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SUNFLOWER - A POTENTIAL OILSEED IN INDIA

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ABSTRACT

Exploitation of sunflower as an oil crop is not entirely a new idea in India. A number of varieties of sunflower were introduced into the country about 15 years back but the crop did not attract much attention of the research workers due to the low oil content of the varieties (25 % oil) and high susceptibility to virus diseases. Interest in the crop was revived when Russian varieties which reportedly had oil content above 50 % became available.

Four sunflower varieties of Russian origin formed the material for the feasibility trials conducted during the last two years to identify the seasons, areas of adaptability and varieties for different regions of the country. Sunflower could be cultivated practically throughout the year in the Southern States, while in other regions of the country either the June or February plantings gave promising results. The studies revealed that sunflower could be fitted into a variety of cropping patterns in different regions of the country without displacing any major crop. Sunflower appears to have a distinct advantage in dryland agriculture as compared to the traditional oilseeds crops of the country. In oil yield per hectare, sunflower is distinctly superior to other oilseed crops in India.

The suitability of sunflower to increase India's oil production in a short time has been clearly demonstrated. Projects are being implemented commencing from July, 1972 plantings, for the large scale cultivation of the crop within a short period. The aim is to bring about 350 000 hectares under sunflower by 1973-64. Sunflower has a great potential as an oilseed crop in India. To realise the potential fully, seed production under selection pressure to maintain high oil content and improvement in technology relating to sunflower cultivation are receiving high priority.

INTRODUCTION

Exploitation of sunflower as an oil crop is not entirely a new idea in India. A number of varieties of sunflower were introduced into the country about 15 years back but the crop did not attract much attention of the research workers due to the low oil content of the varieties (25 % oil) and high susceptibility to virus diseases. Interest in the crop was revived when Russian varieties which reportedly had oil

content above 50 % became available. Furthermore sunflower appeared suitable to increase India's oil production in a short time. This paper outlines the potential of sunflower as an oilseed in India.

TRADITIONAL EDIBLE OILS OF INDIA

India's chief edible oils are groundnut, rapeseed, mustard and sesamum. Groundnut is the most important among the three, as its acreage exceeds the combined acreage of rapessed and mustard. The area and production of these three crops during 1970-71 is given below :

Crop	Area (in '000 ha)	Production (in '000 tonnes)	Net oil availability
Groundnut	7 293	6 065	1 350
Rape-mustard	3 331	1 963	614
Sesamum	2 449	568	180

Until July, 1964, oil seeds and their products constituted one of the most important items of agricultural commodities exported by India. Groundnut and its products constituted the major share of oilseeds exports. During the year ending April, 1964, India exported 37 000 tonnes of groundnuts, 97 000 tonnes of groundnut oil and 802 000 tonnes of groundnut meal valued at nearly Rs 400 millions. However, from July, 1964 the exports of edible oilseeds and oils had to be banned because of increased internal demand resulting from improvement in the standards of living, increase in population and the growth of the processed vegetable oil industry. Therefore, in recent years, India has had to import vegetable oils like soybean and sunflower and tallow to the extent of 100 000 to 200 000 tonnes annually.

The consumption of edible oils in India is either directly as coocking media or in the form of a hydrogenated product called "vanaspati". A decade ago, the usage of groundnut oil in the manufacture of vanaspati constituted about 88 % while the rest was made up of cottonseed oil and sesamum oil. The vanaspati industry has made rapid strides during the last 10 years, its production having increased from 341 193 tonnes in 1961 to 558 478 tonnes in 1971. The proportions of different oils used in the manufacture of vanaspati during 1970-71 were :

Groundnut oil	65 %
Soybean oil	15 %
Cottonseed oil	14 %
Sesamum oil	6 %

REQUIREMENTS OF EDIBLE OILS

It is estimated that the requirements of edible oils for vanaspati manufacture as well as for direct use by 1974 will be of the order of 2,5 million tonnes. Efforts are being made to increase the domestic production fo the three major edible oils and also increase the availability of cottonseed oil by encouraging larger crushings. Nevertheless the rapid increase in demand, the need to build up the oil economy of the country on a self-supporting basis necessitated the identification of a suitable non-traditional oil crop which could be successfully cultivated in the country and which could significantly augment the vegetable oil supplies in a short period.

