REPORT
ON
OIL SEEDS PRODUCTION STRATEGY
FOR
PAKISTAN

MAY 1977

GOVERNMENT OF PAKISTAN
MINISTRY OF FOOD & AGRARIAN MANAGEMENT
ISLAMABAD

FOREWORD

A meeting was held under the chairmanship of the Additional Secretary (Mr. S.K. Mahmud), Ministry of Food and Agrarian Management, on February 18, 1977, to discuss oilseed situation in the country. A Working Group was accordingly appointed to prepare a strategy. The Working Group was advised that its report should be submitted within two months to the Ministry for consideration by the Consultative Group. This constitutes our final report.

The Working Group developed its own guidlines and report format. There are six short chapters giving a condensation of the Group's studies and recommendations. Detailed treatment of some items and oilseed crops is given in appendices. The draft report of the Working Group was considered by the Consultative Group on May 6, 1977 and the suggestions made by the members have been incorporated while preparing this report.

In chapter 6 dealing with implementation of the Oilseed Strategy, we have given work units only, and have not assigned titles nor have we calculated personnel and equipment needs in detail. Those can be calculated later.

As Chairman of the Working Group I wish to thank the Committee members, Mr. Salim J. Malik, Mr. Dost M. Sandila, Dr. Dilawar A Khan, and Dr. Rafiq Ahmad for their assistance in the preparation of this report. Since I left for the University of California on May 10, the task of finalising the report was handled by Mr. Salim J. Malik and Dr. Dilawar Ali Khan.

Paul F. Knowles
Chairman

SUMMARY

National edible oil requirement on an average has been increasing by more than 50,000 tons annually over the last five years reaching the level of 487,000 tons in the year 1976-77. Further requirements are expected to grow even faster. Assuming a population growth of 3% and income elasticity of demand of 0.7% for edible oils, Pakistan's requirements are expected to be close to 824,000 tons by the year 1984-85.

The domestic production of edible oils, of both vegetable and animal origin, has been rather stagnant. Cotton, the major oilseed crop (though grown mainly for its fibre), has suffered serious set-backs, and production has been quite erratic. The performance of other established oilseed crops, namely rapeseed and mustard, groundnut and sesame, has not been encouraging either.

Production of edible oilseeds in Pakistan was reported to be 1,506,000 tons in the year 1976-77 and is expected to increase to 3,001,000 tons by the year 1984-85. Under this consumption and production situation, the deficit is likely to increase from 298,000 tons to 892,000 tons. Valuing this deficit at the average weighted import prices of soybean and palm oil for the period April-June, 1977 ($ 658), the foreign exchange cost of the necessary imports will rise from $196 million in 1976-77 to $261 million by year 1984-85.

Considering the many choices of crops that are available, and the wide range of crop environments that Pakistan is endowed with, possibilities of meeting national edible oil requirements from domestic sources are promising. Production of indigenous vegetable oilseeds like cottonseed, rapeseed and mustard and groundnut offer considerable scope for further expansion. Yield improvement and acreage expansion can be achieved by guaranteeing attractive prices, to the growers and by making them available the certified seed and other inputs.

New oilseed crops namely, sunflower, safflower, and soybean have been successfully field tested in all the provinces of Pakistan under irrigated as well as barani conditions Given the yield potentials under diverse ecological conditions and their adjustability into our cropping system, sizeable increase in our domestic edible oil production can be realized through the extended popularisation of these crops. The growers can be induced to produce these crops by providing them with inputs and technical know-how, attractive prices and an assured market. Our economic analysis indicates that the price structure of the new oilseed crop attractive to the growers is :

Sunflower	Rs.110 per maund
Safflower	Rs.100 per maund
Soybean	Rs.100 per maund

The existing processing and extraction efficiencies are dismally low and are resulting in losses of around 50,000 tons of oil annually. Substantial increase in the recovery of oil is possible by modernising and utilizing the solvent extraction plants. Rapeseed and mustard seed can further add up to the domestic availability of oil for hydrogeration provided the oil from this seed is processed by the latest direct filtran method.

The introduction of new crops however is an extremely difficult task. These are several technical, economic and sociological barriers involved. In view of this there is a need to set-up an oilseed production and development division within the FECC to implement the proposed strategy.

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CHAPTER 1

VEGETABLE OIL SITUATION

In Pakistan the critical vegetable oil situation is a conse-quence of an increase in total consumption far greater than increases in production. The need to import vegetable oil in increasing amounts is imposing a severe drain on the supply of foreign exchange.

