the huller bran must be increased to a minimum value of 12 per cent and silica and crude fibre content on oil--free basis should limited to less than 8 per cent and 16 per cent respectively. This will result in economical extraction of oil simultaneously producing extracted bran of export quality.

(b) Any modification suggested to the huller mill should involve minimum expenditure to the owner, at the same time avoiding complicated or labour intensive operation.

(c) The huller mill owner must benefit substantially in terms of revenue to compensate adequately for any expenditure and to give him incentive to change over to the new operation method.

(d) The main product for the huller mill operator is rice. The modified operation should at least maintain if not improve the quality and yield of rice.

(e) The modifications in operation must be viable for both parboiled or raw paddy so as not to limit the application area of huller mill.

(f) Since a significant proportion of consumers use the huller bran as an important ingredient in their home-made animal feeds, this availability should not be reduced. Hence a target of achieving 50 per cent oil in bran of upgraded quality was aimed at. The rest of the bran will be available for other applications.

9.9.v) Modification in the Huller Mill Operation

The huller mill consists of a rotating cylinder contained in a casing. The cylinder is grooved and a blade is positioned attached to the casing to provide the attrition power for removing of husk and bran. The power input is nearly 30 k WH/tonne of paddy processed. The processing is carried out in two passes with or without removal of husk from the partially polished rice obtained in the first pass. The bran from both the passes is mixed and sold after sieving through a 10 mesh screen to separate the broken rice and larger husk particles.

As compared to the huller mill power usage, the rubber roll sheller unit which removes the husk only, consumes only 2-3 k WH of power per tonne of paddy processed. Hence in our approach the first step was to reduce power input in the huller mill in the first pass.

This has been achieved simply by withdrawing the blade totally the dehusked paddy produced in this operation contains nearly 10–15 per cent of whole paddy, partially polished rise and broken husk. The bran containing mostly husk and small quantities of bran is removed and stored separately. In the second pass the paddy is fed again after removing the broken husk and blades totally inserted to increase the power input. The product now obtained is polished rice and improved quality bran. This bran is sieved through a 30 mesh screen and the bran obtained passing through the sieve is of desired quality containing greater than 12 per cent oil, less than 8 per cent silica and less than 16 per cent crude fibre on oil free basis. The various steps of the modified operation are shown in Fig. I along with an average material balance.

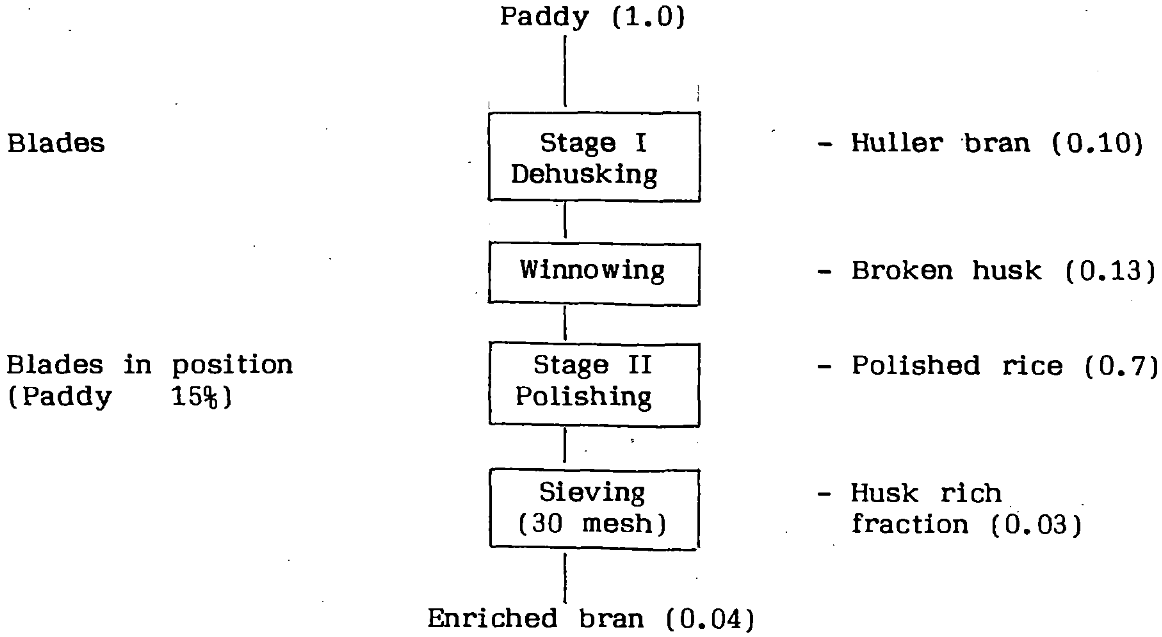


Fig. 1. Steps in modified operation.

The modified operation as described above has been carried out in several huller milling units in the different villages of Tamil Nadu. Nearly 100 tonnes of upgraded bran has been produced and the oil extracted has been found to be of acceptable quality. The analysis of bran obtained in these trials is shown in Table IX-31 which meets the

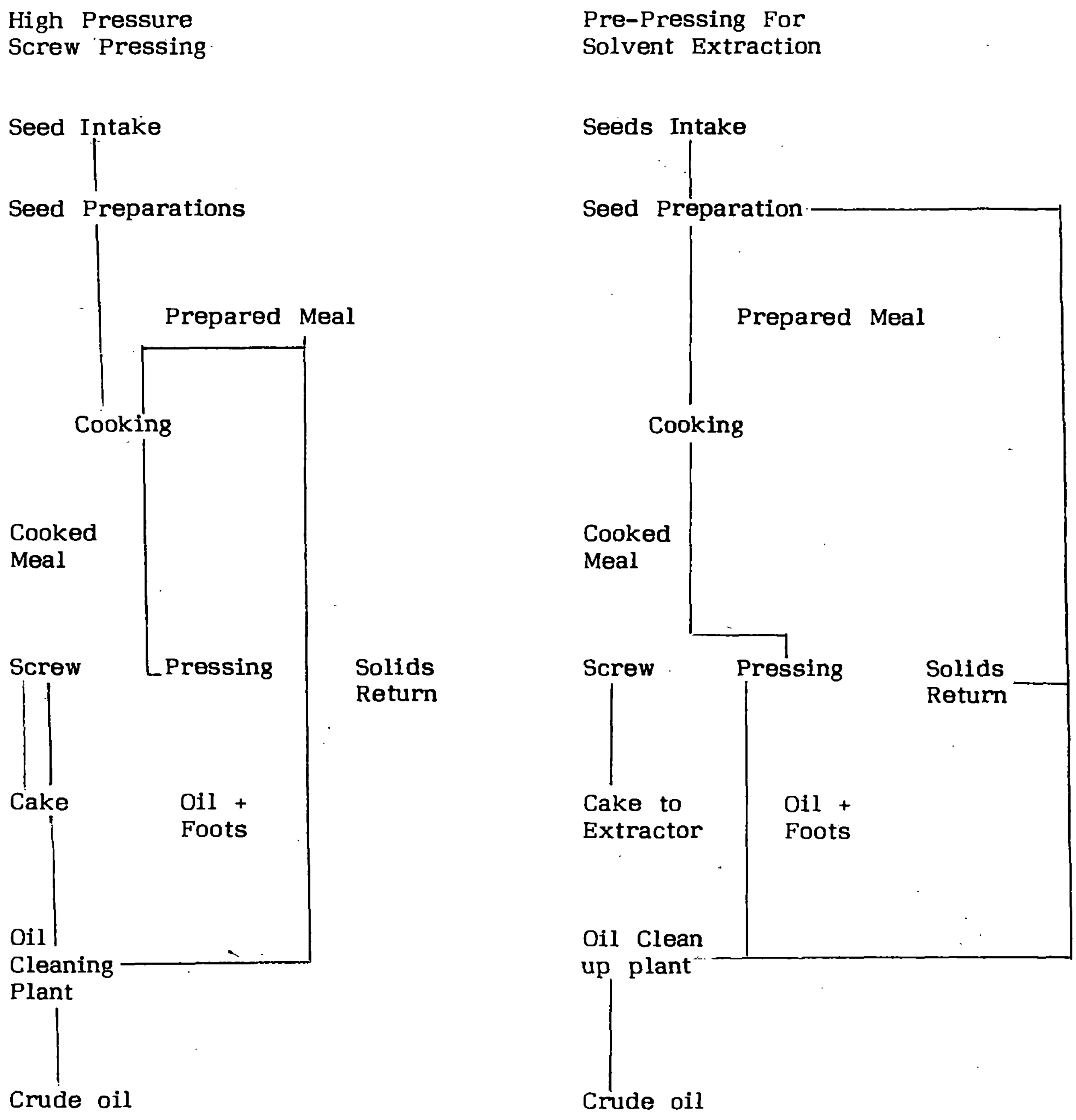

High Pressure
Screw Pressing
Seed Intake
Seed Preparations
Prepared Meal
Cooking
Cooked
Meal
Screw
Pressing
Solids
Return
Cake
Oil +
Foots
Oil
Cleaning
Plant
Crude oil
Pre-Pressing For
Solvent Extraction
Seeds Intake
Seed Preparation
Prepared Meal
Cooking
Cooked
Meal
Screw
Pressing
Solids
Return
Cake to
Extractor
Oil +
Foots
Oil Clean
up plant
Crude oil

Figure - 1

desired specifications. Additional expenditure to the huller mill owner is of the order of Rs.1,000-5,000 depending upon the facilities already existing.

Table IX-31. Quality of bran from modified operation

Paddy	Karinguzhi	Kanchipuram	Arni
	Parboiled	Raw	Parboiled
Oil - %	13.5	15.9	17.7
Fibre - %	10.7	-	10.2
Silica - %	5.5	5.1	4.2

9.9.vi) Economic evaluation of modified operation

The economic advantages of the modified operation to the huller mill owner are shown in Table IX-32. The comparison has been done

Table IX-32. Economics of modified huller mill operation (Basis:1 tone paddy)

	Qty.(tonne)	Price(Rs./tonne)	Revenue(Rs.)
Current Operation Huller bran	0.30	500	150
Modified Operation Upgraded bran	0.04	1,500	60
Huller bran	0.25	500	130
			190

Increase in revenue : Rs.40/tonne.

taking the maximum possible price for the current huller bran. It is clear that at lower bran prices the revenue increase will be even more significant. In the modified operation it has been assumed that nearly 40 per cent of the oil is recovered in the upgraded bran. The upgraded bran produced is nearly 15 per cent of the total, containing around 12 per cent oil content. A higher price for the upgraded bran should be relisable, however, since the bran collecting agents will have to put in extra effort for collection of smaller amounts from distributed locations, a price of Rs.1,500/ tonne has been assumed. The net increase in revenue to the huller mill operator is Rs.40/- tonne of paddy processed. On an average around 5 tonnes of paddy is processed per day by a huller mill, hence the additional income is Rs.200/day which results in a pay-back period of around one month for the additional investment in using the modified operation.

The economics of using the upgraded bran for oil extraction purpose is shown in Table IX-33. The evaluation is done on the basis of extracted meal containing 1 per cent residual oil. Therefore, 9 tonnes of upgraded bran containing 12 per cent oil will need to be processed for producing 1 tonne of the oil. Taking into account the extraction cost of Rs.350/tonne which includes the solvent losses and fixed costs, etc., the cost of oil comes to Rs.9,450/tonne. As compared to the current market price of around Rs.11,000/tonne the upgraded huller bran solvent extraction is fairly competitive.

Table IX-33. Economics of RBO extraction (Basis-oil content 12%)

	Qty.(tonne)	Price(Rs.tonne)	Cost(Rs./tonne) Oil
Bran	9	1,500	13,500
Extraction cost	-	350	3,150
Meal credit	8	900	(7,000)
			9,450

9.9.vii).

The factors presented earlier have considered the total scenario of the huller mill operation in our country and a technically viable modification has been detailed which is advantageous to the huller mill operator, the bran collector and the solvent extraction units. The major advantage, in addition, is the increase in the overall availability of oil in the country. The experience grained by conducting the operation in a few villages of Tamil Nadu has shown that the huller mill operators are interested in following the modified approach since there is a substantial increase in revenue with no adverse effect on the quality of rice produced by them.

In order to extend this operation throughout the country, significant efforts will be required from various agencies to popularise the modifications. It is suggested that local institutions and other agencies are involved in demonstrating the operations to the huller mill operator and explain the national relevance as well as the economic benefits. Our experience has shown that the village level operator graspe the advantages in no time and in certain cases even applied has own initiative in developing an operation method best suited to his machine. Another area where efforts will be required is the organisation of agents for picking up the upgraded material from the individual operators. This organisation is anticipated to be less of a problem, as once the huller mill operators at village level adopt the technology, the collection scheme will develop because of the economic advantages. Initially during the changeover period efforts will be required.

9.9.viii).

Ricebran oil (RBO) has a high content of poly-unsaturated fatty acids making it an excellent quality edible oil. In our country the edible RBO usage is limited mainly because of the high FFA content present in the oil. The high FFA presence is due to the lipase activity in bran which gets activated after separation of bran from rice. Due to our milling infrastructure, explained earlier the bran is stored for several weeks before it is taken for solvent extraction. Considerable emphasis has been put in our country to develop methods for upgradation of RBO and the inherent problems have been identified in individual steps. A review of the different processess available based on commercial viability shows that the double solvent refining route is the most actractive for upgrading of high FFA ricebran oil to edible grade.

Technically the most attractive propostion for upgrading RBO is through the bran stabilisation route. CFTRI has done pioneering work in this area and low cost thermal stabilisers have been designed. The recent developments reported using chemical spray for stabilisation will be of immense potential usage considering the milling operations in our country. However, in the foreseeable future it will be necessary to have technology for upgradation of high FFA ricebran oil. The three methods commonly employed for removal of fatty acids from RBO are: (a) distillative deacidification; (b) fatty acid extraction, and (c) double solvent refining.

In the case of distillative deacidification the operations involved are distillation of fatty acid under high vacuum and post refined for getting edible grade oil. A major problem faced in this approach is the fixation of colours which makes the bleaching of the deacidified oil extremely difficult. Also since high temperatures are involved the oil gets degraded in quality. The second approach on fatty acid extraction involves alcohol water counter current extraction. Since the selectivity is low, a large number of stages are involved which result in very high capital costs.

Considering the various advantages and disadvantages, the double solvent refining route is the most commercially viable operation. The process involves neutralisation of fatty acid in the degummed and dewaxed oil using two immiscible phases namely hexane and aqueous alcohol under mild conditions. The soap stock is extracted into the aqueous phase which is decanted, hydrolysed and distilled to recover the fatty acid. The organic layer containing neutral oil is desolventised and bleached to get the edible grade ricebran oil. In terms of bleaching, a column bleaching technology has been developed by us which can economically bleach the oil to a final colour aceptable for edible grade refined oil. The technology can be applied to produce different grades of oils in terms of colour based on specification for its ultimate usage. An economic evaluation of the variable costs for this process along with the by-product credits has been shown in Table IX-34. It is observed that the costs are firly attractive as compared to the current price of edible oil in India.

Table IX-34. Economics of DSR upgrading (Basis : 30% FFA RBO)

	Qty.(tonne)	Price(Rs.tonne)	Cost(Rs./tonne)
Raw RBO	1.71	10,000	17,100
Processing Cost		1,709	3,067
Credits			
D F A	0.45	14,500	(6,540)
L A O	0.156	10,000	(1,560)
W A X	0.041	10,000	(410)
Sod, sulphate	0.073	3,000	(218)
Post-refining			284
		Variable Cost	11,723

9.9.ix) Conclusion

An all around effort is essential for increasing the availability of natural oils in India. A scheme has been proposed here through a simple technological breakthrough in improving the huller bran quality for economical recovery of ricebran oil through this source. The potential is larg and additional 2-3 lakh tonnes of ricebran oil can be generated by spreading this modified operation throughout the country. It is recommended that various agencies in the country work in unison to popularise the improved operation through demonstration and discussions at the village level operators. The upgrading feasibility of ricebran oil to edible grade has been discussed and it has been shown that producing edible grade oil from RBO with up to 30 per cent FFA is commercially viable.

Rice Bran Oil

The paddy production in Indian is at present of the order of 800 lakh tonnes. On an average of one per cent oil content, the potential availability of rice bran oil (RBO) would be about 80 lakh tonnes. However, the actual availability is 1,50,000 tonnes (Chhatrapati, 1983). Although the total potentials not realisable as about 35 per cent of the paddy is hand pounded, there is still a great gap between the actual availability and realisable potential. Bridging this gap would require decreasing the production of non-economical huller bran with low oil content. This could be achieved by conversion of the huller mills to sheller mills or modern mills or modifying the huller mills to enable production of huller bran with a higher oil content to make the extract economical. Conversion of huller mills to sheller mills or suitable modifications of huller mills to give higher oil bran will almost double availability of oil

Rice Bran Oil

Potential	:	8.0 lakh tonnes
Actual	:	1.5 lakh tonnes

The total production of RBO can be divided into edible grade (26,000 tonnes) industrial grade (1,24,000 tonnes) (Seth, 1983). The primary difference between the two grades is the higher free fatty acid content (25-70%) in the latter. This increase in free fatty acid occurs as a result of the action of the endogenous lipase on oil in the bran during storage. The industrial grade oil is used for soap making. The edible grade oil obtained from fresh rice bran has low free fatty acid (5-6%) and is used for making refined oil or vanaspati

Rice Bran Oil

Total Oil 1,50,000 tonnes	
Edible 26,000 tonnes From better quality bran Usage:Vanaspati, refined oil	Industrial 1,24,000 tonnes From poor quality bran Usage:Soaps

Upgrading the industrial grade oil to edible grade oil will boost the edible oil availability and restrict imports. The first process (A) consists of dewaxing the hexane miscella followed by double solvent

Upgrading Industrial RBO to edible RBO

	FFA	Colour	Odour
Industrial	30-45%	Dark	Brany
Edible RBO	0.25%	Light	Acceptable

Upgrading Technology

A : RBO-Miscella Dewaxing Double Solvent Refining

B : RBO-Miscella Dewaxing Desolventising

Oil : Bleaching Thin Fil Distillation (FFA 2-3%) caustic Neutralisation.