The choice of a suitable crop to meet the demand for edible oils in the country depends on how best the crop could be adapted to the special conditions under which it has to be developed. Taking into account the fact that India already raises a variety of oilseed crops and that there is great pressure on land to meet the increasing needs of several agricultural crops, a potential oilseed crop would have to fulfil the following requirements :

1 - It should be early maturing facilitating its inclusion in multiple cropping patterns so that least disturbance may be caused to other crops.

2 - It should thrive successfully under a wide range of soil and climatic conditions, particularly under dry farming conditions.

3 - The oil yield per hectare should be high as compared to traditional oilseed crops.

4 - The quality of oil should be superior to that of most other oils from the nutritional point of view and it should be qualitatively suitable for manufacture of vanaspati.

FEASIBILITY TRIALS WITH SUNFLOWER

In September, 1969 four varieties of Russian origin, namely :

1. Vniimk,
2. Peredovik,
3. Armavirskj,
4. Armaverts,

were obtained from USSR. These along with an earlier introduction, namely, "Sunrise Selection" formed the material for the initial feasibility trials on sunflower in the country. About 100 feasibility trials on sunflower have been conducted by the All India Coordinated Research Project on Oilseeds, the Dryland Agricultural Project an the Agricultural Universities to identify the seasons, areas of adaptability and varieties for the different regions of the country. The research work was supplemented by a large number of demonstrations of 1/2 hecatres each laid out on farmers' fields during 1971. The results of these trials which are outlined below have amply demonstrated the potential of sunflower as an oilseed in Indian agriculture.

SUITABLE SEASON FOR SUNFLOWER

Agriculturally speaking, there are two main cropping seasons in India, namely, the kharif (June-Sept.) and rabi (Oct.-Apr.). The kharif season is the most important for cropping because it is the south-west monsoon period during which 75 % of the precipitation for the whole year is received. The season is characterised by long days. The rabi season coincides with the winter and early summer month and receives about 25 % of the total rainfall of the year due to north-east monsoon. In certain areas of the country, as in the south, where climatic conditions are favourable for raising a crop throughout the year (the winter temperatures do not normally go below 10°C), the sowings during the rabi season may continue October through February and the seasons are further differentiated into rabi and summer seasons. The temperature conditions during the different seasons of the important regions of India are described belows :

Region	Season	Temperature	
		maximum	minimum
Southern	Kharif	27 - 34	18 - 25
	Rabi/summer	27 - 32	10 - 19
Western	Kharif	31 - 37	21 - 25
	Rabi/summer	28 - 35	8 - 21
Eastern	Kharif	30 - 37	22 - 27
	Rabi/summer	27 - 34	9 - 17
Northern	Kharif	34 - 39	20 - 27
	Rabi/summer	21 - 34	1 - 17

Since India is a vast country, the above climatological data are only broad indications and there are variations in climate within each region described above. The feasibility studies with sunflower were conducted in all the three seasons, namely, kharif, rabi and summer in 11 States in the country. The average yields of sunflower in the three seasons in the different States are as follows :

Average sunflower yields in kg/ha in three seasons at different States

State	Season		
	Kharif June-July to Sept.-Oct.	Rabi Oct.-Nov. to Jan.-Feb.	Summer Feb.-March to May-June
SOUTHERN			
1. Tamil Nadu	1 364	1 836	716
2. Mysore	1 383	-	792
3. Andhra Pradesh	733	1 737	1 387
WESTERN			
4. Maharashtra	1 124	1 098	-
5. Madhya Pradesh	932	791	-
6. Gujarat	1 075	2 037	-
NORTHERN			
7. Rajasthan	1 404	-	1 250
8. Uttar Pradesh	481	1 243	2 490
9. Punjab & Delhi	176	863	-
EASTERN			
10. Orissa	320	-	-
11. West Bengal	716	1 638	1 714