Consumption

Consumption of vegetable oil in Pakistan is increasing rapidly. Growing population, expanding urbanization, increases in household incomes, and the high prices and limited availability of animal fats are considered as the major reasons for this upsurge. Consequently national edible oil requirements on an average have been increasing by more than 50,000 tons annually over the last five years reaching the level of 407,000 tons in the year 1976-77. Per capita consumption of vegetable oil has risen to 6 kg per annum by the year 1976-77 bringing it to a comparable level with countries in similar development stages. But in comparison with the per capita consumption of edible oils achieved in the developed world Pakistani consumers stand far behind (Table 1.1). Future requirements are expected to grow even faster. Assuming a population growth of 3% and income elasticity of demand of 0.7% for edible oils, the national consumption requirements are expected to be close to 824,000 tons by the year 1984-85, giving a per capita consumption of 8 kg per annum. As shown in Table 1.2, requirements of crude vegetable oil will increase from 525,000 to 892,000 tons over the 1976-77 to 1984-85 period.

Production

Pakistan has very few oilseed crops that are grown commercially (Table 1.3). Most important is cottonseed followed by species of the mustard family including raya, toria, sarson and taramira. Groundnut and sesame are consumed mostly as seed and yield essentially no oil. Castor and linseed are minor crops, and other oilseed crops are grown on an experimental or semi-commercial basis. Details of production of established crops are given in Chapter 2 and in separate appendices.

Table - 1.1: Per capita consumption of food fats and edible oils - An international comparison.

(Kg/capita/year)

Country	Vegetable oils	Animal fats	Butter	Total	Invisible fats	Total food fats
India	3.9	0.3	0.8	5.0	5.6	10.6
Pakistan	6.0	-	3.4	9.4	6.3	15.7
Iran	5.8	1.1	1.4	8.3	5.9	14.2
Sudan	6.1	0.4	0.9	7.4	14.0	21.4
Turkey	9.2	0.2	2.5	11.9	10.3	22.2
Malaysia	8.0	1.3	1.0	10.3	7.5	17.8
Sweden	11.4	3.2	5.1	19.7	26.3	46.0
Canada	9.7	6.3	5.8	21.8	32.8	54.6

Source: Adapted from FAO, Commodity Policy Study on Oilseeds, Edible Oils, Oilcakes and Meals, Table - 5, Page 58. For Pakistan the figures in this table relate to the year 1976-77 and in the case of other countries for the year 1970-71. There has been no significant change in the per capita consumption of edible oils and fats in Pakistan over the 1970-71 to 1976-77 period.

Table - 1.2: Projected national requirements of edible oils, 1976-77 to 1984-85 (000s of tons)

	1976-77		1984-85	
	Oil and fat as consumed	Crude vegetable oil needed	Oil and fat as consumed	Crude vegetable oil needed.
Vanaspati	367	403	628	690
Refined vegetable oil	37	39	109	115
Crude vegetable oil	83	83	87	87
Total	487	525	824	892

Source; FAO Commodity Policy Study, Appendix I, Table - 7.

Table 1.3: Acreage and production of oilseeds in Pakistan (Acreage in 000s, and production in 000s of tons).

Crop	Acreage 1970-71 to 1974-75*	Acreage 1974-75	Production 1970-71 to 1974-75*	Production 1974-75	Production of oil 1970-71 to 1974-75*	Production of oil 1974-75
Rapeseed and mustard	1,203	1,116	275	244	93.5	83.0
Groundnut	90	100	51	56	23.0	25.2
Sesame	78	56	10	8	4.0	3.2
Soybeans	5	2	1	-	-	-
Sunflower	2**	-	1*	-	-	-
Cottonseed	4,733	5,019	1,277	1,248	166.0	162.2
Total edible oilseeds			1,615	1,556	286.5	273.6
Castor	14	3	2	1	-	-
Linseed	20	20	4	4	-	-
Total industrial oilseeds			6	5	-	-
Total all oilseeds			1,621	1,561	286.5	273.6

*5-year average, 1970-71 to 1974-75.

**4-year average, 1970-71 to 1973-74

Source: Agricultural Statistics of Pakistan, 1975. It is assumed that all oil is extracted from oilseeds in the following amounts: cottonseed (13%); rape and mustard (34%); groundnut (45%); and sesame (40%).

Yields per acre of all oilseed crops including cottonseed are low (Table 1.4). There has been only a slight increase over the last 25 years.

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Table 1.4: Yields of oilseeds (in maunds/A) over a 25 - year period in Pakistan.

Crop	Yields - (5 years' Averages)				
	1950-51 to 1954-55	1955-56 to 1959-60	1960-61 to 1964-65	1965-66 to 1969-70	1970-71 to 1974-75
Rapeseed & mustard	4.1	4.7	4.9	5.2	5.8
Groundnut	-	10.2	14.0	15.3	15.4
Sesame	3.1	2.7	2.9	2.8	3.5
Cottonseed	4.6	4.6	5.5	6.3	7.3
Castor	-	3.3	1.6	2.4	3.9
Linseed	5.7	5.8	5.8	5.1	5.4

Source: Agricultural Statistics of Pakistan, 1975.