C : RBO-Dewaxing (Lipofrac Process) 90% Ethanol Extraftion Caustic Neutralisation

refining (hexane and isopropanol) containing alkali 1 to 25% excess over theoretical requirementto neu-tralise free fatty acids (Goenka, 1983). The second method (B) involves de-acidification of the dewaxed, bleached oil by distillation of the fatty acids under high vacuum (3.4 mm/hg) and at 250-260 c. The low FFA (2-3%) oil obtained is then caustic refined to get refined grade RBO (Rao, 1983). In the process (C) dewaxing is carried out by the Lipofrac profess using surface active agents to facilitate wetting of the wax crystals which is followed by centrifuging. The dewaxed oil is extracted with 90% ethanol to bring down the FFA so that it could be caustic refined (Bhattacharyya and Bhattacharyya, 1983). Generally for all the above processes, a satisfactory refined RBO could be made, provided the starting oil has reasonable colour and its FFA content is preferably not more than 30%

9.10 RAPESEED-MUSTARD PRODUCTION IN INDIA

Among nine annual oilseed crops grown in the country rapeseed--mustard assumes significance in the national economy by occupying second position in area and production next to groundnut. It is one of the most important edible oilseed crops of the Indo-gangetic Plain. In spite of being an important oilseed crop, not much attention was paid to this crop till late seventies. It was only after the establishment of the All India Co-ordinated Research Project on Oilseeds in 1967 that the research work on rapeseed-mustard got a fillip. Technical problems limiting the productivity were indentified and priorities fixed for their solution at regional/state/national level. The research work carried out at different research centres has brought forth valuable information on various aspects of crop improvement and production technology which are briefly highlighted as under.

1) High Yielding varieties

Development of high yielding varieties of rapeseed-mustard has been one of the major objectives of the project. In this process, a large number of promising varities have been developed. Out of these, more than 50 varieties have been recommended for general release at national, state or zonal level. The diversified breeding methodology employed for increasing the productivity of rapeseed-mustard demonstrates a very high degree of genetic plasticity in the recently developed material (Kumar, 1984). In the last three years, 19 varieties of mustard, two of toria and one of yellow sarson have been recommended at All India level for release/pre-release testing (Table IX-35). A perusal of yield levels indicates that the newly recommended varieties of mustard under irrigated conditions give an increased yield ranging from 9.0 to 32 per cent over the standard varieties. Under rainfed conditions, the increased yield ranges from 8.92 to 20 per cent. In toria and yellow sarson, 9.0 and 31.3 per cent increased ased seed yield have been obtained (Anonymous, 1984). The development of such as high yielding yellow sarson variety, YSP-6 for eastern India particular for rainfed situation is of significance since its oil is very much liked by the people due to its high pungency.

Table IX-35. Recently recommended varieties of rapeseed-mustard for release/pre-release multiplication

Variety	Suitable for rainfed/ irrigated areas	Year of recommendation	Av. yield (kg/ha)	Per cent increase over the standard variety
		All-India Level		
Mustard				
Kranti	Irrigated	1981*	1,478	18.43
RLM-198	Irrigated	1981	1,425	9.00
Krishna	Irrigated	1982	1,372	12.70
RLM-514	Rainfed	1982	931	11.56
Toria				
Pant Toria-30	Irrigated	1982	995	9.82
Pant Toria-303	Irrigated	1982	991	9.32
North-Western Zone (Jammu & Kashmir, H.P., Punjab, Haryana, Delhi, Rajasthan and Gujarat).				
Mustard				
RH-7859	Irrigated	1984	1,918	22.71
RH-7361	Rainfed	1983	1,576	8.92
RH-30	Rainfed	1984	1,615	16.86
		Central Zone (U.P. and M.P.)		
Mustard				
RLM-185	Irrigated	1983	1,285	11.00
RK-1467	Irrigated	1983	1,327	14.00
KRV-24	Irrigated	1984	1,431	20.66
KRV-47	Irrigated	1984	1,566	32.04
KRV-74	Irrigated	1984	1,402	18.21
RK-1418	Irrigated	1983	1,303	12.00
RK-1418	Rainfed	1984	1,499	20.02
RK-9	Rainfed	1984	1,480	18.57

Table IX-35 (Contd.)

Variety	Suitable for rainfed/ irrigated areas	Year of recommendation	Av. yield (kg/ha)	Per cent increase over the standard variety
	Eastern Zone (Bihar, West Bengal, Orissa and Assam)			
Mustard				
Pusa Bold	Irrigated	1982	1,322	17.00
RW-351	Irrigated	1983	1,401	25.04
RW-85-59	Irrigated	1983	1,449	29.38
RH-30	Irrigated	1983	1,401	25.09
RH-781	Irrigated	1983	1,394	24.46
RH-785	Irrigated	1983	1,238	10.50
Yellow Sarson				
YSP-6	Rainfed	1984	928	31.26

*Recommended by the Central Variety Release Committee in 1983.

2) Production Technology

A) AGRONOMIC STUDIES

The main objective of this study is to find out the maximum potential of recommended varieties. Studies carried out on important agronomic aspects, have generated data which are of immende value in increasing the productivity of rapeseed mustard in the country. For example, planting mustard in narrow-rows (30 cm) has given more yield (2,140 kg/ha) than at 45 cm (1,880 kg/ha). Further, planting of variety Varuna in north-south direction under Kanpur conditions gives 2,100 kg/ha than east-west planting. Studies on response of mustard show that the application of 20 kg sulphur and 1 kg boron per hectare increase the yield of mustard significantly (Anonymous, 1981). Border method of planting, wherein every fourth row is left as such or planted with a very slow growing crop like sugar cane and potato has not only increased the seed yield over the standard practice, but also helped in saving 25 per cent seed and fertiliser. Such a type of planting facilitates plant protection operation.

B) ROLE OF EACH TECHNOLOGICAL PACKAGE ON SEED YIELD

The contribution of each technological package on seed yield has been worked out for important agro-climatic zones. The results of studies on toria crop at Pantnagar and mustard at Hissar demonstrtes 77.2 and 201 per cent increase in productivity when full technological package is adopted (Table IX-36). When the contribution of individual recommended technological package for toria at Pantnagar and mastard at Hissar is considered, the use of standard variety alone is found to give 42.4 and 20.2 per cent increase in yield of toria and mustard, respectively. The application of fertiliser with standard variety has increased the productivity level by 56.5 and 88.6 per cent toris and mustard, respectively. Likewise, the practice of irrigation with standard variety has increased yield of toris and mustard by 34.4 and 36.6 per cent, respectively. The plant protection practice with standard variety, however, does not show any increase in yield of toria (Table IX-37).

Table IX-36. Effect of package of practices on yield of toria and mustard.

Treatment	Toria		Indian Mustard	
	Seed Yield (kg/ha)	Per cent Increase/ decrease over local variety with local practices	Seed Yield (kg/ha)	Per cent Increase/ decrease over local variety with local practices
Local variety with local Practices	1,006	-	590	-
Standard variety with local Practices	1,435	42.6	709	20.2
Standard variety + fertilisers (F)	1,574	56.5	1,113	88.6
Standard variety + irrigation (I)	1,352	34.4	806	36.6
Standard variety + plant protection (PP)	806	19.9	1,053	78.5
Standard variety + I + F	1,717	70.7	1,177	99.5
Standard variety + I + PP	1,514	50.5	810	37.3
Standard variety + F + PP	1,470	46.1	1,364	131.2
Standard variety + full package and practice	1,783	77.2	1,778	201.3

Table IX-37. Effect of package of practices on yield of toria under rainfed conditions in West Bengal

Treatment	Seed Yield (kg/ha)	% Increase/decrease over local variety with local practices
Local variety	409.98	-
Improved variety	549.98	83.54
Improved variety + Fertiliser	752.47	83.54
Improved variety + Pest control	619.14	51.02
Improved variety + Disease control	543.31	32.52
Improved variety + Pest + Disease Control	631.64	54.07
Local variety + Full package	639.97	56.10
Improved variety + Full package	874.97	113.42

Studies on the contribution of different technological package under rainfed conditions on toria in West Bengal demonstrate 113.42 per cent increase in yield over the local variety when the full technological package is adopted (Table IX-37). Improved variety when fertilised gives 83.54 per cent increased yield. The contribution of improved variety alone was 34.15 per cent.

3) Maximisation Trial on Mustard

Having looked into the performance of high yielding varieties in different agro-climatic zones of the country, maximisation trial with released/improved varieties of mustard was laid in 1983-84 at the experimental area of the co-ordinating Unit at Hissar. It was possible to realise the yield of improved varieties of mustard ranging from 1,852 to 2,815 kg/ha by adopting the full technological package (Table IX-38).

4) On-farm Testing

The newly developed varieties of rapeseed-mustard recommended for pre-release testings, were grown at the farmers fields in 10 States during 1982-83 and 1983-84 crop season. It was observed that the farmers of Uttar Pradesh, Delhi, Bihar and Gujarat were able to realise the seed yield of rapeseed-mustard beyond 2,400 kg/ha by adopting the important technological package (Table IX-39). In fact some of the farmers of Gujarat State harvested the seed yield of mustard to the extent of 3,334 kg/ha by adopting important technological package (Kumar, 1983).

5. Impact of New Technology

The impact of the newly developed technical knowhow coupled with transfer of technology, in recent years, have resulted in overall boosting of the production and productivity of rapeseed-mustard in the country. The area, production and productivity which was 3.0 m ha., 1.23 m tonnes and 408 kg/ha in 1966-67, has increased to 4.19 m ha, 2.47 m tonnes and per cent respectively of rapeseed-mustard in the last 16 years.

Table IX-38. Maximisation trial showing the performance of improved varieties of mustard in India

Variety	Seed Yield (kg/ha)
Prakash	2,815
VH-30	2,667
Patan-67	2,667
RLM-198	2,370
Kranti	2,370
Krishna	2,370
Shekhar	2,370
NR-40	2,222
Seeta	2,222
Pusa Bold	2,222
RW-175	2,000
RLM-514	1,926
T-6342	1,926
Varuna	1,852

Table IX-39. Performance of improved varieties of rapeseed-mustard at farmers' fields

State	Variety	No. of demonstrations	Seed Yield (kg/ha)
	Mustard		
West Bengal	RW-351	6	1,612
	Pusa Bold	1	1,557
	RW-85-59	5	1,695
Orissa	Kranti	3	1,069
	Pusa Bold	5	902
Bihar	Varuna	1	2,100
	Raur-1	1	2,000
U.P.	Kranti	3	1,810
	Pusa Barani	1	2,650
M.P.	Kranti	2	1,620
	Krishna	1	1,560
	Pusa Bold	1	1,400
Gujarat	Varuna	8	2,457
Delhi	Pusa Barani	1	2,800
Punjab	RLM-619	4	1,900
	Gobhi Sarson	2	1,550
Haryana	Prakash	20	1,418
	RH-30	69	1,770
	Toria		
Assam	M-27	10	913
U.P.	T-9	1	1,651
Bihar	T-9	2	1,000
Haryana	Sangam	14	1,128
	Yellow Sarson		
Bihar	Rauys	1	2,800

6. Challenges

The progress made in terms of increasing the production and productivity of rapeseed-mustard in the country is very satisfactory. However, much needs to be done to produce 24 m tonnes of edible oilseed to meet the domestic requirements of fats and oils by the turn of this century. Considering the minimum 20 per cent contribution of rapeseed-mustard in the oilseeds economy of the country, 4.80 m tonnes of rapeseed-mustard would be required to be produced by 2000 A.D.

7. Production Strategies

In order to produce such a huge quantity of rapeseed mustard in a period of 16 years, a multi-pronged approach is suggested.

A) VARIETAL REPLACEMENT

It has been observed that the farmers often prefer to grow their old and traditional varieties without looking into the merits of the new varieties. This is one of the major constraints affecting the production of rapeseed-mustard in the country. More than 50 improved varieties have been recommended or released at national or state or zonal level. Even though these varieties are higher yielders, their speread is rather too slow because of unawareness on the part of the farmers about the yield potential of these improved varieties. To overcome this problem, an organised time-bound programme is required to replace the old varieties. Unless this is done expeditiously, the advantage of new varieties cannot be exploited.

B) SEED PRODUCTION

Although there are a number of high yielding varieties of rapeseed mustard recommended for different agro-climatic conditions of the country, there is no suitable and adequate mechanism to produce and supply the quality seeds of improved varieties. The seed production and distribution system, therefore, needs to be strengthened to ensure timely availability of adequate quantity of quality seeds of improved varieties.

C) LOCATION SPECIFIC TECHNOLOGICAL PACKAGE

Based upon the diverse agro-climatic conditions and constraints that have been limiting the production and productivity of rapeseed--mustard, technological package having 18 steps has been suggested (Kumar, 1982). This is based upon the assumption that bulk of the area under this crop is rainfed and that both water and fertilisers and likely to be limited in availability, The package steps need to be well demonstrated/explained to the farmers.

D) TRANSFER OF TECHNOLOGY

The production technology developed for rapeseed-mustard demonstrates that the present available technology is capable of giving a quartum jump to the productivity and production of rapeseed-mastard in the country. But when an average yield (5.89 q/ha) at national level is observed and the yields of 8.8 and 5.8 q/ha obtained under irrigated and rainfed conditions in different size group of soldings in Bihar, Uttar Pradesh, Rajasthan, Punjab and Haryana States (Anonymous, 1980) a different picture is obtained. These findings obviously suggest that there is a wide gap between the production potential and actual realisation. In order to narrow the gap, production strategy needs to be geared up to facilitate the speedy diffusion of technological inputs and services at the field level with an aim to optimising crop output productivity of rapeseed-mustard. One of the ways for the speedy transfer of technology is to organise demonstrations at block level to highlight the effect of different technological package over the traditional practices.

E) EXPANSION OF AREA

Another way to achieve the target is to identify potential areas for cultivations of rapeseed-mustard, to the under irrigated and rainfed conditions as a pure of intercropped with potato or sugar cane or wheat. The irrigated area under rapeseed-mustard needs to be considerably expanded not only in command areas of Hirakud and Delta Irrigation Projects of Orissa; Rajasthan Canal Project. Bhakra Canal Command

and Tubewell Commands of Punjab; Western Yamuna canal and Lift Canals of Haryane; Chambal and Tawa Commands of Madhya Pradesh; Mangsmati and Mayurakshi Commands of West Bengal and Ramganga, Sards Sahayak and Gandak Commands of Uttar Pradesh, but also in Gujarat, West Bengal and Assam as a possible replacement for wheat. Besides, there are a number of potential areas in north-eastern hill States, Bihar, Himachal Pradesh and Jammu and Kashmir where the cultivation of rapeseed-mustard need to be popularised. Attempt should be made to encourage the cultivation of early maturing rapeseed-mustard as a summer crop particularly in Lahaul-Spiti, Kinnaur and Chamba district of Himachal Pradesh and in Anantnag and Pulwama districts of Kashmir.

9.11 AGRONOMIC CONSIDERATION FOR MUSTARD UNDER IRRIGATED CONDITIONS

a) Improved Seed

Experimental evidence suggests that simply by replacing the seed of old variety with the improved one, the yield of mustard (raya) increased by 14 to 26% at Ludhiana and Hissar respectively. Already a number of new desirable improved varieties of mustard like 'Varuna', 'Parkash', 'KLM 198' and some other have been developed and released.

b) Timely Sowing

Sowing of mustard at the right time is essential to harvest good yield. The optimum time has also to be determined in view of vagaries of low temperature or frost and occurrence of pests and diseases in a locality. Late planting generally tends to give lower yield, which may primarily be due to shorter duration of reproductive phase and thus allowing less time for the formation os siliquate and development of seed. The experiments conducted in some northern states where raya is mostly grown have revealed that first fortnight of October is the optimum sowing period for this crop. At Ludhiana each fortnight delay in sowing beyond 1 October resulted in 11.7, 33.5, 51.3 and 66% decrease in yield compared with 1 october sowing. A similar experiment conducted at Pantnagar revealed that planting of mustard (variety 'Varuna') on 1 October resulted in the highest yield of 25.3 q/ha. At each successive fortnight delay in planting after 1 October, the reductions in yield were 24.9, 46.9, 54.6 and 59.2%. At Gurgaon, 10 October sowing recorded the highest yield, which was 11.4, 53.3 and 122.3% higher than the crop sown on 25 October, 10 November and 25 November respectively.

c) Plant Density

The stand of crop in farmers' fields is generally low and uneven. To ensure good yield, the optimum number of plants per unit area and the geometry of crop is important. The optimum spacing between rows and within the row may, however, vary with the variety, soil type and its nutrient status and the availability of soil moisture. Experiments conducted at Ludhiana, Hissar and Kanpur have revealed that a spacing of 30 cm x 10 cm for 'RLM 198', 30 cm x 15 cm for 'Parkash' and 45 cm x 15 cm for 'Varuna' was best at the respective place, under irrigated conditions. Even direction of sowing (north-south) and skip-row technique have been found to yield better under many situations.

d) Adequate Fertilization

Mustard responds to nitrogen application almost inveriable and to phosphorus, sulphur and some mocronutrients under certain specific situations. Fertilizers should therefore be applied preferably on soil--test basis.