The above results show that in the southern States sunflower could be cultivated practically throughout the year. It was also observed that the maturity period of the different varieties did not vary much in the different seasons, the range being 71-100 days in all the seasons. In the case of Western and Northern States, the kharif and summer season, respectively, appear to be optimum. Though October-November planting also gave good results in some areas, it was observed that the maturity period of the crop was prolonged up to 169 days, probably because of the low temperatures in the winter season, as compared to 90 to 115 days in the kharif and summer seasons. In regard to the eastern region, adequate number of trials were not conducted to draw definite conclusions but the indications are that the rabi and summer seasons might be more suitable. The low yields in kharif seasons might be due to the fact that in the areas where the trials were laid out, the season is marked by heavy rainfall.

VARIETIES

The varietal performance in the different States shows Vniimk, Peredovik and Armavirskj-3497 as the suitable varieties for the southern States. For the northern States, Vniimk and Armavirskj which were of 125 days duration were found best for January planting and Armaverts - a variety of 80 days duration was found suitable for April planting. For the Western States, Vniimk appears to be the best variety.

POTENTIAL AREAS

SOUTHERN REGION

The Southern States appear to be the most potential areas for the rapid development of the crop as the yield levels during all the three seasons may be considered satisfactory. Moreover, the time taken for maturity by the crop (about 100 days) facilitates its inclusion in multiple cropping patterns. However, the yields of irrigated sunflower during the rabi and summer seasons are not high enough to stand competition

with irrigated groundnut and hybrid jowar which yield 2,0 and 4,0 tonnes, respectively, per hectare. Sunflower may have an edge over groundnut, if the price is higher but as of today, there is near parity in the prices of both sunflower and groundnut which is about Rs 1 300 per tonne. Until such time as necessary skill and technology is developed to take sunflower yields beyond two tonnes per hectare, its potentialities lie as a rainfed crop in the kharif season.

In the kharif season, the distinct advantage of sunflower appears to be its superior productivity under conditions which are not optimum for groundnut cultivation. Trials conducted at various locations under the All India Coordinated Research Project and Dry Land Agriculture during monsoon season of 1971 have shown that sunflower out-yielded groundnut at all locations as demonstrated by the data given in the following table :

Crop	Yield in quintals per hectare						
	Bijampur	Rajkot	Akola	Anantpur	Hyderabad	Jodhpur	Mean
Sunflower	6,0	10,7	11,1	7,5	7,4	6,3	8,2
Groundnut	4,0	4,7	5,2	5,9	4,3	4,1	4,7
Sesamum	2,0	1,3	2,6	2,9	2,6	2,3	2,3

A study on plant population density carried out at the Hyderabad Centre of the All India Coordinated Project for Dry Land Agriculture using variety Armavirskj of Russian origin threw some interesting light on yield stability of the crop at different densities. It appears that sunflower population between 56 to 98 thousand plants/hectare will minimise the risk of crop failure during subnormal years while giving nearly maximum yields during normal years. Plant populations between 18 to 32 thousand/hectare have shown fairly constant yield with an average production of 912 kg grain/hectare. The highest yield of 1 478 kg/ha was obtained at 67 000 plants/hectares indicating the possibilities of planning crop mixtures with the assurance of a reasonable yield. This interesting feature needs to be ascertained for other varieties of sunflower.

In addition to this, its suitability in dry land agriculture, sunflower could be a strong competitor to groundnut in certain situations. Groundnut yields are adversely affected when the rainy season is short or when the crop is sown late because of delayed monsoon. Drought in later stages of the crop not only results in poor pod formation but also poses a harvesting problem. Under such conditions, sunflower will be a more profitable crop. Further, groundnut does best on light soils only and black soil areas where a low economy groundnut crop is at present raised could be diverted for sunflower. Sunflower could also be a good substitute for horsegram (Dolichus biflorus) and bajra (Pennisetum typhoides) in marginal lands.