These results show that raya is very responsive to N application and gives linear response even up to 125 kg N dose. However, a dose of 80 kg N/ha for Haryana and 100 kg N/ha for Punjab is recommended under irrigated conditions.

Table IX-40. Response of raya to nitrogen application (annual reports of Oilseed Crops, Hissar and Ludhiana)

Hisser			Ludhiana		
Dose of N (kg/ha)	Yield (kg/ha)*	Increase (%)	Dose of N (kg/ha)	Yield (kg/ha)**	Increase (%)
0	1,694	-	0	964	-
40	2,103	24	50	1,421	47
80	2,346	38	75	1,524	58
120	2,381	41	100	1,691	75
			125	1,842	91

*Mean data of 5 years, **Mean data of 3 years.

Shekhawat et al. (1972) in Rajasthan concluded that application of 30 kg N/ha resulted in an increase of 56 to 65% in yield and with 60 kg N/ha the increase was 66 to 121% over no nitrogen. The response with 30 and 60 kg P_2O_5/ha was much less than that with N.

At Behrampur (West Bengal), 5 levels of N from 0 to 300 kg/ha were tried on raya 'Varuna' for 3 years under irrigated conditions. It was concluded that 120 kg N/ha may be optimum and economic dose. Regarding split application, the yield differences were not significant in any year.

Table IX-41. Response of raya to micronutrients at different locations

Treatment	Yield (kg/ha)				Mean
	Ludhiana	Hissar	Kanpur	Berhampur	
Control	391	2,148	1,580	664	1,196
S 10 kg/ha	833	1,880	1,962	694	1,342
S 20	918	1,983	1,889	716	1,376
S 30	876	1,981	1,872	680	1,352
S 40	935	1,971	1,976	657	1,385
Zn 10	942	1,983	1,676	695	1,300
B 1	893	2,143	1,847	641	1,381
S 20 + Zn 10	1,003	1,843	1,753	731	1,332
S 20 + B 1	952	1,924	1,763	734	1,318
S 20 + Zn 10 + B1	1,049	2,019	1,790	768	1,406
Zn 10 + B 1	884	1,941	1,728	667	1,305
CD at 5%	163	NS	140	NS	

All the micronutrient treatments produced significantly higher yield over control at Ludhiana and Kanpur (except that the control yield did not differ from that of 10 kg Zn at Kanpur). The increase in yield at Ludhiana ranged from 442 kg (113%) to 658 kg (168%) and at Kanpur from 6 to 25%, over control. There were no significant differences in yield over control at Hissar and Berhampur. The mean values of four locations showed some superiority in favour at all treatments over control but not among various treatments.

Table IX-42. Fertility Status of Soil

	Initial Fertility Status of Soil				ppm						pH
	Organic C%	N (kg/ha)	P	K (kg/ha)	S	Zn	Cu	Fe	Mn	B	
Ludhiana	-	L	H	M	11	0.72	0.40	6.15	4.95	-	8.7
Hissar	-	M	M	H	11	0.67				0.68	8.7
Kanpur	0.45		13.5	210							6.8
Berhampur	0.024		28	328							7.8

e) Timely Irrigation

Results eveal that one irrigation applied at flowering increased the yield by 26% compared with only 9% at pod-formation stage, over no irrigation. Two irrigations i.e. 1 at flowering and 1 at pod formation, were at part with only irrigation at flowering.

The results of some irrigation experiments on raya conducted at Ludhiana revealed that it should preferably be sown after applying heavy pre-sowing irrigation (i.e. 10-12 cm). One irrigation should be applied after 3-4 weeks of sowing. Irrigation given at this stage promotes deep rooting, which helps in the use of water stored in the lower soil layers. Another irrigation should be applied at flowering stage. If the crop is threated by frost damage, crop should be given an irrigation at that time.

Table No. IX-43. Irrigation effect on raya yield at Hissar

Treatment	Grain yield (kg/ha)		
	1970-71	1972-73	Mean
No irrigation	967	1,710	1,338
One irrigation at flowering	1,549	1,831	1,338
One irrigation at pod formation	1,235	1,656	1,495
One irrigation at flowering + One at pod formation	1,813	1,534	1,673
CD at 5%	471	143	

The response to a given level of irrigation is also determined by the fertility status or the dose of fertilizer applied. On soils of low fertility on where the crop has not been supplied any fertilizer, the response to increasing levels of irrigations is usually very low, but under adequate fertilization, 3 irrigations resulted in 4-fold increase in yield of mustard (33.23 q/ha) compared with 8.32 q of control at Kanpur (Singh, 1974).

f) Package Approach

The experimental evidence suggests that effective implementation of improved practices in package form increases the yield tremendously per unit area. The improved variety recorded an increase of 14% in yield over local variety. Over the improved variety, the contribution of fertilizer was 35%, of irrigation 67%, of plantprotection measures 111%, of irrigation + fertilizer 85%, of irrigation + plant protection 167%, and of combination of irrigation + fertilizer + plant protection (package) 263%. The adoption of package recommendations resulted in an increased profit of Rs.3,152/ha over improved variety.

In a similar study at Hissar conducted for 2 years, the improved variety alone contributed 26% increase in yield over local variety. Over improved variety, the contribution of fertilizer was 71%, of irrigation 19%, of plant protection 43%, of irrigation + fertilizer 120%, of irrigation + plant protection 68%, of fertilizer + plant protection 111%, and of irrigation + fertilizer + plant protection (package) 238%. The data also indicated that maximum return per rupee (1:69) was with the change of variety only. By spending Rs.595/ha in the form of package recommendations, an additional net income of Rs.3,476/ha was obtained.

9.12 High-yield varieties of toria [Brassica campestris (Linn.) var. toria)

Among the rapeseed and mustard group of oil crops, toria is the earliest maturing one. It usually matures in 85-110 days. Because of its early maturity characteristic, it usually escapes frost and aphid infestation, which are the major field hazards in production of Brassica oil crops in India. In frost-prone areas therefore farmers prefer to grow it as a short-duration crop, supporting mixed crop with sugarcane, gram, lentil, pea, or as a catch crop in intensive crop rotations with cereal crops. Usually the farmers raise this crop with the local varieties which often have poor yielding potentials and generally do not respond much to the improved agro-technology. Therefore, there is considerable need for developing high-yielding varieties in this crop.

Table IX-44. Impact of production factors on raya yield at Ludhiana in 1978-79 (Initial fertility status : NPK : low, high, medium; pH 8.5; treatment : 80 kg/ha; 2 irrigations; 2 sprayas)

Treatment	Seed Yield (kg/ha)	Increase in Yield		Gross Income (Rs/ha)	Cost of factor (Rs/ha)	Net profit	
		Actual (kg/ha)	Per cent			Actual	Over variety (Rs/ha)
Local Variety	407			1,221	15	1,206	
Improved variety (V)	465	58	14	1,395	20	1,375	
V+Fertilizer (F)	629	164	35	1,887	320	1,567	192
V + Irrigation (I)	765	300	67	2,295	70	2,225	850
V + Plant protection (PP)	980	515	111	2,940	150	2,790	1,415
V + I + F	859	394	85	2,577	390	2,187	812
V + I + PP	1,227	762	167	3,681	220	3,461	2,086
V + I + F + PP	1,689	1,224	263	5,067	540	4,527	3,152

a) Breeding System of Toria

Originating from lotni brown sarson, toria is basically a self-incompatible crosspollinated crop plant. The mechanism of cross-pollination is primarily because of presence of self-compatibility mechanism, entomophily, very high content of sucrose in nectaries (40 to 61%) to attract honey bees and extrores another arrangement. Generation after generation self-incompatibility mechanism maintains panmixis and a high degree of heterozygosity. Eventually, it also frustrates any effort of inbreding and fixation of genotypes. Hence, in such an outbreeding population, the breeding strategy for stepping up the yield would be the adoption of a breeding procedure which maintains the balanced heterozygosity for optimum plant productivity.

In crosspollinated crops like toria, this could be accomplished throuch the selection (mass-selection, recurrent selection etc.), breeding of synthetic and composite varieties and utimately breeding of the superior performing commercial hybrids. Presently a number of mass--selection populations have been pressed in for commercial cultivation. However, they have not made much impact on the overall rapeseed production in the country. It is now generally viewed that the breeding of composites and synthetic varieties would be a logical way to break the present yield plateau in this crop.

b) Evaluation of Genatic Divergence in Toria Germplasm

Genetic diversity in elite Indian rapeseed germ-plasm has been studied, utilizing Mahalanobis D^2 statistics in a collection of 27 indigempis amd exptoc (canadian) germplasm (Agarwal, 1976). In this analysis, days to maturity contributed the highest (46%) towards the expression of genetic divergence, a number of parents were picket from within and between the 11 gene constellations observed. Crosses were made between them. These parents were also classified based on their geographical distribution and plant-type diversity and the average extent of heterosis was estimated (Table 8.45).

The D^2 statistics is meaningful and adequate for selecting genetically divergent parents from the Indian toria germplasm (Table 1). However, if D^2 is not feasible to follow, it would be better to make crosses between the parents of east Indian (West Bengal and Assam) and Canadian Brassica campestris types. The detailed analysis indicated 'B54' of West Bengal and 'Span' of Canadian sarson germplasm to be genetically the most divergent.

The toria x toria crosses expressed comparatively less heterosis than toria x sarson crosses (Agarwal, 1976; Doloi, 1977). Therefore it appears that in toria composite breeding programmes, some introgression of sarson germplasm would be useful to enhance the yielding ability of toria varieties.

Table IX-45. Extent of heterosis with respect to seed yield in crosses of the parents chosen on the basis of D^2 statistics, geographical distribution and phenotypic diversity.

Type of cross	No. of crosses	Average yield heterosis (%)
Based on D^2 statistics		
Within-gene constellations	13	20.6
Between-gene constellations	18	60.5
West India x West India	7	3.5
West Indian x East India	9	38.0
West Indian x Canadian	9	25.4
East Indian x East Indian	4	42.0
East Indian x Canadian	3	54.4
Canadian x Canadian	2	18.7
Based on phenotypic diversity		
Toria x toria	22	27.7
Toria x sarson	32	59.3
Sarson x sarson	10	78.4

9.13 SESAME

As stated earlier sesame seed has been a very promising oilseed crop for West Bengal. Since early seventies, the production of sesame seed in West Bengal has increased by nearly 10 folds. The production of sesame seed in West Bengal rose from 0.2 lakh tonnes in 1975-76 to 1.40 lakh tonnes in 1988-89, accounting for about 30% of all India production. The production target of 5 lakh tonnes of sesame seed in West Bengal by the end of Eight Plan.

a) Effect of Climate on Growth and Production of Sesamum

Sesamum (Sesamum indicum) grows round the year in some part of the State or other and flourishes on a wide range of soils from light to heavy, sandy loam to black soils. It does not talerate waterlogging or acidic soils. In northern India it is mostly cultivated in kharif as a rainfed crop. In peninsular region it is cultivated in more than one season. The kharif varieties do not fair well in rabi season (November sowing) and vice versa. The varieties grown during rabi are typically short-day plants and hence do not flower under long-day conditions of 12 or more hours. The kharif varieties are however day-neutral.

In West Bengal Sesamum is basically a crop of the warmer climate, though its cultivation extends also to cooler climate as available in the Himalayas up to 1,500 m altitude. The plants grow luxuriantly and give best yields in temperature range of 24-32°C. Higher temperature than this at the time of flowering and fruit setting brings about premature shedding of flowers and reduction in capsule number and seed yield. Lower temperature (below 12°C) at flowering results in production of sterile pollen or premature flower fall. Invariably the winter-grown sesamum plants are shorter in height and put up less vegetative growth compared with the kharif-grown crop.

Sesamum is basically a short day plant, and with a 10 hour day will normally flower in 40 to 45 days, but many varieties have become locally adapted to various light periods. The local varieties which are bred and grown over years in a particular tract under a set of climatic conditions show considerable variation in growth and yield when shifted from their original home. The differences in growth and production observed in the short and long season types in India emphasize the need for selecting the most suitable variety for seasonal planting. The time of sowing of sesamum acts as a predisposing factor for incidence of certain diseases and pests in the crop. Premonsoon sowing of sesamum with summer showers in May helps the crop to escape phyllody. Incidence of heavy rains during the grand period of growth makes the plants more susceptible to phyllody.

Sesamum a fairly drought-restistant crop is highly susceptible to moisture stress at the seedling stage. Once established, it comes up wel with the available soil moisture. In 1979, when the drought conditions prevailed in the western districts of Orissa, sesamum was next to arhar, which stood drought better than rice and gave some yield to the growers. Excess of moisture at seedling stage also bring about loss of plants due to damping-off.

Tolerance of any crop to salt concentration in soils (saline soils) is an asset for the region. There is report that several sesamum varieties tested at 10,000 ppm showed variation in their degree of tolerance to salinity, suggesting that there is scope for breeding for salt tolerance.

b) Incidence of Pests and Diseases

Foliar pests are of major importance in India. Antigastra catalaunalis, known as sesamum left-roller, is a major pest of sesamum, and in acute infestation it completely destroys the crop.

Phyllody (vector Bemisia tabaci (Gen.) is caused by virus. Attempts were made to breed for phyllody resistance by corssing Sesamum indicum x S. Prostratum, but so far there is no single strain reported to be completely resistant to phyllody.

c) Sesamum Species and Varieties

Sesamum today is a vailable in a multitude of forms recognizable on the basis of maturing (early and late), season of cultivation (Kharif, rabi and summer), number of capsules per axil, number of carpels per fruit and seed colour. On the basis of chromosome number, sesamum is divided into three groups.

Group	Chromosome number	Species
Group I	2n = 26	S. indicum
	2n = 32	S. alatum
	2n = 32	S. prostratum
		S. augustifolium
		S. angloense
Group II	2n = 64	S. radiatum
		S. occidentalis

Sesame is a self polyneted so far yield performance is concern there are best protene varieties are found all over in there. These varieties may be introduce in West Bengal considering the agro climatic zone of the state to improve the space of production of sesame oil in the state. Varieties are as follows :

Amount the above varieties a few of them already introduce in the state but the out come of the same not yet received in detailed. Considering the agroclimatic zones of the state. The higheldıng varieties already suggested by the TMO West Bengal that in Tista and Alluvial region Extension of Sesame acreage as jute substitute to be introduction. In gangetic Alluvial Region.

Extension of sesame as jute substitute and pre-kharif crop after harvest of potato/winter vegetable by increase the horizontal expension of sesame.

Table IX-46. Performance of the best fourteen crosses (mean yield/plant)

Sl.No.	Crosses	Mean yield per plant
1.	HD 31 x Co 1	5.60 g
2.	HD 47 x Co 1	4.90 g
3.	HD 68 x Co 1	4.85 g
4.	HD 31 x TMV 3	5.50 g
5.	HD 47 x TMV 3	5.05 g
6.	HD 68 x TMV 3	4.40 g
7.	HD 16 x TMV 3	4.40 g
8.	HD 16 x TMV 6	6.06 g
9.	HD 62 x TMV 3	8.60 g
10.	HD 62 x TMV 6	8.40 g
11.	HD 24 x TMV 6	3.70 g
12.	HD 24 x Co 1	4.25 g
13.	HD 45 x TMV 6	5.05 g
14.	HD 45 x Co 1	8.75 g

In Vindya Alluvium Extension of sesame as a rainfed 2nd crop in field should be popularise among the farmars. In the West Bengal use of low quality seed is the major constraint to uniform stand establishment of the crop. The usual practice of the farmer to dry the seeds even upto eight days after threshing. The present experiment was taken up in 1985 to find out the optimum dryin requirement of seasum for ensuring the maximum viability of seeds.

Seven kilograms each of sesamum seeds of the improved varieties Kayamkulam I and Thilothama were dried for one day and their moisture content noted at the end of drying. One kilogram from the major lot was stored separately in an air tight tin container which constituted the first treatment.

The remaining six kilograms of seeds were dried on the second day and their moisture content recorded at the end. One kilogram from this lot was stored again separately in an air tight container and this constituted the second treatment. The remaining five kilograms of seed stored. The procedure was repeated upto the seventh day. The seven samples thus stored in seven containers fromed the treatments.

Drying was done for six hours in direct sun light from 10 am to 4 pm spreading the seeds uniformly and stirring occasionally.

As stated earlier sesame seed as been a very promissing oil seed crop for West Bengal the production of the same increased very nearly 10 folds in 1988-89 it reached to 1.40 lakhs tonnes the production target of 5 lacks tonnes for sesame seed in the West Bengal by the end of eighth plan but we should have to adopt fiellinding varieties of sesame seed and have to popularised the same among the farmers. With a knowledge of modern technology so far introduced in the oil seed production from of the state financial and technical guidance is the foremost requirement for the development of sesame production in the state is necessary.

It is found from the market research that til oil of West Bengal, Assam, Tripura origin can not be sold for direct human consumption without agmark lebel. But there is no provision in agmark for greading Til Oil of West Bengal Assam and Tripura. Origin as far standards let down in PFA rules this problems reacts amount the mill honours and also extented in its normal force among the farmars as the marketing facilities for the Til oil is restricted by the Govt. policy or may be consider as an administrative laps reduced the production front of Til oilin the state.

It evidend from the Govt. statistic in different Oil years within the last two plans some times Til Oil production towards greater than that of the rapeseed mastered oil production in the state.

9.14 SOME MINOR INDIAN OILSEEDS

1. Ambadi (Hibiscus cannabinus)
2. Dhupa (Vateria indica)
3. Dukudu (Celastrus paniculatus)
4. Indian almond (Terminalia catappa)
5. Indian kapok (Bombax malabaricum)
6. Kamala (Mallotus philippinensis)
7. Karanja (Pongamia glabra)
8. Kokum (Garcinia indica)
9. Kusum (Scheleichera trijuga)
10. Mahua (Madhuca iatifolio)
11. Mangoseed (Mangifera indica)
12. Maroti (Hydnocarpus wightiana)
13. Nahor (Mesua ferrea)
14. Neem (Azadirachta indica)
15. Niger (Guizotia abyssinica)
16. Pilu-Khakhan (Salvadora oleoides)
17. Pisa (Actinodaphne hookeri)
18. Rubber seed (Hevea brasiliensis)
19. Sal (Shorea robusta)
20. Sunnhemp (Crotolaria juncea)
21. Tea seed (Camellia sinensis)
22. Tobacco seed (Nicotiana tabacum)
23. Undi (Calophyllum inophyllum)
24. Watermelon seed (Citrullus valgaris)

Minor oilseeds of three origin are another important renewable resource. There are about 100 species of tree borne oilseeds having oil content and characteristics conforming to any commercial interest. Of these, over a dozen oilseeds for producing vegetable oils viz., sal, mohua, neem, karanja, kusum, kokum, undi, mango-stone, rubberseed, nehor, dhupa, pisa and khakan, etc., are already recognised as of commercial significance and are being processed. Complete and aughentic estimates of production of these minor oilseeds are not available, however, gaoss potential of oils of tress origin is estimated at around 15.1 lakh tonnes and 20 lakh tonnes according to the estimates of Khadi and Village Industries Commission (KVIC) and Minor Oilseeds Association of Calcutta, respectively. Out of the total potential available, a very low percentage only is being utilised. There are also fluctuations in the production of oils from these sources. The main problem with the minor oilseeds is the collection of oilseeds within the limited period. Infrastructure for collection, and pretreatment of the seed to avoid deterioration of the seed and development of free fatty acids, there storage and extraction has to be created to exploit this valuable potential.

Most of the oil obtained from minor oil seeds are dark, and possess disagreeable smell and contain non-lipid constituents with a variety of structural features and characteristics. It has been observed that some of these non-lipids are toxic and make the oil unsuitable for edible purposes. These problems are aggravated by the hostile conditions during collection from the forest areas, storage, and subsequent processing.

The oil, because of these limitations has limited applications which in most cases contain antinutritional factors as investigated by animal/poultry nutritionists and toxicalogists. Significant work has been done on processing of these economically important oil seeds and oils but very few have been successfully processed to produce good quality oil. No successful attempts to upgrade the quality of oil cake for better utilisation have been done. It has been observed that conventional processes of refining, bleaching and deodorisation are not very effective to upgrade the quality of oil. Recent advances on modified approach of pretreatment of these oilseeds prior to solvent extraction with hexane have goven encouraging results to produced a good quality oil and meal. Economic considerations for commercial scale production by modified processing technology have yet to assessed.

Looking at the oil scenario of the available potential and gap in demand and supply of the vegetable oils, there is a good scope to minimise the gap to about 90% if the total potential of the oils from unconventional oil bearing mate-rials if fully tapped. About 24 lakh tonnes of oil could be added to the vegetable oil wealth of the country, from unconventional resources, viz., 4 lakh tonnes from rice bran, 15-18 lakh tonnes from minor oilseed and 5 lakh tonnes from expeller pressed cakes.

Attempts to develop a modified approach to the technology for processing of minor oilseeds to obtain better quality oil efforts for recovery of oil from expeller pressed cakes have to be made.

Expeller pressed cake provides another significaet source of oil. Out of 87 lakh tonnes of cake porential available, only 12.3 lakh tonnes were processed by solvent extraction giving about 1 lakh tonne of oil (1984-85 estimate). On the basis of 7% recovery of oil from the cake by solvent extraction, about 6.1 lakh tonnes of oil could have been made available, instead of only 1 lakh tonne of oil presently being extracted from the cake. The rest of the cake containing about 5 lakh tonnes of oil is left unextracted and directly fed to the cattle or used as fertilizer. About 5 lakh tonnes of additional oil could be available if the total potential of oil-cake is utilised for solvent axtraction.

Research and developmental work should be intensified for solving the problems of technological gap in processing of oilseeds and oils as projected under the status of oil processing technologies of various oilseeds.

a) Tree-Origin

Among the 24 minor Indian Oil seed stated earlier in this Chapter 11 important tree origin oil seeds are found whide spread throught the country. The distribution general characteristic and fatty acid compotions are as follows :

1. Mahua (Madhuca latifolia syn. Bassia latifolia)

Mahua is largely found in the Sub-Himalayan tracts and is particularly concentrated in the State of Uttar Pradesh, Madras, Maharashtra, Gujarat Bihar, Orissa, Madhya Pradesh, Mysore and West Bengal. The flowers are used for extracting liquor and also valued as cattle feed. Madhuca latifolia is replaced in South Indian by M. longifolia, the oil of which is also used for the same purposes. Both the species are frequently cultivated in and around villages, as avenue trees, etc.

The seeds (1 to 4) are contained inside fleshy fruits. The kernels weigh about 75 per cent of the whole seed and contain about 50 per cent of the fat.

Mahua oil is a pale-yellow, semi-solid fat with the following characteristics:

Specific gravity (15/15°C)	0.920
Refractive index (40°C	1.460
Saponification value	187-194
Iodine value (Wijs.)	58-63
Acid value	5.40
Unsaponifiable matter (%)	1.5 to 3.0
Setting point (°C)	18-25
Melting point of fatty acid (°C)	39-45
Melting point (°C)	23-31
Titre (°C)	38-40

The fatty acid composition of the oil is reported to be under :

	Acid	Percentage
1.	Palmitic	23.7
2.	Stearic	19.3
3.	Lignoceric	1
4.	Oleic	43.3
5.	Linoleic	13.7

The fat is obtained by hot expression in screw presses and hydraulic presses, ghanis, and sometimes in oil expellers.

The total production of mahua seeds in the state is given below:

States	No. of trees	Yield Per tree	Total estimated production (tonns)	Actual Collection (tonns)
West Bengal	1,61,700	20-80 lbs	2,941	1,000

Estimates by Khadi and Village Industries Commission. Directorate of Economics and Statistics, Ministry of Food and Agriculture.

2. **Neem** (Azadirachta indica)

The neem tree is found all over India occurring wild or planted as a shady tree in villages and cities, on roadsides, on canal banks, etc. It thrives best in drier climates shere the rainfall ranges between 18 to 45 inches and occurs largely in the States of Uttar Pradesh, Madras, Maharashtra, Gujarat, Mysore, West Bengal, Rajasthan, Madhya Pradesh and Delhi. The time when the fruit matures and falls from the tree, varies from State to State.

The seed is contained in a fruit which is more or less oval in shape and about 3/8 to 1/2 inch in length and 1/4 inch in thickness.

It consists of a soft pulp covered with a thin skin and a seed inside the pulp. The oil content of the kernal is about 50 per cent.

The oil is contained in the kernal and can be obtained by expression either in improved bullock of power-driven ghanis, hand screw presses or hydraulic cage presses. Pressing in expellers is not satisfactory. There are two methods of processing neem fruit. One method consists of depulping the fruit and subsequent decortication of dried depulped fruit and the other consists of drying of whole fruit and decortication of dried whole fruit. Pressing of kernel yields comparatively better quality oil than pressing of whole fruit or undecorticated neem seed.

Neem oil is a brownish-yellow, non-drying oil with an acrid and bitter taste and unpleasant odour. The quality of the oil differs according to the quality of seed and the method of processing it.

The characteristics of the oil processed at Harcourt Butler Technological Institute, Kanpur are given below :

Specific gravity (30/30°C)	0.9189	
Saponification value	193.0	
Iodine value	75.0	
Hehner value	88.7	
Acid value	4.0-16.0	
Unsaponifiable matter (%)	2.0	
Colour (Lovibond)	40 Y 6 R	in 1" cell

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Palmitic	13.6 - 14.9
2.	Stearic	14.4 - 19.1
3.	Arachidic	1.3 - 2.4
4.	Oleic	49.1 - 61.9
5.	Linoleic	7.5 - 15.8

The oil finds use in the manufacture of soap. Some methods have been suggested in the literature for removing the unpleasant odour of the oil. A method for refining of neem oil by alcoholic extraction and the recovery of bitter principles having medicinal and insecticidal properties, has been developed at the National Chemical Laboratory, Poona. The oil is also used in medicine. It can also be used for the production of industrial oleic acid, stearic acid, etc.

Neem cake finds ready use for manurial purposes. It is particularly valued for its strong insecticidal properties and as a white and destroyer in fields and gardens.

In a country like ours with the majority of its population suffering from fat deficient diat it is important that the use of edible oils like ground nut, Sunflower etc. by the industry should be minimise. There are fairly large resources of inedible and minor oils in the country which have not been exployted one of them is NEEM.

Estimated production and collection of Neem seeds in the state is given below :

State	No. of trees	Yield per trees	Total estimated % of production (tonns)	Actual collection (tonns)
West Bengal	2,65,000	50 lbs.	2,339	615

3. Karanj or Pongam (Pongamia pinnata syn. P. glabra)

This is an evergreen trees, commonly found in villages, roadsides, banks of rivers and in forests. In localities where it is known to have been cultivated successfully, the absolute maximum shade temperature varies from 100° to 120°F, the absolute minimum from 30° to 60° and the rainfall from 20 to over 100 inches. The fruit or pod is 3 inches long and encloses reddish seeds, each about 1 inch long weighing about 1 gm. The seed contains about 27 to 39 per cent of oil and a resinous substance. Villagers collect the seeds and decorticate them with the help of wooden hammers or by thick sticks. Separation of kernels from shells is done by winnowing processes. The seed is chiefly pressed in expellers though ghanis are also being used. In expellers 24 to 26 per cent of oil and 68 to 72 per cent of the cake are reported to be obtained.

Karanj oil is an acrid, reddish-brown, non-drying oil with the following characteristics :

Specific gravity (32°C)	0.9273
Refractive index (32°C)	1.4774
Saponification value	187.5
Iodine value (Winkler's)	82.9
Acid value	7.5
Acetyl value	14.5
Unsaponifiable matter (%)	2.6

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Myristic	0.23
2.	Palmitic	6.06
3.	Stearic	2.19
4.	Arachidic	4.30
5.	Lignoceric	3.22
6.	Dihydroxy stearic	4.32
7.	Oleic	61.30
8.	Linoleic	9.72
9.	Linolenic	0.46

The oil is chiefly used for leather tanning, lighting and to a small extent in soap making, medicine and lubrication. The cake may be used for manurial purposes.

The chief use of karanja oil is in soaps. The oil has a peculiar odour, has 68 per cent unsaturated fattry acids (iodine value 80) and 2.5 per cent non-glyceride compounds consisting of furano flavonoids such as karanjin (I) (Limaye, 1936), isolonchocerpin (II) (Naik and Bringi, 1973) and pongamol (III) (Rangaswami and Seshadari, 1940). These cause a colour change in the soaps made from karanja oil. The method developed for upgrading karanja oil are: (1) alcoholic alkali extraction which is now unconomical (De's Sa et al., 1955), (2) distillation of the minor compounds under vacuum, and (3) high pressure hydrogenation whereby the structure of the phenolic compounds are changed.

The total number of Karanja trees in the areas where survey has been carried out in the state is estimated stated below:

State	No. of trees	Yield Per tree	Potential Production of seeds (tonns)	Actual Collection of seeds (tonns)
West Bengal	51,600	30-40 lbs.	734	26

Information from C.C.F.

4. Undi (Calophyllum inophyllum)

Undi is an evergreen tree found in the eastern and western coastal regions of India and in the interior parts of West Bengal. The trees grow near the seashore on the sandy places, along the river banks, near the water resources, and in the gardens. The tree starts following after the tenth year. It flowers twice a year in January-February and in June-July. The fruits mature at the end of April or in May and in October-November.

The undi fruits are green and round and turn yellow when mature. The diameter of the fruit is about 3/4 of an inch, with four compartments inside. It is made up of pulp, hard seed coat, soft and coat and kernel which is about half an inch in diameter. The seeds fall from the tree and are collected by picking. The removal of the seed from the outer brittle shell is done by breaking the nuts with a light hammer or by placing the nuts on a hard floor and pressing them with wooden planks. The kernels are very rich in oil content. Dried kernels contain up to 73 per cent of oil. In ghanis the oil yield is about 63 per cent. Undi oil is bluish yellow when it is freshly extracted in a ghani. The oil has the following characteristics :

Specific gravity (15°C)	0.9415-0.9452
Refractive index (15°C)	1.4699-1.4772
Saponification value	191-202
Iodine value	82-98
Acid value	27-78
Unsaponifiable matter (%)	0.25-1.4

The fatty acid composition of the oil is reported to be as under

	Acid	Percentage
1.	Palmitic	15.6-18.5
2.	Stearic	6.1-12.2
3.	Oleic	48.5-53.1
4.	linoleic	15.8-24.1

The oil is mainly used for burning purpose in villages and for varnishing country boats. It is also often used for massaging rheumatic patients and in ointments for wounds. Undi oil can also be used for soap making.

Surveys carried out under the schemes financed by the Indian Central Oilseeds Committee indicate that undi is concentrated in the Southern part of India i.e., in the States of Kerala, Madras, Maharashtra and Mysore.

Central oil seeds commission started their investigation on the same but the data not yet published on the state of West Bengal. Though undi is available in the inerior parts of West Bengal as stated earlier.

5. **Kusum** (Schleichera oleosa syn. S. trijuga)

This tree is found in dry forests in many parts of India, Burma and Ceylon. It occurs in the lower Himalayas from the Sutlej to Nepal, in the Sub-Himalayan tracts and Siwaliks up to an altitude of 3,000 feet, throughout Central India, the East and West Coast regions, the Deccan and Karnatak. The tree bears leaves and flowers early in the spring season. A sample of seed from the Landsdowne forest division of Uttar Pradesh contained 54 per cent of kernels. The oil content in kernel was found to be 57.1 per cent.

Kusum oil is a yellowish-brown, semi-solid fat and has been found by the Harcourt Butler Technological Institute, Kanpur, to possess the following characteristics:

Specific gravity 32/52°C	0.9099
Refractive index 40°C	1.4607
Saponification value	234.3
Iodine value	60.2
Hehner value	88.7
Acid value	31.3
Unsaponifiable matter (%)	2.1
Acetyl value	4.0

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Myristic	1
2.	Palmitic	5-8
3.	Stearic	2-6
4.	Arachidic	20-25
5.	Oleic	60
6.	Linoleic	3-4

The oil can be obtained by expression of seeds or kernels in expellers and hydraulic presses, etc.

The Chief Conservators of Forests in the State of West Bengal have mentioned about the occurrence of kusum trees in the states. The available information is summarised below :

State	Quantity of seeds available	Area where available	Quantity of seeds collected
West Bengal* (13,800 trees)	401 tons		59

* Indian Central Oilseeds Committee Scheme.

6. Khakan (Salvadora oleoides)

This is a small tree or large sharub which grows well in the dry, sandy and saline tracts of Northern India. The tree can stand high temperature and requires about 10 to 24 inches of rain for its growth. It is abundantly found in North Gujarat, Saurashtra, Kutch, Rajasthan and the Pubjab. There are two varieties of khakan, one bearing sweet seeds which are used as cattle feed and the other bearing bitter seeds which are collected and crushed for oil. The fruiting season in June-July. Collection of seed is done by cutting the seed-bearing small twigs of the trees. The twigs are dried and beaten against a hard surface and the seed separated. The seeds are stored after proper drying.

The seeds contain about 42 to 43 per cent of a greenish-brown, pungent oil which has the following characteristics:

Specific gravity 35.5°/15.5°C	0.9205
Saponification value	247.2
Iodine value	14
Acid value	2.02
Solidifying point	31.1°C

That fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Caprylic	4.4
2.	Capric	6.7
3.	Lauric	47.2
4.	Myristic	28.4
5.	Oleic	12.0
6.	Linoleic	1.3

Twentyfive to 30 per cent of oil can be expelled by crushing in the ghanis. Due to low melting point of the oil, extraction is carried out better in the summer season. The oil is similar to coconut oil due to its lauric acid content which is about 47.2 per cent and is, therefore, very valuable for soap making. It would help to reduce the use of coconut oil in the soap making industry.