NORTHERN REGION

In the northern States, where the January-February plantings seem to be optimum, there are several situations where sunflower could be a distinctly advantageous crop. These are outlined below :

1 - Toria (Brassica campestris var. toria) and wheat constitute a two crop rotation in some parts of this region. Toria is generally planted after August, 15 and comes to harvest by end of December. The optimum time for planting wheat is November and delaying the planting till January is reported to reduce yield to 2,0 tonnes per hectare as against the normal yield of 3,5 tonnes per hectare. Therefore, farmers harvest toria earlier than it should be with the result that the optimum yields of toria are not realised. It is considered economic to harvest toria when it is fully mature and raise sunflower instead of wheat in January. Though sunflower yields might be slightly lower than that of wheat, the price advantage being with sunflower (Rs 1 300,00 per tonne as against Rs 760/of wheat), toria-sunflower rotation would fetch more income than toria-wheat.

2 - Sunflower can follow potato after the latter is harvested in February. It can also be planted as an inter-crop in sugarcane.

3 - Experiments conducted at the Agriculture Research Institute, Kanpur by planting sunflower at the end of March after harvest of wheat also gave encouraging results. Armaverts - a variety of 80 days duration - was found to be suitable and it gave an average yield of 2,5 tonnes per hectare.

4 - Sunflower can be introduced in low rainfall areas and can also substitute low yielding kharif crop, bajra.

WESTERN REGION

In the western States, sunflower is expected to get established as a choice crop for the low rainfall regions. In medium black soils with high moisture retention capacity, the crop had done well giving 1,6 tonnes per hectare with barely 750 mm rainfall.

EASTERN REGION

In the Eastern States, the feasibility trials conducted so far are too few for drawing definite conclusions on the prospects of sunflower in this region of the country.

FERTILISER REQUIREMENTS

There have not been many fertiliser experiments so far though a number of them are planned for the future. The response of sunflower variety Sunrise to three levels of N (0, 30 and 60 kg/hectare) and three levels of P and K each (0, 60 and 120 kg/hectare) was examined. The crop was raised during kharif and protective irrigation given when necessary. The response to N was linear and significant as will be seen from the data given in the following table :

N dose (kg/ha)	Seed yield (q/ha)
0	14,9
30	17,3
60	20,6

There was no response to either P or K or any of the N, P and K interactions. Response to P and K may, however, vary depending on soil type. Total uptake and rate of N and P uptake were also studied at three stages of the crop, 21 and 52 days after germination and at harvest (87 days). The rate of N uptake was maximum during the period 83 to 87 days. Therefore, application of nitrogen during flowering appears desirable.

In another experiment, placement and broadcast application of fertilisers were compared. It was found that broadcast application promotes root development in the superficial layers of soil. Under dryland conditions such a condition is decidedly a disadvantage as the plants with a superficial root system will be more adversely affected by drought.

OIL YIELD PER HECTARE

If any crop is to be successful as an oilseed crop, it is obvious that the oil content of the seed as well as the oil yield per hectare should be high as compared to the already established oil crops. Sunflower compares very favourably with other oilseed crops of India as the follow table would show :

Crop	Yield in kg/ha	Oil % (expeller)	Oil production/ha	N° of days
Groundnut (in shell)	800	30 %	240	100 - 120
Rape-mustard	590	30 %	177	150 - 170
Sesamum	230	45 %	104	90 - 100
Sunflower	900	35 %	315	90 - 110

It would be seen that sunflower leads both in total oil yield per hectare and in per day production also. It has a close competitor in groundnut but the latter suffers severely when the rainy season is short or when sown late because of delayed monsoon and the oil yield from groundnut would naturally be much lower under such conditions.

CONCLUSIONS

The results of the exploratory trials conducted on sunflower during the last two years in the country and the already known facts about the crop lead up to the following conclusions :

1 - Sunflower can be grown successfully with satisfactory yield levels practically in all regions of India and on a variety of soils. With extra skill developed after intensive agronomic exploration of the crop, yield levels of the crop could be further increased.