7) **Pisa** (Actinodaphane hookeri)

Pisa tree is a small evergreen tree found in the warm and moist forests of the lower hills in the eastern and western Ghats and in Assam and Sikkim. It occurs mainly in Ahmednagar, Nasik and Satara districts of Maharashtra State and some parts of Mysore, especially in Kanara and Shimoga districts.

The flowers of pisa are particularly valued for honey in Mahabaleshwar. The fruits mature by the end of May and middle of June. The seeds are small in size and their collection difficult, if they fall on the ground. Seeds are collected mostly by cutting the branches hearing fruits and then plucking them. The pisa seed is surrounded by a pulp with high moisture content and therefore, calls for immediate depulping to avoid the probable growth of fungus in the seed stock. Proper and completely drying of seeds in the shade reduces the chances of deterioration of seeds when stored.

The seed contains 48.4 per cent of a reddish-brown oil which has the following characteristics:

Specific gravity 25°C	0.925
Refractive index 50°C	1.449
Saponification value	255.3
Iodine value (Hanus)	10.9
Acid value	4.0
Unsaponifiable matter (%)	1.92
Acetyle value	11.3
Melting point	43-44°C

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Lauric	96
2.	Oleic	4

The seed contains about 96 per cent of lauric acid, and is, therefore, a suitable substitute for coconut oil in soap making. The systematic cultivation and proper exploitation of pisa, therefore, requires serious attention due to its commercial possibilities.

Pisa trees are also found in the evergreen forests of Mysore State. It is estimated that about 132 tons of seeds are available in the Sirs, Siddapur and Kumta Ranges.

This type of trees also in Assam and Sikim as stated earlier but not been utilize as nonconventional source of oil, proper utilisation of this seeds which are available in the hilly tract tarai and Dwars should be explode to meet the deficite of the state.

8. **Kokum** (Garcinia indica)

The kokum butter is obtained from the seed of Garcinia indica, a tree about 50 to 60 feet in height growing in the evergreen forests of the Western Ghats from Konkan southwards in Mysore (Coorg, Shimoga, North and South Kanara). Madras (Nilgiris) Maharashtra and Kerala. It is also reported to flourish in the evergreen forests of Assam, Khassi and Jaintia Hills and West Bengal. The fruit is about 1 to 2 inches in diameter and is red in colour, sometimes with yellow tinge. The rind of the fruit is acidic in the teste and is used and is used for culinary and medicinal purposes. The fruit contains 3 to 8 seeds. The kernels are crushed for oil.

The seed contains 23 to 26 per cent of an oil with the following characteristics:

Saponification value	189
Iodine value	34.7-36.7
Melting point	39-43°C

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Myristic	0-1.2
2.	Palmitio	2.5-5.3
3.	Stearic	52-56.4
4.	oleic	39.4-41.5
5.	Linoleic	1.7

The seeds are decorticated by beating with a rod. The oil is extracted by boiling the kernels in water. The oil collects at the top and is skimmed off.

Kokum fat is used for burns and injuries as vaseline. It is also used as a substitute for ghee, and in soap manufacture.

The kokum trees mainly available in the district of Ratnagire, Kanara and Surat. Taking 25 per cent of the trees as not bearing fruits and an average yield of 25 lbs. per tree, the total production of kokum seeds was estimated at about 386 tonns. In West Bengal Kokum trees are pre-domenent around Jointiea hills tribel people use the same as ves-line and as a substitute of Ghee.

Proper exploration utiliazation and chemical culture may popularies Kokum fat and as a cooking medium. Which is already a popular fat for the local tribal people.

9) Nahor (Mesua ferrea)

Nahor tree occurs in large numbers in the evergreen forests of Burma, Assam, Bengal, Western Ghats and in the Andamans. In the cultivated conditions, it is found chiefly as an ornamental tree under various local names. The flowering season of the tree is February--March, which extends up to April-May in some places. The fruits are borne two months later. The fruit is reddish in colour and contains from one to three seeds.

The nahor seed is about an inch in length and contains a kernel of nearly the same size. The kernel is rich in oil having 46 per cent in Malabar seed, 34.5 per cent in Bengal seed, and 49.8 per cent in Assam seed.

The oil from the Assam seed was found to possess the following characteristics:

Specific gravity (32°C)	0.922
Refractive index (32°C)	1.4674
Saponification value	196.0
Iodine value (Wij's)	90.0
Acid value	10.0
Unsaponifiable matter (%)	3.2

The fatty acid composition of the oil is reported to be as under:

Acid		Percentage
1.	Myristic	0-1.8
2.	Palmitic	8.0-8.5
3.	Stearic	10.4-15.8
4.	Arachidic	0-1.8
5.	Oleic	55-66
6.	Linoleic	10-20

Nahor oil is used mostly for burning purposes. The dark brown colour and mild pungent odour of nahor oil limits its uses in soap making. Nahor oilcake is rich in nitrogen content and can serve as a good manure.

Nahor occurs mainly in the State of Assam and in Palghat district of Kerala State.

Nahor may be introduce or explode in the hilly tract of Himalaya or in Midnapore which may solve a considerable amount of non-conventional oil of tree origin in the State of West Bengal.

10. Sal (Shorea robusta)

Sal tree is found in the tropical Himalayan region from the Sutlej to Assam, in the Eastern districts of Central India and in the Western Bengal Hills. It is very abundant in Chhota Nagpur and in the Tarai forests of Northern India. The seed is, at present, not being used due to the afforestation work being carried out in certain parts of the country. Season of seed collection is from May to July and the cost of Seed collection is estimated between Rs.5/- to Rs.15/- per md.

The kernel from the seed obtained from the Dehra Dun area was found to contain 14 per cent of fat with the following characteristics:

Specific gravity (99/33°C)	0.8692
Refractive index (40°C)	1.4579
Saponification value	190.0

Iodine value (Wij's)	37.9
Hehner value	94.2
Acid value	10.6
Unsaponifiable matter (%)	0.87
Melting point (°C)	34.7
Titre (°C)	33.4
Reichert-meissl value	1.0

The fatty acid composition of the oil is reported to be as under:

	Acid	Percentage
1.	Palmitic	8.26
2.	Stearic	34.24
3.	Arachidic	12.24
4.	Oleic	41.42
5.	Linoleic	2.73

The oil is said to be extracted by the 'boiling process'. However, in view of the low oil content 'solvent extraction process' would serve the best purpose.

The fat can be used as a substitute for cocoa butter in confectionery, as a substitute of tallow, for textile sizing and in soapmaking. Sal seedcake appears to be a potential source for the production of starch as it contains 31.25 per cent of true starches.

The potientiality of Sal tree not yet estimated in the state of West Bengal - Sal as a forest resource (wood) and its economic estimate earlier stated in the vegitation chapter.

In the national level they potential of Sal seeds 688 thousands tonnes the Directorate of Oil seeds development of Hydrabad estimated the availability was only 12.6 thousand tonnes.

Sal fat is greenish brown, has a typical sal odour and has a glyceride composition which enables its use as such or after fractionation as a cocoa butter extender. Its use for this purpose is affected by the quantity of impurities such as epoxyand dihydroxy-stearic acid triglycerides as they have an influence on the melting and mould release characteristics of the fat (Bringi et al., 1972). While common refining could produce satisfactory grade material from good quality sal fat, very recently technology has been developed for upgrading even poorer quality fat (Bringi et al., 1972). This technology is based on industrial adsorption chromatography. The good quality sal fat has a great demand abroad as cocoa butter extender.

Sal fat used as cocoa butter extender in chocolates.

Problems in use	- Green colour, minor components, viz., epoxy - and dihydroxy-stearic acid triglyceride.
Technology	- Technology for decolourisation and upgrading by adsorption process available.

While it does not seem that sal fat is incorporated in confectionaries in India, the Prevention of Food Adulteration Act has specified the standards for sal fat for use in confectionery. For this purpose the values for 9-10 epoxy and 9-10 dihydroxy stearic acid content in the fat should not exceed 3 per cent. More recently there is a proposal to permit use of sal fat in vanaspati up to 10 per cent.

The total availability can roughly be estimated at about 10 lakh tons of non-conventional oilseeds in the country as detailed below:

		Tonns
1.	Mahua	2,17,566
2.	Neem	4,14,633
3.	Karanj	95,711
4.	Undi	3,798
5.	Khakan	45,943
6.	Pisa	340
7.	Kokum	471

8.	Kusum	934.
9.	Nahor	5,699
10.	Sal	2,12,230
		9,97,325

The above approximate assesment of availability of non-conventional oilseeds is based on efforts made from time to time by the Indian Central Oilseeds Committee, Khadi and Village Industries Commission, State Governments and other organisations. It does not include the data where surveys have not been carried out or of the seeds about which information is not available. These figures are thus of the tentative and indicative nature. For example, according to Hindustan Liver Ltd., perhaps, about 30,000 tons or more of mahua oil are being marketed every year while on the basis of the estimates given above, the figures for mahua oil works out to about 15,000 tons (from 41,870 tonns of seeds).

There is, therefore, a need for a concerted, coordinated programme for the survey of various non-conventional oilseeds in the country with regard to their available potential and concentration. In forest areas, it was suggested, the quantities of oilseeds (having an oil content say above 15 per cent) available annually should be determined by regional surveys and the promising among them grouped together according to locality and ripening time. This will not only indicate the total potential of non-conventional oilseeds in the country but also facilitate the collection of seeds.

In view of the large number of non-conventional oilseeds available in the country, it may be difficult, in the initial stages to carry out a resources survey of all the species at a time. It will involve a heavy organisational responsibility in the concerned departments of the State Government who will be charged with the function of implementation the programme as also a heavy expenditure. It was, therefore, felt that survey as well as practical work on collection and utilisation of non--conventional oilseeds should be started on the selected species whose oils are in demand by the industry. From among the species available, the following properties should be fixed for work during the next Five Year Plan period:

First priority	-	Mahua, neem, karanja and undi
Second priority	-	Kusum, khakan, dhupa and kokum
Third priority	-	Nahor
Fourth priority	-	Pisa and sal

However, due consideration might be given to the other species available in abundance, in different States.

Keeping in view the above considerations, it is recommended that a model scheme for the sample survey of non-conventional oilseeds in forest areas with the specific objective of making a survey of the eleven approved species which offer scope for commercial utilisation and collection of requisite data should be drawn up and forwarded to State Governments for drawing up schemes on these lines.

b) Non Traditional Oil Potintial and Projects

The utilisation of oils and fats is generally categorised as (1) household use (2) vanaspati (3) soap (4) paint and industrial use. While the household use includes liquid edible oils, those used for applying to the body and hair and those used for illumination, the industrial use of oils includes lubricants, preparation and use of fatty acids, their derivatives, oleochemicals, etc.

There is a variety of sources for oils but each oil has its characteristic fatty acid, glyceride and non-glyceride composition. They have therefore to be processed to make them suitable for using as edible oils, vanaspati, margarine, soaps, paints, or for other industrial used.

To explore the non-conventional oil there are various sources in our country so far explored and yet to be explored like: Mango tree is planted for the fruit which is valued for its ripe pulp, but the seed kernel gives oil. Sal trees are grown in forest for timber but their seeds give fat. Kusum trees are grown for shellac, as a host for shellac insect, but its seeds yield oil. And there are many other tree like neem, Karanja, mahua which grow in the country. Oil can be extracted from seeds of these trees.

The given details is the national scinerio of the non-traditional oils in India.

1. Rice bran oil

Potential	:	8.0 lakh tonnes
Actual	:	1.5 lakh tonnes

2. Castor oil

Production	:	1,20,000 tonnes

Potential and actual availability of some minor oilseeds and oils ('000 tonnes)

Name of Oilseed	Production	Actually Processed	Oil Produced
Sal	6,000	270	23
Neem	2,000	300	30
Karanja	500	32	8
Kusum	200	12	4

Source: Swaminathan, 1980.

3. Oil palm

Considering the importance of oil palm in augmenting the resources of edible oil, two projects for raising its plantation over as area of 6,060 ha were started in India in early seventies. An area of 3,660 ha in Kerala and 2,400 ha in Andaman and Nicobar Islands is to be covered under the projects. These two sits have been selected keeping in view the rainfall, soil and other agroclimatic conditions. Size of the plantation is proposed to be expanded further in due course depending upon the availability of land and other allied considerations.

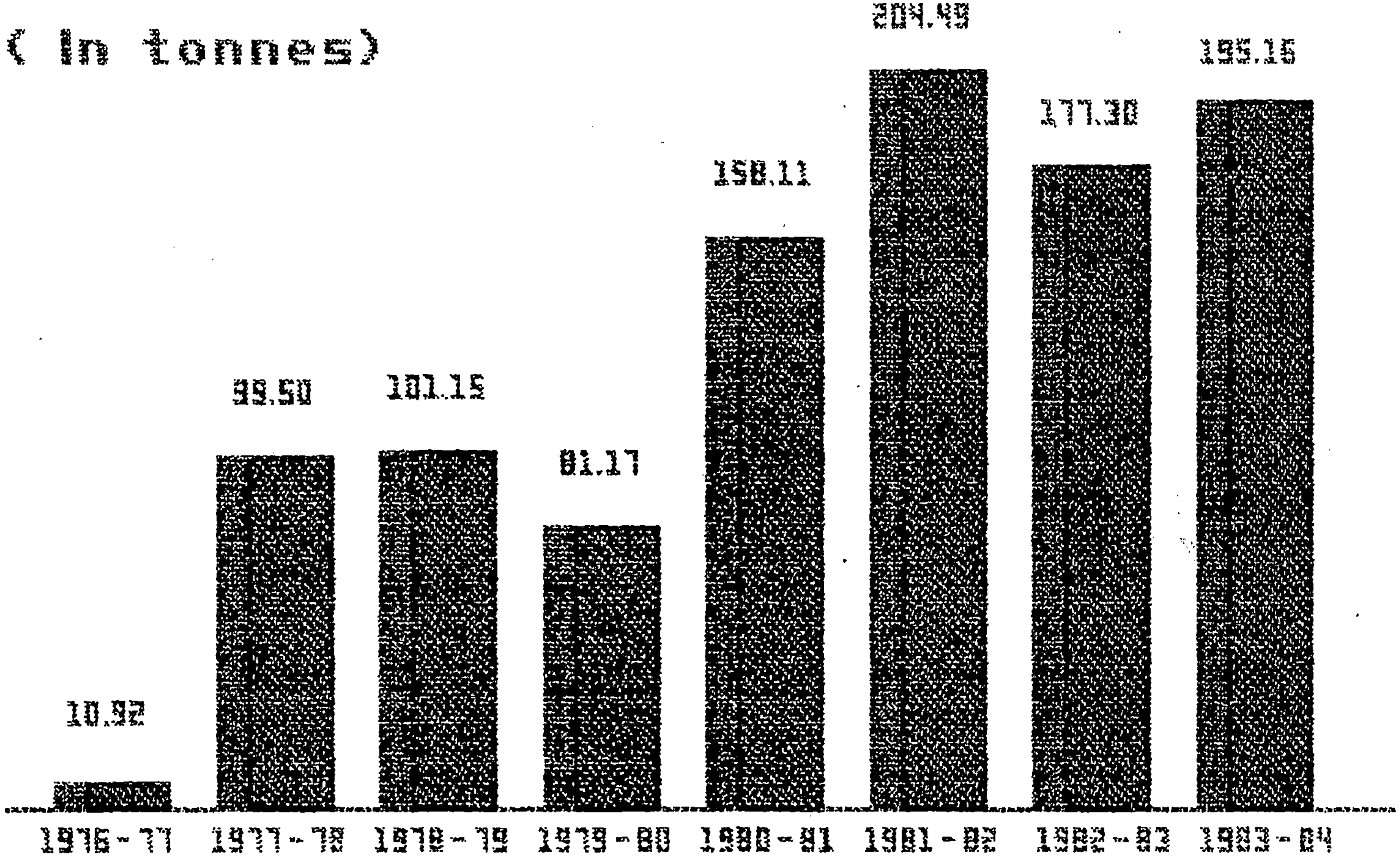
c) Different projects of non-traditional oilseeds development

1. Kerala project

The project was started in 1971 for planting an area of 2,000 ha on forest land in Anchal range of Quilon district. Programme is being executed by oil palm India Ltd. in which Government of India is sharing almost equal finance with Government of Kerala. Under the project an area of 1879 ha has been covered so far after felling and clearing the forest land. A plant having processing capacity of 2 tonnes FFB/hour has been installed to produce oil from mature bunches. Under the Sixth Plan, expansion of oil palm plantation to another 1,660 ha in the same region of 2,000 ha project was initiated during 1980-81. Out of 1,660 ha, the plantation on 1,426 ha has been completed. Besides, State Government of Kerala has also raised the oil palm on an area of 400 ha out of 500 ha targetted area under Western Ghats Development Programme. Another 500 ha area is proposed to be planted under the scheme of Rehabilitation of Sri Lanka Repatriates. Total area under oil palm plantation at present in Kerala State is 3,705 ha. The entire planted area is covered under high yielding tenera variety.

Plantation carried out under 2,000 ha project has begun to yield fruits and crude palm-oil is being produced from them and soilid. Normally 20 kg of palm oil and 2 kg of kernel oil is yielded by fresh fruit bunches (FFB). But due to initial setback in plantation, expected yield of FFB could not be realised from 1971 plantation. Production of palm oil during the period from 1976-77 to 1983-84 is indicated below:

Year	Oil production (tonnes)
1976-77	10.92
1977-78	99.50
1978-79	101.15



Palm oil production

Year	Oil production (tonnes)
1979-80	81.17
1980-81	158.11
1981-82	204.49
1982-83	177.30
1983-84	195.16

Cultivation of oilpalm in India is in infant stage. Lack of expertise in management of crop and inadequate milling facilities are some of the major factors which have limited the yield of oil. Recently several measures have been taken to improve the yield of FFB and oil.

2. Andaman and Nicobar Islands Project

Under 2,400 ha project, an area of 1,000 ha has been planted. Programme is being implemented by Andaman and Nicobar Islands Forests and Plantation Development Corporation Ltd. A small processing plant is also in operation. It is proposed to plant 30,000 ha area in these islands in the near future.

Oilpalm plantation in India has not yet yielded desired results. Therefore, there is a need for further strengthening research and development programmes to enhance palm-oil production. Seed of high yielding tenera variety which has been found suitable for planting in India is imported from either Malaysia or Ivory Coast.

Efforts are being made to produce seed of this variety indigenously. Recently, tissue culture method has been applied to oil palm cultivation in several countries where it has helped in increasing palm oil yield. The method can gainfully be adopted in India as well. Expanding the crop in small holdings around present plantation and raising oilpalm under irrigated conditions are other ways of increasing palm-oil production. With research and developmental efforts coupled with good crop management practices and modern milling facilities, the productions of palm oil can be increased to a larger extent in future.

A few palms were raised in Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu both as ornamental and for experimental purpose in the past. Results are encouraging.

d) Major tree origin - non-traditional oil in India

In the past two decades indigenous technology has been developed for utilising non-traditional oils from tree borne oilseeds for industrial use and in a small way for edibles also. The programme has enabled us to achieve some measure of self reliance, earned foreign exchange by export and employment generation, albeit seasonally, amongst the most deprived rural people engaged in collection. In the following pages I have summarised the processing technology available for upgrading five non-traditionl oils viz., sal, mowrah, neem, karanja and kusum which are widely recognised as offering the greatest scope for increasing oil supply.

The estimate of potential availability of the above oils is 17 million tonnes, with sal alone accounting for 45% of the total. The actual production has fluctuated 3-5% of the potential in the past decade i.e. 50,000 to 80,000 T. Considering the inaccessible areas and wide dispersal a modest target of 30% i.e. nearly 5,00,000 T. Should be our goal but even the meager collection is showing a disturbing decline. The technology mission should have a closer look at the dwindling seed collection and remove the irritants speedily to aim at a practical collection target. The efforts of our sceintists and technologists and the assets created for implementing the technology will be in vain, if we follow the ostritch like attitude in the matter of raw material collection. Liberal fiscal incentives will also spur collection. The availability of edible grade rice bran oil shot up from 20,000 T a few years ago to 1,00,000 T or more now entirely due to fiscal incentive and this example should serve as an eye opender.

1. Sal

The modest collection of sal (about 2000 T oil) in 1970 rapidly picked up and teached a peak of nearly 26,000 T oil (200,000 T seeds) in 1979 and equally rapidly, declined to a few thousand tonnes for reasons mentioned earlier. The harvesting and post harvest practices of processing the seed influence the oil quality. Over the years the practices have been streamlined to obtained satisfactory quality oil).

2. Mowrah

The estimated potential of mowrah kernels is 1.1 million tonnes and oil 400,000 T assuming an average 36% yield. The actual yearly collection (1976-84) ranged 19,000 to 30,000 T. The oil (IV 60-65, S.V. 187-196) has fatty acid composition: palmitic 25, stearic 22, oleic 36 and linoleic 16%. The absence of any unusual fatty acids or non-lipid components are factors facilitating straightforward refining to obtain an acceptable edible fat. The oil is included in the VOP list for vanaspati manufacture.

3. Neem

An estimate of theoretical potential of oil is about 350,000 tonnes on the basis of a conservative recoverable oil yield of 10% from about 3.5 million tonnes of seeds/kernels. The production of the late 70's was around 30,000 T but sharply declined to 11 to 14,000 T during '78-'79 season.

4. Karanja

The theoretical potential of the oil is estimated to be 135,000 T but actual collection has been stagnan at around 4,000 to 6,500 T/year, The oil is mainly used for soaps after sulphonting and sulphation in leather tanning industry. The oil has IV 90: S.V. 185-195 and major fatty acids are palmitic 10 oleic 49 and linoleic 19%.

5. Kusum oil

The potential of the oil is estimated at 66,000 T but the yearly collections are low and fluctuate between 4000 and 5000 T. The oil is unique as it contains only 3.6-3.9% glycerine while normal vegetable oil contains 9-10% glycerine. The chemistry of the oil is now know.

e) Forest trees

In India, many oil bearing trees are being found in the forest and sal (Shorea robusta) is one of the best examples which was commercialised due to better collection methods. Similarly, other oil bering forest trees can be commercially exploited with advantage. The acreage of such trees could be increased through afforestation or reforestation and increasing plant population in a given area of these trees will make the collection easier and cheaper. An attempt has been made to identify suitable areas for various oil bearing forest trees (Table 1) and a brief description of some of promising plants is given.

Table 1 : Oil bearing trees

Local Name	Botanical name/yield	Suggested suitable area for forestation
Pilu	Salvadora oleoides S 45% oil 50 kg seeds/tree	Dry desert area - U.P., Punjab, Rajasthan, Gujarat, M.P.
Kusum	Scheleichera oleosa S/U 40% seed 70% kernel	Dry forests of U.P., Bihar, Orissa
Pisa	Actinodaphne hookerii S 48% oil 20 kg seed/tree	Hill slopes of Sikkim, Western Ghats, Orissa, Konkan
Dhupa	Vateria indica S 25% oil 100 kg/tree	Western Ghats, Maharashtra to Kerala
Kokum	Garcinia indica S/U 40% oil 40 kg kernel/ tree	Western Ghats, Maharashtra to Kerala
Undi	Calophyllum inophyllum S/U 60% oil 2 tonnes/ha	Western Ghats, Maharashtra to Kerala, Andaman

Local Name	Botanical name/yield	Suggested suitable area for forestation
Nahor	Mesua ferrea 75% Kernel 20 kg oil/ tree	Assam, Himalayas, Western, Ghats, Andaman
Karanja	Pongamia glabra 40% Kernel 20 kg oil/ tree	River streams throughout India

Salvadora oleoides, commonly known as pilu is indigenous to India and is grown on dry and desert areas of Uttar Pradesh, Rajasthan, Panjab, Gujarat and Madhya Pradesh. It is an evergreen shrub which grows to a maximum height of 20 feet.

The tree flowers in March and fruits appear in April/May. The fruits are small berries. The seeds are small with greenish yellow dictyledons. The kernel is about half a centimetre and contains about 40-45 per cent oil.

The oil is green in colour, with a melting point at 41°C and a specific gravity of 0.867. Its iodine value is 5.5 and saponification value varies from 243.1 to 245.2. The fatty acid composition of the pilu oil is given below :

Lauric	21.2%
Myristic	52.9%
Palmitic	18.9%
Oleic	5.9%

The oil is used in soap making and in medicines. The oilcake contains 19 per cent protein and is used as cattle feed. The fat can substitute coconut oil and finds use in various industries.

Scheleichera oleosa (Kusum) is growth in Himalayan forests of Uttar Pradesh, Bihar and also in Orissa. It is a large deciduous tree which flowers during February to April and fruits during June-July. The fruits are green and found and contain a reddish brown seed with very little pulp. The seeds are decorticated and crushed for oil extraction. It contains about 57-60 per cent oil.

The oil is yellowish brown in colour with a meltiing point at about 25°C and with a specific gravity of 0.895. The iodine and saponification values vary in the range 53-60 and 220-234, respectively.

The fatty acid composition is as follows :

Saturated acids	34-42
Oleic	57-67
Linoleic	2-5
Free fatty acid as oleic	7.9
Unsaponifiable matter	1.5-3.0

Actinodaphne hookerii or pisa is grown on high altitudes and moist forests of evergreen type. It is found on lower hills of Western Ghats and also in Orissa.

It is a mall evergreen tree and attains a maximum height of 40 feet. It flowers in December/January and fruits in May/June. The fruits are oval shaped and about half an inch long. The seeds are small with brittle shell. Each tree yields about 14 kg of seed. The kernel contains about 48 per cent oil. The fat has solid consistency and is a good substitute for coconut oil. It is yellowis brown in colour with a strong aroma and has a melting point of 43-44°C. The iodine values vary in the range 8.5-10.9 and saponification value is 257.

As much as 90-96 per cent of the fat is lauric acid. The fat is best for the manufacture of detergents and the oil cake is used as manure or cattle feed.

Vateria indica or dhupa is grown in evergreen and semi-green forests of Western Ghats from Maharashtra to kerala. It is an evergreen tree, with a maximum height of 60 feet. It flowers during March/April and fruits during May to August. The fruits are oval shaped brown and hard and measuring 2.5"x1.5". The seeds are enclosed in the thick shelled pods. The kernel is yellowish cream and contains 22-27 per cent oil.

The oil is a white fat with a melting point of 35°C. The iodine and saponification values very between 36-43 and 187-192 respectively.

The fatty acid composition is as follows :

Palmitic	9.7%
Stearic	40.7%
Oleic	42.2%
Linoleic	2.3%

The oil is used in soap-making and the oil cake is used as a manure.

Garcinia indica also known as kokum is grown on coastal belts and Western Ghats in India. It grows to a maximum height of 60 feet. The trees flower in January/February. The fruits are fleshy and 1.5"-2" in diameter and contain black, ovoid seeds. The seeds contain 40 per cent fat.

The fat is greyish in colour with a melting point of 41°C. The iodine value is 35 while the sponification value is 189.

The fatty acid composition is as follows:

Stearic	52-56
Palmitic	2.5-5.3
Oleic	39.4-41.5
FFA as linoleic	1.7

The oil is used as vaseline and also for soap making.

Calophyllum inophyllum (undi) is found in the coastal area and Andaman Islands. It is an evergreen tree with a thick foliage and grows to a maximum height of 40 feet. The trees flower in March/April and the fruits are set in July/August. The fruits are green in colour and about 2" in diameter. The kernel contains 70 per cent oil. Each tree yields approximately 50 kg of dry fruits. The oil is greenish yellow in colour and has strong pungent smell with a specific gravity of 0.941. The iodine and saponification values vary in the range 82-98 and 192-201, respectively.

The fatty acid composition of the oil is as follows :

Palmitic	15-18%
Stearic	6-12%
Oleic	48-53%
Linoleic	15-24%
Unsaponifiable matter	1.3%

The oil is used in soap and varnish manufacture and in prepation of medicines for rheumatism and skin diseases. The oil cake is a good manure. This is unsuitable for edible purposes due to toxic non-fatty constituents.

Pongamia glabra also known as karanja is found in India, Malaya, Seychelles, Pasific Islands. In India, it grows well in Orissa, Karnataka, Maharashtra, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh and Tamil Nadu.

It is an evergreen tree and attains a maximum height of 50 feet. It fruits twice in a year-during September/October and March/April. The pods are flat eliptic, 3" long and enclose one or two kidney shaped brownish red seed. A mature tree yields 40-60 kg of pods per season. The cotyledons contain 30-40 per cent oil.

The oil is dark-brown in colour with a repulsive odour and a specific gravity of 0.839. The iodine and saponification values vary in the range 83-85 and 183-184, respectively.

The fatty acid composition is as follows :

Lauric	1.6%
Myristic	7.9%
Palmitic	3.7%
Stearic	2.2%
Oleic	62.1%
Linoleic	11.9%
Linolenic	5.0
Unsaponifiable matter	3.8-4.4%

The oil is used for soap as well as for tanning and lubrication. Oil cake is a good manure for oranges and paddy.

Mesua ferrae (nahor) is indigenous to India and Burma. In India it grows in forests of Assam, Himalayas, Bengal, Western Ghats and Andaman.

It is an evergreen straight stemed tree and attains a maximum height of 50 feet. It flowers during February/March and fruits from April to August. The fruits are conical, hard and about 3" in diameter and contain two to three shining brown seeds. The kernel is yellow in colour and contains 75 per cent oil. The oil is slightly viscous and dark-brown in colour with a specific gravity of 0.917-0.936. The iodine value and the sponification value vary in the range 85-89 and 197-206, respectively.

The fatty acid composition of the oil is as follows :

Myristic	1.6%
Palmitic	8.5%
Stearic	10.4%
Oleic	11.2%
Linoleic	66.5%

The oil is used for soap making. Oil cake is rich in nitrogen content and is a good manure.

9.14 PROCESSING TECHNOLOGIES

a) Present Position

The vegetable oil industry in India is characterised by widely scattered production units. These are at all levels of technology from simple, traditional bullock driven ghanis to sophisticated solvent extraction plants. Efforts at improved power driven ghanis. The next phase was the introduction of cagepresses first of manually or hydraulically powered type and then electrically powered oil screw presses i.e. expellers.

About forty years ago came the solvent extraction plants which used the oilcake, still containing oil, that are left after expression in ghanis or in screw presses as their main raw material.

Today, pressing of oilseeds is almost exclusively done by continuous screw presses know as expellers.

The vegetable oilseed processing industry by and large is inefficient. Virtually in all fields of vegetable oils processing their is excessive consumption of steam, power, and energy. It also suffers from non-availability of raw material and has to rely extensively on manual operation which has resulted in reduced efficiency in utilisation of full-capacity as is evident from the following Table.

b) Production Capacity

	No. of units	Installed capacity in million tonnes	Utilisation percentage
1. Ghanis	96,000	N.A.	N.A.
2. Oil Millers (Expellers)	15,000	30.00	30%
3. Solvent Extraction Plants	350	11.00	35%
4. Refineries	100	0.80	30%

c) **Screwpress in Oilseed Processing** (Expellers):

If we are first to look specifically at the screw press, the two ways in which it has been used to expel oil from oilseed are: first as a high pressure operation to low residual oil contents; second as a pre-press operation prior to solvent extraction. Figure 1 shows these two operations. In both cases, the four stages which influence pressing efficiency are: (a) seed preparation (b) cooking (c) screw pressing and (d) separation of solids from expelled oil and return to cooker/screw press. Unless all four steps are properly done good results will not be obtained. In high pressure pressing, the objective is to obtain the maximum value of oil and cake with quality, capacity and running costs. In a pre-press operation, the overall objective remains the same but is based on the output of both press and extractor. Often in pre--press operations the degree of rolling is increased and the degree of cooking reduced.

The oil in the seed is contained in sacs of fibrous capillaries. The application of pressure causes the capillaries to be reduced in volume and the oil to be expelled. But by the same effect the capillaries are narrowed, sheared and eventually scaled by the application of increasing pressure. Even the optimum operation of all four steps, puts a practical limit on the residual oil content that can be obtained by a high pressure screw press.

d) **Types of Expellers**

M/s. Anderson was the first company to manufacture and market a continuous screw press. They introduced four ranges which are dual purpose machine and pre-press expellers. The largest of the machines is used solely as a pre-press prior to a solvent extraction plant. This press uses a single horizontal main worm shaft which runs through 66" long by 12" diameter barrel. The capacity is 200 T/Day. The other well known expellers are Dam-man. Croes, The French Oil Mill Company, Krupp Maschinenfabriken. Simon-Rosedowns and the Stock of Amsterdam.

Design of expellers manufactured in India are almost identical to Anderson or French except for some differences in kettles, location of driving, gearboxes and design of worm assemblies on worm shaft. These expellers are identical in their overall features and construction of worm types, compression chambers, end cone etc. Most of the manufacturers in India are manufacturing expellers with a capacity ranging from 1 T/Day to 50 T/Day.

Over the years the extraction efficiency of expellers has greatly improved with respect to expellers feeding, pressing pressure (as high as 1600 kg/cm^2) and reduction in pressing time. Most of the 15,000 mills (expellers) in India have old generation expellers leaving approximately 8 to 10% residual oil in cake. Expellers made in India suffer from obsolescence of design, high wear and tear of critical components, high power consumption, low extraction efficiency and frequent break downs. This is due to inefficient design, poor manufacturing technology and the use of low grade materials.

In contrast, design of oil Expeller has undergone major refinements in industrially advanced countries since it was introduced in the year 1906 in U.S.A. Modern machines have high oil extraction efficiency with residual oil in cake down to 2.5%. The other technological innovations/refinements are; (a) computer optimized main shaft and worm design; (b) Heat treated alloy steel main shaft and barrel bars, stellite coated worms and collars; (c) Integrated vertical and horizontal bouble chamber design with separate drive motors; (d) water cooled main shifts and cage inserts; (e) Hydraulically actuated/motorised end cone adjustment; (f) centrasised lubrication in gear boxes and antifriction bearings and (g) Double speed worm shart design.

e) Solvent Extraction

The unrecoverable oil by mechanical expression of the oil bearing material can most efficiently recovered by solvent extraction. Batch type and continuous extractors are available. The batch type extractors principally in the form of small units (as low as ½ tonne/day capacity) are used for recovery of pharmaceutical oils or other expensive oils where the tonnage of materials handled does not justify the expenses of installing continuous extractors. However, batch type extractors varying from 2-12 tonnes capacity (generally a veritical cylindrical kettle) are being used in the country for extraction of oilseed cakes and rice bran.