2 - In oil yield per day and per unit area, it compares very favourably with the traditional oilseeds of the country.

3 - It can be main oilseed crop of the country, particularly in the scarce rainfall areas, where it might replace a traditional oilseed or other grain crop which at present give low economic returns.

4 - Sunflower can be raised as a catch crop in the existing rotation patterns in view of its short growing period and photo-insensitivity or it can be inter-cropped with another crop of slow growth rate. Areawise, the potentialities for sunflower development are, therefore, very large.

5 - The seed rate being low, the area under the crop could be rapidly increased.

6 - Sunflower seed will be a welcome raw material for utilising the capacity of the oilseed crushing industry of the country to the fullest extent.

7 - Since sunflower could be cultivated in all the three seasons, it will help even the arrivals of the production in to the market and minimise price fluctuations from season to season and stabilise the oil economy.

8 - Sunflower oil is already being used in the manufacture of vanaspati in the country. A preliminary survey has indicated that sunflower can easily replace any other cooking medium available in the country. The oil being a high quality edible oil, consumer acceptability is expected to present no barrier.

Keeping all these facts in view, India is going ahead with plans for large scale cultivation of the crop within a short period. Projects have already been implemented to bring about 160 000 hectares under sunflower during the current agriculture year 1972-73 and 350 000 hectares during 1973-74.

FUTURE THINKING

From the data presented above, it appears certain that sunflower could become an important oilseed crop in Indian agriculture. However, whether the initial momentum gained in favour of the crop will be sustained would depend a good deal on the oil content of seed and maintenance of high yield levels beyond 1 000 kg per hectare under rainfed conditions. It is hoped that yield levels would tend to increase in due course with a better understanding of the crop and improvement in technology relating to sunflower cultivation. No less important would be the maintenance of oil content of seed above 50 % as it is this attribute of the Russian varieties that has revived interest in sunflower crop. Top priority for seed production under selection pressure is the current thinking.

Yield is a very complicated concept, but from the experience gained so far in sunflower cultivation,

the following topics have been identified as deserving immediate considerations :

1° - A high incidence of hollow and incompletely filled seed was observed in most sunflower plots all over the country. Experiments will be planned to approach this problem from following considerations :

1 - Présence of insect pollinators with particular reference to temperature and insecticides ;
2 - Micronutrient deficiency ;
3 - Correlation with size of head ;
4 - In-breeding degeneration ;
5 - Self-incompatibility.

2° - Fertiliser-cum-population density trials separately for irrigated and dry land conditions would be undertaken. The possibility of improving the efficiency of the fertiliser through placement and split application in relation to the stage of the sunflower plant, will be explored with particular reference to dry land agriculture.

3° - The sunflower material now being handled are heterogenous populations rather than varieties. These will be evaluated and uniformity with respect to plant height, maturity and oil content will be aimed at. Enriching the germ plasm, collection building up synthetics, hybridisation and disease resistance programms will receive attention under a separate research project for sunflower.

4° - Though pest and disease problem is not severe at present, a build up of pests is not unlikely as area increases because several pests including Heliothis armigera, Prodenia litura, Aphis gossypii, etc... have been noticed. Plant protection schedules against these will have to be formulated.

5° - Studies on seeding methods, effect of seed size on seedling vigour and competition, seed size and oil content, intercropping, nutritional requirements for each soil climatic zone and critical stages in relation to moisture stress will be taken up.

6° - Since sunflower oil will be largely used for the manufacture of the hydrogenated production called vanaspati, breeding for varieties high in cleic acid content will be attempted so that hydrogenation costs are reduced. Studies alos will be taken up on influence of temperature on oil quality with special reference to different seasons of cultivation of sunflower.

7° - Research on fabrication of implements for seeding, threshing and grading will be strengthened.

Itwill be seen from the above discussion that sunflower has a great potential as an oilseed crop of India but to realise the potential fully and stabilise the oil economy of the country with the help of sunflower is a challenge which agricultural scientists of my country are getting ready to meet.