The continuous extractors designed for handling large tonnage of material available today are basically the improved versions of the Bollman of Baslat extractor of the percolation type of the Hilderbrandt or 'U' tube immersion type extractors. The most popular extractor design used today is the percolation type such as Potocel, Lurgi (Germany), CMB (Italy), Anderson (USA), French (USA), Desmet (Belgium), Rosedown and Thompson (England) and Gianazza (Italy). In India, Desmet continuous extractors are popular and are being manufactured within the country. In these plants the residual oil content in the cake is 0.5-0.7%. The range of capacity is 25-500 tonnes/day and most of the plants, particularly soybean processing units are running under capacity utilization. The advances in the solvent extraction have been seen in energy conservation and over increasing size of extraction plants. Solvent extraction process is capital intensive (Rs. 2 million for 25 T/Day plant) and volume is tensive.

f) Refining

The expellers oil is subjected to further processing namely alkali refining for removal of free fatty acids, bleaching for removal of colour and finally deodourization for removal of flavour to obtain a bland oil. In India it is a common practice to consume the ghani and expeller pressed oils like groundnut, mustard, niger and coconut.

Refining is therefore, Limited to most requirements of vanaspati making, certain sections of the population and or handling of solvent extracted oils, which cannot be marketed for edible use without refining. In tropical climates like in India, the expeller pressed oils have better stability compared to refined oils.

g) **Refining Technology**

The conventional process of alkali refining in most Indian plants, results in losses during refining which depend on the type of oil and the FFA content. This is generally a little more than twice the FFA of the oil. The improvement in the alkali refining process constitutes a short mix/continuous process in which the oil is mixed with alkali only for a fraction of a minute and centrifuged. This process reduces the oil loss. This technology is available in the country and has been adopted by some oil processors.

h) **Miscella Refining**

This process also uses alkali for removal of FFA from the oil. However, this differs from the conventional processes in that alkali is added to the solvent oil mixture. The refining losses are low as there is practically no entrained oil in the soap stock. This process in best carried out in the solvent extraction plants where the miscella (solvent-oil mixture) could be first refined prior to removal of the solvent from the oil. At present there are no such plants working in the country. A few plants have been imported for refining of rice bran oil and their performances are still to be watched.

i) **Physical Refining**

This process operates on the principle of distillation of the fatty acids from the oil. The process uses high temperature and low pressure and has not found favour in other countries for the traditional oils. The process has been adopted commercially for his refining losses, One physical refining plant set up for refining of high FFA rice bran oil in Punjab has the problem of extreme darkening of the refined oil. The process has not been found suitable for refining of rice bran oil.

j) **Extraction**

The Alcon Process described by Penk O Lurgi Cmbh, West Germany claims process advantage in extraction of soyabeans which in view of our current interest in soyabean processing may be of interest. In this process the main differences from the conventional process is the interposing additional facilities of a conditioner tempering apparatus drier and cooler incorporated between the preparational unit and the actual extractor. In Principale this aims at the elimination of enzyme activity by intensified moisture, temperature and time treatment. Enzyme activity begins in the soyabean at average temperatures. The processed crude oil is low in phosphatide contents after water degumming with values ranging between. .03%-.05% (10-17 PPM). It is claimed that such crude oils can be delivered directly to the physical refining which means that the bleaching and deodorization including deacidification by distillation are the remaining refining steps. Another advantage was claimed to be a very low loss of hexane. Due to pre-treatment the urease activities of the toasted meal is very low in all cases. The lecithin sludge obtained showed a very low moisture content. The physical refining process is applicable very safely to oil arriving from this process apart from some variation in the consumption of bleaching earth, other utilities such as steam, electric power etc. Practically identical. The flavour, taste storage stability characteristics and other parameters were comparable.

Another Germany Company M/s. Krupp has patented a process (U.S. Patent 4168 May 17, 1977) which has been tried on Canola/Rape Seed Oil in Canada. This is called VPEX Process. In the VPEX process instead of conventional 7 steps starting from seed cleaning conditioning--flaking-cooling-prepress-solvent extraction-desolven extraction, the VPEX process consists of 5 steps viz. cleaning-conditioning-press-splvemt extraction-desolvent extraction. With these modifications, the VPEX was successfully incorporated into this existing operation.

As in the case of extraction of vegetable oils several processes have been described for the weaning of animal fats as tallow. Eearlier there were batches or various continuous extraction processes and the fatty issues from cattle or pig were rendered in a dry process batchwise continuous with the help of various solvent extraction process.

In India slaughter house industry is not very big but recently due to the arrangement of meat supplies to gulf countries, bye-product tallow may be available in larger quantities along with the other bye-products available from animal glands. Two different types of new processes have been installed. In some of these waste heat from the system itself is used and tallow and meal are processed under comparatively low temperature using pre-heaters and low pre-press. These are the Waste Heat De-watering (WHD) of machanical systems. In the WHD systems the material is continuously fed into a low pressure de-watering twin screw prepress which separates the soilid particles and fat and water mixture. The fat/water mixture is directed to the evaporation which is driven by vapours from a drier and evaporated under vaccum. This is a so-called waste heat evaporator. An evaporated liquid is not fed into the drier and mix to the solid from the press. The rest is dried in drier and the fat is removed by high pressure presses.

In the mechanical wet rendering system the materials is pre-broken, pre-heated and pre-pressed and then the solids are directed to the drier and the liquid goes to the evaporating site. It is possible to remove the fat before and after the evaporation. But in any case the fat is removed before the residual liquor which is basically water and the lolid is fed to the drier. The drier acts as a non-fatty particulate solid mixture and produce a low fat content, meal of high quality with high presure presses. Overall the mechanical wet rendering system is slightly better.

Both systems used pre-heaters at 65°C-90°C range. The waste heat de-watering process costs about 50% more than a traditional dry rendering process. However, the good energy efficiency, the qualities of fat and meal allow the return of the cost within 2-5 years. This is a Norwegian Process developed by 'Stored Bartz, A.S. Bergen, Norway'. The firm has introduced 45 such plants in different parts of the world.

k) Physical and alkali refining

Ten common oils including corn, sunflower, canols, soyabean, groundnut, rice bran safflower, coconut, palm kernel and palm have been so compared after being refined by the two processes. While the traditional processing steps in the case of corn oil, sunflower seed oil and canola (rape seed oil) consists of degumming-alkali refining-bleaching-dewaxing and deodorization, in the case physical refining degumming, the steps were bleaching-dewaxing-steam refining-deodorization. While in all other cases colour, stability and various other parameters more or less were comparable but slightly better in the case of physical refining.

The benefits of physical refining compared to the conventional caustic process would be better if crude oil qualities were better. While on the subject of physical refining under Indian conditions one has to take account of the problem of treatment of very high FFA rice bran oils (over 10%-30%) in which of course physical refining after degumming allows recovery of high quantity of fatty acids. However, the oil which has fixed colours and is difficult to remove and the traditional alkali refining and bleaching methods can be resorted to as a further step.

While on the subject of rice bran oil, binary-miscella refining of high acid value rice bran has been introduced as a new approach. There are already 5 such units installed in India-one near Calcutta, three in Andhra Pradesh and one in Punjab. The Calcutta Plant is based on technology supplied by De Smet, Belgium and the other plants are with Japanese (Yashino) Technologies. The processes involved are (1) degumming, (2) solvent dewaxing, (3) binary solvent deacidification, (4) bleaching, (5) deodorization. There is also a single solvent refining process introduced by M/s. Pennwalt India using food grade hexane. In the binary solvent process the solvents are hexane plus alcohol or isopropanol. They both claimed very good process advantages. It is claimed that upto a FFA level of upto 30% a very low refining loss about 1.1 to 1.5 times Wesson loss is achieved. While on the other hand the binary solvent refining process would appear to be attractive, ethyl alcohol, the desired solvent is often scare and its substitute the isoproponol is much costlier. The double solvent process was introduced in Europe under the name 'NEUHI' process as early as in 1955-56 by De Smet and was then only suggested for use in oils having more than 7% FFA.

In the case of rice bran oil in Indian conditions our attention should be diverted more to production of better quality of stabilised rice bran and conversion to huller to sheller mills and if not processed immediately, be subjected to a proven stabilisation process and then use the conventional methods/machineries which are available/manufactured in India.

l) Hydrogenation

Hydrogenation is important to Indian economy as about 1 million M.T. of vegetable oils are used for this process. The parameters of selectivity and trans isomer formation by manipulating with three variants - pressure, temperature and agitation still remain for manipulation. One new development (Hastert, JAOCS, Cannes Proceedings) in the field of equipment has been use of flat bed turbine agitator. One tries to increase hydrogen concentration at catalyst surface by increasing the pressure, temperature and agitation. Increasing the pressure increased the hydrogen concentration at the catalyst surface, and has the effect of increasing the preferential selectivity and transisomer make. Obviously, the rate of reaction is increased in all the three cases.

Since the mode of agitation has not changed appreciable since 50 years there has been little study of mixing techniques which has been shown commercially successful at this time is Buss loop reactor. It employs an injector type nozzle mix on the venturi principle introduced by M/s. Buss Limited Basal, Switzerland.

m) Integrated Expander (Extruder) Technology

Expander Extruder is somewhat like a glorified expeller, but with a difference. The expeller has a long barrel made of hard wearing barrel bars, in which a shaft is mounted with worms of different pitch and depth with an arrangement of knife bars for interruption, for uniform mixing. Plain and tapered collars are also mounted on the shaft at certain intervals and the shaft is rotated by a geared motor. The barrel bars are separated from each other by spacer. At the end of the barrel, there is an arrangement made of cones or jaws, which constricts the orifice between the barrel chamber and the shaft to the desired extent.

n) Pre-press Operation

The speed of the worm shaft plays an important role iin the output of an expeller. Higher the speed, higher is the oil content in the expeller cake. Thus in a pre-press operation, output of the expeller can be increased to 200% to 300% by increasing the worm shaft speed with suitable worm arrangement, moisture and temperature condition, leaving 8% to 15% oil in the pre-pressed cake. This pressed cake is subsequently passed through a solvent extractor, after proper preparation and conditioning to remove the oil in the pre-pressed cake leaving about 0.7% oil in the deoiled meal.

o) Expander

In the case of an expander, the barrel or chamber made out of barrel bars in the expeller is replaced by a solid walled cylinder, diameter and length of which is determined by the capacity for which it is designed.

The shaft rotating in the cylinder is mounted with special type of worms, with an arrangement for interruption for uniform mixing. There is also an arrangement to inject live steam and water into the cylinder at certain predetermined distances from the drive end of the shaft. The cone or jaws are replaced by a die plate which has a number of dies of tapered hole on the inside surface at a certain depth and later the holes are straight upto the outer surface of the die.

p) Distribution of Oil Mills in Eastern Region

There has been an unblanced development of oil milling industry in the Eastern Region. The distribution of oil mills together with the installed capacity in Eastern State can be gleaned from the following table:

Number of Oil Mills together with the capacity in Eastern Region

State	Number of Oil Mills	(In 000 tonnes) Installed capacity (in tonnes of oilseeds) for 300 days/shift
Orissa	66	60
Assam	120	156
West Bengal	605	643
Manipur	12	8
Tripura	10	9
Total	813*	876*

*Source: Directorate of Oilseeds Development: Hyderabad.

The aforesaid table indicates that West Bengal is having the largest number of oil mills in the Eastern Region. The oil mills in West Bengal sprang up on historical reasons. The close proximity to market helped concentration of the oil mills in Calcutta. The initial locational advantages do nor more exist.

The oil mills in the Eastern Region differ in their organisational and structural set up. The number of oil mills in West Bengal is more than 600, the majority of which are essentially small and unorganised. These oil mills work intermittently on account of inadequate local production and uncertain supply of quality oilseeds from other producing States. The inflow of oilseeds from the producing States like Gujarat, Andhra Pradesh, Punjab, Haryana, Rajasthan and U.P. have considerable declined in recent years in view of rapid development of the oil milling industry there. The oilseeds producing States are primarily interested in despatching oils to the Eastern Region, the principal consumers of mustard oil and coconut oil in the country, rather than despatching oilseeds in order to be processed in the local mills. Disproportionate railway freight rate between oilseeds and oils is also a factor working against the interest of the oil milling industry in the Eastern Region. The Central Transport subsidy for N.E.R. area is reported to be not adequate for healthy growth of the industry.

q) Utilisation of Oil Cake for extrection of oil

From the privious data we find that the mazor number of oil mills are located in West Bengal which provide the main production require for the Eastern Region in India. A large quantity of edible oil produced in West Bengal are from the traditional Ghanies. Whatever be the method of extrection of oil from the seeds we loose 7% oil in the oil cake. With the help of improved technology we can extract 5% more oil from the seeds.

Thus we may reduce the gap of 5% with the help of modern technology in the state of West Bengal. There are quite a number of solvent extraction units in and arround Burdwan these plants are mainly utilise for soyabean oil extraction on an experimental basis. Special attention should be given in this sector as modernisation of the oil industry in general has remained stagnated because of inadequate resources of the entrepreneurs and the reluctance of the financial institutions in providing finance to oil milling industry presently heading towards sickness. The state of affairs have come to such a pass that efficient processing and extraction of oils have become very difficult. The situation may go beyond redumption if timely action is not take. It is necessary, therefore, that the process of modernisation of this important food processing sector be speeded up.

The need for doing so has become more apparent for Eastern Region which has not been able to keep pace with even initial modernisation in the past due to lack of raw materials, i.e., oilseeds. Since the picture has now undergone some change and is undergoing a change with the increasing production of oilseeds, the sick oil milling solvent extraction industry of Eastern Region in general and West Bengal in particularrequires a special consideration. The modernisation finances should be made available on soft terms. The financial help to Government/Bank/Privet Investment sould help maintaining the required growth of the oil-based industries and this in turn would help recovered of vegetable oil, presently going wastage due to poor extraction efficiency.

AICOPRO APPROVED TECHNICAL PROGRAMME FOR THE YEAR 1990-91

As per approved programme formulated during the Annual Oilseed Workers' Group Meetings, each of the 61 AICOPRO Centres were assigned specific number of demonstrations to be laid out in their mandate crop/crops under real farm situations to highlight the superior productivity potentials and economics of latest crop varieties, production and protection technologies, proven cropping system involving oilseeds either as sequential, inter or catch crops vis-a-vis prevailing farmers practices in the region. The crop wise break up of demonstrations assigned to various AICOPRO centres in their specific mandate crops are listed in Table IX-47.

A total of 1193 demonstrations (kharif 423, rabi/summer 770) of 0.4 ha each with adjacent plots of local practice were assigned of 61 AICOPRO centres. As many as 356 demonstrations during kharif and 747 demonstrations during rabi/summer were conducted in different agroecological situations. (Table IX-47). The centre wise and crop wise details of implementation of the programme has indicated the successful conduct of 92 per cent of the assigned demonstrations (Table IX-48 to IX-55).

The various categories of demonstrations include (i) whole package orientated demonstrations (ii) cropping system oriented demonstrations and (iii) adaptive trials of component technology.

They yields and economics of varius demonstrations carried out under the project in each of the mandate crops are presented in Table IX-60.

(i) Whole package oriented demonstration

These demonstrations were intended to evaluate the productivity potentials and benefits of improved crop technologies over the previailing farmers practices in different oilseed crops and crop growing situations.

The demonstrations undertaken by the various AICORPO centres under a wide range of crop growing situations clearly point out beyond doubt that the existing per hectare yields and incomes from oilseed crops can be pushed up substantially even with the technology currently recommended. As compared to the local practices prevailing with the farmers, the demonstration plots involving the improved technologies registered additional yield to the tune of 41 to 50 per cent in kharif and rabi/summer groundnut, 44 to 71 per cent in kharif and rabi/ summer sesame, 90 per cent in castor, 63 per cent in niger, 53 per cent in sunflower, 71 per cent in safflower, 64 per cent in linseed and and 50 per cent in rapeseed and mustard.

The results of the past three successive years of demonstrations on oilseed crops have conclusively proved the nenefecial impact of improved technology over prevailing farmers practices (Table IX-58).

In many of the crops the additional investment incurred for improved technology towards input and operational costs is only marginal and the benefits acrued from such investment is substantial. From the data on incremental benefit: cost ratio (BC ratio) it is conspicuous that farmers who resorted to the recommended improved technology realised higher incremental B:C ratios to the tune of 11.18 in kharif groundnut (minimum 1.91, mean 6.65), and 29 (minimum=2.06, Mean=7.40) in rabi/ summer groundnut; 9.00 in kharif sesame (minimum=1.70, mean=3.97) and 6.15 (minimum=1.31, mean=2.92) in rabi/summer sesame; 8.99 in castor (minimum=2.05, mean=3.38), 2.18 (minimum-1.53, mean=1.82) in niger; 7.19 in sunflower (minimum=1.88, mean=4.49), 11.83 in linseed (minimum=1.12, mean=4.33) and 12.92 in rapeseed-mustard group crops (minimum=1.04 and mean=7.69).

Similarly the results of the demonstrations carried out from 1988-89 to 1990-91 have also shown beneficial incremental B:C ratios in all the oilseed crops grown under different agro-climatic conditions (Table IX-58).

(ii) Cropping system oriented demonstrations

In recent years, a number of productive and profitable cropping systems involving oilseeds as sequential and intercropping either interse or with other traditional crops have been identified under the AICOPRO network. Some of the most promising cropping systems have been tested under real farm situations to a limited extent in various oilseed producing states. Some of the systems worth mentioning are: intercropping of safflower with traditional rabi crops such as gram, wheat, linseed and coriander in deccan rabi tract, intercropping of pigeion pea with groundnut (Chintamani in Karnataka) in kharif (rainfed), Torai with Gobhi Sarson in Punjab and Madhya Pradesh. Besides, the preformance of Safflower was also evaluated vis-a-vis one or more traditional competing crops in the traditional safflower growing belt (Karnataka and Maharashtra). The trials to evaluate the productivity potential of safflower in non-traditional areas of Andhra Pradesh and Malwa plateau (Indore) of Madhya Pradesh have been laid out during 1990-91 also. For the first time, the performance of sunflower during spring season in the indo-gangetic plains of Uttar Pradesh was evaluated during the current year.

The relative economics of selected cropping systems are presented in Table IX-56.

Safflower as an intercrop with traditional low yielding rainfed rabi crops such as gram has been successful at all the locations (additional net returns over base crop gram: Solapur 5690 Rs/ha, Annigeri: 1700 Rs/ha, Jalgaon: 834 Rs/ha; Incremental benefit cost ratio Solapur: 11.20 Annigeri: 2.72, Jalagaon 2.76) and wheat (additional net returns over base crop wheat : Annigeri : 1427 Rs/ha, incremental benefit cost ratio=1.56) in karnataka and linseed (additional net returns over base crop linseed at solapur: 5767 Rs/ha, incremental benefit cost ratio= 51.95). Similarly at chintamani (Karnataka), intercropping of pigeonpea with groundnut in 3:1 row proportion yield additional net returns to the extent of Rs.8430/ha over corresponding sole crop of groundnut with an incremental benefit-cost ratio of 3.88

Brassica napus, popularly knows as "Gobhi Sarson" has gained importance as an oilseed crop under assured irrigated conditions of Punjab. Intercropping of Gobhi Sarson with Torai has registered additional net returns of Rs.3040/ha in Bhatinda with an incremental benefit cost ratio of 6.15 over the sole crop of Gobhi Sarson. Similarly at Morena (MP), the combination of Torai + Gobhi Sarson has resulted in additional returns of Rs.5817/ha (IB:C=3.53) in comparison with the sole crop of mustard. In sequential cropping, the torai-wheat rotation was found to be more remunarative (additional returns: Rs.9866/ha, additional cost: Rs.3980/ha, incremental benefit cost ratio=2.48) as compared to growing sole crop of mustard at Morena (M.P.).

According to the available results of the demonstrations of the performance of safflower vis-a-vis other rabi crops both in its traditional areas and in non-traditional areas such as malwa plateau of Madhyay Pradesh and Andhra Pradesh, safflower has been found to be a very remunerative crop under residual moisture conditions as well as under minimal irrigation (Table IX-57) as compared to the other rabi crops such as rabi sorghum, gram and wheat in solapur, wheat in Annigeri, gram in Indore, sorghum, gram and coriander in Tandur.

In recent years, sunflower is gaining increasing popularity as spring crop after potato in several parts of Uttar Pradesh. In order to exploit the full productivity potentials of sunflower, in non-conventional areas such as Indo-gangetic belt, the results of as many as 17 demonstrations under real farm situations have revealed the supremacy of sunflower crop with an average net returns of Rs.3443/ha and a IB:C ratio of 1.88 (Table IX-59).

(iii) Adaptive trials of component technology

Under this programme, the newly developed populations/hybrids of sunflower were evaluated against the existing popular varieties in Akola. The results clearly indicated that the new variety/hybrid alone can contribute to the yield increase to the tune of 12 to 26 per cent with an additional net returning from Rs.1095 to 2626/ha. Thus the choice of a right variety alongwith the recommended practices can boost up the production substantially (Table IX-60).

Table IX-47. Progress of Implementation of Frontline Demonstrations in Oilseed Crops During 1990-91

Sl. No.	Crop	No. of Demonstrations Assigned			No. of Demonstrations Conducted			Percentage implementation
		Kharif	Rabi/Summer	Total	Kharif	Rabi/Summer	Total	
1.	Groundnut	156	144	300	149	126	275	92
2.	Sesame	97	89	186	69	78	147	79
3.	Niger	52	-	52	52	-	52	100
4.	Sunflower	-	57	57	-	43	43	75
5.	Castor	118	-	118	86	23	109	92
6.	Safflower	-	85	85	-	85	85	100
7.	Linseed	-	135	135	-	135	135	100
8.	Rapeseed-Mustard	-	260	260	-	257	257	99
	TOTAL	423	770	1,193	356	747	1,103	92

Table IX-48. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91. (Groundnut)

Sl. No.	Name of the Centre	No. of Demonstrations			
		Kharif 1990-91		Rabi 1990-91	
		Assigned	Conducted	Assigned	Conducted
1.	Aliyamagar	6	5	9	14
2.	Amreli	6	6	9	9
3.	Anand	-	-	5	5
4.	Bhavanisagar	-	-	5	5
5.	Chianki	10	27	-	-
6.	Chintamani	10	10	5	-
7	Chiplima	5	-	10	6**
8.	Dharwad	8	8	7	7
9.	Durgapur	10	13	-	-
10	Jagtial	5	-	10	-
11.	Jalgaon	8	11	7	7
12.	Kimagadj	10	10	5	5
13.	Kadiri	10	10	5	5
14.	Khargaon	6	6	9	9*
15.	Latur	10	10	5	-
16.	Mainpuri	10	-	-	-
17.	Palem	6	5	9	9
18	Rahuri	-	-	5	4
19.	Raichur	4	3	15	24
20.	Sriganganagar	10	9	-	-
21.	Vridhachalam	6	1	15	17
22.	Yellamanchili	6	-	9	-
	TOTAL	146	134	144	126

* Diverted to Raipur Centre
** Out of 6,5 demonstrations were conducted by Bhubaneswar

Table IX-49. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Sesame)

Sl. No.	Name of the Centre	No. of Demonstrations			
		Kharif 1990-91		Rabi 1990-91	
		Assigned	Conducted	Assigned	Conducted
1.	Nagpur	2	2	4	4
2.	Amreli	10	13	-	-
3.	Berhampore	-	1	5	5
4.	Bhubaneswar	10	5	15	20
5.	Gurdaspur	10	10	-	-
6.	Hoshangabad	-	-	15	-
7.	Jagtial	10	-	10	-
8.	Jalgaon	5	8	-	-
9.	Mandore	10	14	-	-
10.	Mauranipur	10	8	-	-
11.	Tikamgarh	10	9	-	-
12.	Vridhachalam	10	-	15	25
13.	Yellamanchili	10	-	-	-
14.	Vellayani	-	-	10	9
15.	Dholi	-	-	15	15
	TOTAL	97	69	89	78

Table IX-50. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Niger)

Sl. No.	Name of the Centre	No. of Demonstrations during 1990-91	
		Assigned	Conducted
1.	Chindwara	10	10
2.	Dindori	10	10
3.	Kanke	18	18
4.	Raichur	4	4
5.	Semiliguda	10	10
	TOTAL	52	52

Table IX-51. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Sunflower)

Sl. No.	Name of the Centre	No. of Demonstrations during 1990-91	
		Assigned	Conducted
1.	Akoda	17	17
2.	Bangalore	10	6*
3.	Coimbatore	10	10
4.	Latur	20	10
5.	Kanpur	15	17
6.	Bhavanisagar	6	4
7.	Ludhiana	15	9
8.	Rajendranagar	15	15
	TOTAL	107	69

*Conducted by Dharwad Centre

Table IX-52. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Castor)

Sl. No.	Name of the Centre	No. of Demonstrations during 1990-91	
		Assigned	Conducted
1.	Dantiwada	10	9
2.	Junagadh	20	15
3.	Mandore	10	7
4.	Palem	25	25
5.	Raichur	20	18
6.	Semiliguda	10	12
7.	Tindivanam	10	10
8.	Darsi	13	13
	TOTAL	118	109

Table IX-53. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Safflower)

Sl. No.	Name of the Centre	No. of Demonstrations		
		Assigned	Conducted	Target for 1991-92
1.	Annigeri	15	15	15
2.	Indore	15	15	15
3.	Jalgaon	15	15	15
4.	Solapur	15	15	15
5.	Tandur	25	25	15
	TOTAL	85	85	75

Table IX-54. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Linseed)

Sl. No.	Name of the Centre	No. of Demonstrations		
		Assigned	Conducted	Target for 1991-92
1.	Berhampore	10	10	15
2.	Chiplima	5	13	-
3.	Faizabad	10	12	15
4.	Gursapur	15	15	15
5.	Kangra	15	12	15
6.	Kanke	5	1	15
7.	Kanpur	15	15	15
8.	Kota	10	9	15
9.	Mauranipur	5	15	15
10.	Nagpur	15	7	15
11.	Raipur	15	16	15
12.	Sagar	15	10	15
	TOTAL	135	135	165

Table IX-55. Centerwise and cropwise progress of implementation of frontline demonstrations in oilseed crops during 1990-91 (Rapeseed-Mustard)

Sl. No.	Name of the Centre	No. of Demonstrations		
		Assigned	Conducted	Target for 1991-92
1.	Bawal	15	6	15
2.	Berhampore	15	15	15
3.	Bathinda	15	15	15
4.	Bhubaneswar	15	15	15
5.	Dantiwads	10	10	15
6.	Dholi	15	11	15
7.	Faizabad	10	13	15
8.	Hissar	15	20	15
9.	Jobner	15	15	15
10.	Junagadh	10	9	15
11.	Kangra	5	8	15
12	Kanpur	15	16	15
13.	Khudwani	15	15	15
14.	Ludhiana	15	15	15
15.	Morena	15	16	15
16.	navgaon	15	14	15
17.	Pantnagar	15	15	15
18.	Shillongani	15	15	15
19.	Sriganganagar	15	14	15
	TOTAL	260	257	285

Table IX-56. Production potential and economics of some promising intercropping systems vis-a-vis traditional cropping systems at different location (1990-91)

Sl. No.	Centre	No. Demns	Seed Yield (kg/ha)			Mean gross returns(Rs/ha)		Net returns (Rs/ha)		Addl. cost over role crop(Rs/ha)	Addl. returns over sole crop(Rs/ha)	B:C ratio
			Intercropping system		Sole crop	Inter cropping system	Sole crop	Inter cropping system	Sole crop			
1.	Annigeri	(4)	Wheat+ 733	Safflower 720	Wheat 938	6115	4688	29075	3392	912	1427	1.56
		(3)	Gram - 500	Safflower 300	Gram 625	6700	5000	3418	2342	624	1700	2.72
2.	Bhatinda	(1)	Toria+ 900	G.Sarson 1400	G.Sarson 1800	18090	15050	14613	12107	494	3040	6.15
3.	Chintamani	(10)	Groundnut+ 1398	Arhar 223	Groundnut 830	16435	8005	10255	4000	2175	8430	3.88
4.	Jalgaon	(4)	Coriander+ 878	Safflower 433	Coriander 1126	12661	11258	10711	9616	308	1402	4.55
		(5)	Gram+ 1030	Safflower 500	Gram 1594	11195	10361	8811	9279	302	834	2.76
5.	Morena	(4)	Tona+ 1800	G.Sarson 825	Mustard 2200	21876	16058	14826	10657	1650	5817	3.53
6.	Solapur	(3)	Gram+ 830	Safflower 861	Gram 1192	13912	8222	10890	5708	508	5690	11.20
		(2)	Linseed+ 370	Safflower 873	Linseed 508	12359	6592	9808	4152	111	5767	51.95

Table IX-57. Production potentials and economics of safflower with other competing crops

Sl. No.	Centre	R/I	Crops		Mean seed yield (kg/ha)		Mean gross returns (Rs/ha)		Mean cost of cultivation (Rs/ha)		Addl. returns over FP (Rs/ha)	Addl. cost over FP (Rs/ha)	Net returns (Rs/ha)		Incremental B:C ratio
			IT	FP	IT	FP	IT	FP	IT	FP			IT	FP	
1.	Solapur	R(2)	Safflower	Jowar	1165	1185	11068	5987	2610	2148	5081	462	3458	3839	11.00
		1(1)	Safflower	Jowar	1215	1320	11543	6635	3010	2523	4908	487	8533	4112	10.09
		1(1)	Safflower	Wheat	2010	1530	19095	6120	3123	3583	12979	460	15972	25376	
		R(1)	Safflower	Gram	1725	1280	16338	8833	2610	3065	7559	459	13778	5768	
		I(1)	Safflower	Gram	1940	1550	18430	10695	3075	3505	7735	432	15357	7190	
2.	Indore	LI (8)	Safflower	Gram	966	530	7876	4600	2699	2424	3278	275	5177	2178	11.98
		R(7)	Safflower	Gram	890	520	7226	4496	2648	2172	2730	478	4578	22324	5.11
3.	Annigeri	1(4)	Safflower	Wheat	1375	2470	12720	10680	2328	6555	2040	3732	9897		
		R(1)	Safflower	Wheat	500	1000	4625	4000	1823	1513	625	310	2802	2487	2.02
4.	Tandur	R(2)	Safflower	Jowar	875	1175	7437	3497	2437	2762	3940	325	5000	735	
		R(3)	Safflower	Gram	988	625	8392	5055	2387	2145	3337	2425	6005	2910	13.79
		R(3)	Safflower	Coriander	475	153	4035	1232	2072	1480	2803	590	1969	248	4.75

Table IX-58. Yield and economics of improved technologies in oilseeds in relation to prevailing farmers practices (1988-90 to 1990-91)

Crop	Number of Demonstrations	Mean Yield (kg/ha)		% increase over FP	Mean cost of cultivation (Rs/ha)		Mean Addl. cost over FP(Rs/ha)	Mean Addl. returns (Rs/ha) over FP	Incremental B.C. RAtio
Groundnut, K,RF	209	1299	910	43	4892	3660	1145	3118	2.48
Groundnut K,I	93	1853	1270	46	6056	4550	1524	4691	2.92
Groundnut, R/S,I	305	2179	1629	34	6705	5631	1508	5672	4.74
Mustard, RF	46	9439	596	59	3244	2038	1170	2505	2.60
Mustard, I	339	1763	1327	33	3371	2780	729	3450	6.66
Torai, I	54	1207	819	47	3306	2610	564	3016	12.46
Toria, RF	34	746	437	71	3008	1825	1142	2826	2.50
Sesame,K,RF	159	589	359	64	2229	1579	687	2272	2.83
Sesame R/S,I	105	810	546	48	3315	2413	923	2681	3.33
Sunflower,R/S,I	82	1445	924	56	5112	3749	1164	3824	2.77
Sunflower K	9	1286	814	58	4056	3289	738	2964	3.61
Safflower RF	40	926	498	86	2135	1256	719	2918	5.18
Safflower LI*	10	1157	830	87	1776	1454	320	3539	10.82
Niger, RF	147	422	249	69	1581	882	715	1418	1.99
Castor RF	45	1295	858	51	3182	2150	954	2268	2.76
Castor I	91	2818	2184	29	5389	4720	655	3953	8.90
Linseed RF	166	560	349	60	2111	1369	742	2144	3.36
Lineseed I	140	938	548	71	3156	1856	1168	3267	3.61

* Limiteted Irrigation to improved plots only

Table IX-59. Demonstrable potentials and economics of spring sunflower (Irrigated) under real farm situation in the indo-gangetic belt : Kanpur (U.P.)

Sl. No.	District	No., of Demns.	Maximum yield (kg/ja)		Mean yield (kg/ha)		% increase over LT	Gross returns (Rs/ha)		Cost of cultivation (Rs/ha)		Addl. reutnrs (Rs/ha) over LT	Addl. cost (Rs/ha) over LT	Incremental B:C ratio
			HT	LT	HT	LT		HT	LT	HT	LT			
1.	Kanpur (Dehat)	12	1400	900	1163	775	50	9763	6583	5919	4055	3180	1864	1.71
2.	Etawah	3	1500	850	1292	800	62	11242	6800	5633	3960	4446	1673	2.66
3.	Fatehpur	1	-	-	1200	820	46	10200	6970	5800	4095	3230	1706	1.89
4.	Farukhabad	1	-	-	1250	780	60	10425	6630	5550	3606	3995	1944	1.95
	Mean	17*	1500	900	1193	782	53	10090	6647	5847	4015	3443	1830	1.88

*Total

HT = High level technology viz., EC 68414, line sowing (45x20 CM), 80N, 60P_2O_5 kg/ha

LT = Low level technology viz., modern, an early maturing variety, Broadcasting and nil or low doses of fertilizer (10N, 30 P_2O_5)

Table IX-60. Productivity potentials and economics of varietal trials

Crop	Centre	No. of Demns.	Variety		Yield (kg/ha)		% increase over FP	Gross Returns (Rs/ha)		Cost of Cultivation (Rs/ha)		Net Returns (Rs/ha)		Additional returns over FP (Rs/ha)
			IT	FP	IT	FP		IT	FP	IT	FP	IT	FP	
Sunflower	Akola	1(2)	BSH-1	EC 68414	1288	1025	26	12875	10250	4050	3863	8825	6387	2626
		1(1)	BSH-1	SURYA	1400	1250	12	14000	1000	4225	4000	9775	600	4000
		1(2)	MSFH-17	EC 68414	729	629	17	6781	5886	4900	4275	1881	1411	1095
		1(1)	EC 68414	MODERN	1125	1000	13	11250	10000	4075	4075	7175	5925	1250