On the whole domestic production of edible oils, of both vegetable and animal origin, has been stagnant. Cotton, the major oilseed crop (though grown mainly for its fibre), has suffered serious set-backs, and production has been rather erratic. With the exception of 1971-72 and 1972-73 crops, cotton production has been running well below targeted levels. The year 1976-77 can be called the disaster year as production dipped down to the record low level of 21-22 lac bales, thereby giving cottonseed production of around 800,000 tons. The performance of other established oilseed crops, namely rapeseed and mustard, groundnut and sesame, has not been encouraging. Failure to move the production of oilseeds (excepting cottonseed) off of a plateau, in spite of the Nation's need for vegetable oil, suggests that there are important constraints to increased production. These constraints are dealt with separately for each crop in appendices. The more important of these constraints, which do not apply equally to all oilseeds, are:

1. Unavailability of good quality seed of improved varieties.
2. Inadequate control of pests.
3. Generally low and unstable prices.
4. A fixed price for vegetable oil to be used in the manufacture of vanaspati ghee which imposes a ceiling on the prices paid for oilseeds.
5. Uncertain markets for new oilseed crops.
6. Lack of knowledge on the part of farmers regarding the agronomics of new oilseed crops.

Government is putting major emphasis on increasing production of edible oils by adapting measures that include increased use of better quality seed, fertilizer and pesticides. New oilseed crops are also being introduced. The supply expansion program laid out in the 5th Six Year Plan (Table 1.5) places major reliance on cotton and rapeseed and mustard crops. Cotton production is targeted to increase by more than 90% and rapeseed and mustard by more than 100%. The production of other traditional oilseed crops is also contemplated to increase sizeably but, due to their limited scope in total oilseed production, the increase will have only nominal significance. Emphasis on new oilseed crops including sunflower, safflower and soybean is another important element of government strategy for increasing vegetable oil production in the 5th Six Year Plan. Our estimates show that the production of edible oilseeds with the contemplated improvement programs will only increase from 1,506,000 tons in the year 1976-77 to 3,001,000 tons by the year 1984-85. After allowance is given for seed, human and animal consumption and wastes, net availability of edible oilseeds for oil production will move from 1,243,000 tons in 1976-77 to 2,516,000 tons by the year 1984-85. With the existing extraction and processing efficiencies, the recovery of edible oils from the available oilseeds will increase from 227,000 tons in 1976-77 to 495,000 in 1984-85 (Table 1.6).

Table 1.5: Production & Availability* of oilseeds for oil production, 1976-77 - 1984-85 (000 tons).

Oil Seed Crop	1976-77 Production+	1976-77 Availability for oil production	1984-85 Production+	1984-85 Availability for oil production
Cottonseed	1,154**	981	2,131	1,854
Rapeseed & Mustard	260	234	512	461
Groundnut	72	11	115	29
sesame	10	8	13	10
Other oilseeds (sunflower & safflower)	10	9	180	162
Total:	1,506	1,243	3,001	2,512

Source: 5th Six Year Plan and Commodity Policy Study.

* Availability has been worked out after taking into consideration deductions for seed, human and animal consumption & wastes as per table II, page 65 in the Commodity Policy Study.

\+ Targeted production. Production projections beyond 1982-83 are based on the assumption that the 5th Plan period growth rates for various oilseed crops will be maintained through the year 1984-85.

** The actual production is reported to have declined to 800,000 tons due to severe damage to cotton crop by excessive rains, floods, and insect pest infestation. It is expected that similar set backs will not reoccur in the near future.

However, the realization of the targeted increase in supply is heavily dependent on the performance of cotton which is highly susceptible to environmental factors. Although rapeseed and mustard are less affected by changing environmental conditions, the targeted increase will require major increases in incentives and inputs.

Table -1.6: Production targets for edible vegetable oil 1976-77 through 1984-85 (000 Tons).

Crop	Edible Oil Production *	
	1976-77	1984- 85
Cottonseed	137	265
Rapeseed & mustard	80	166
Groundnut	4	10
Sesame	3	4
Other oilseeds (sunflower, soy/bean and safflower)	3	50
Total:	227	495

* Extraction rates as per Table 1.3.

Table - 1.7: Foreign exchange cost of the projected edible vegetable oil deficit (millions of US dollars).

Period for which the import prices considered.	Price/ton **	Year	
		1976-77	1984-85
Average weighted im[illegible] prices [illegible] pal[illegible] so[illegible] [illegible]ean [illegible] Jan. [illegible] 197[illegible]	$ [illegible]	134	179
Average [illegible]ighted import prices of palm & soy/bean oil April-June, 1977.	$ 658	196	261
Quantities of vegetable oil deficit (000 Tons).		298*	397

* Due to severe damage to cotton crop, the cottonseed production is reported to be around 800,000 tons, Consequently, the edible oil deficit in this year will be no less than 340,000 tons.

**In these calculations, the palm oil and the soy/bean oil prices have been assigned 60 and 40 percent weights respectively.

Assuming that the supply expansion programmes are fully realized, the gap between projected demand and supply will continue to grow. The difference in 1976-77 between consumption (525,000 tons) and production (277,000 tons) is 298,000 tons --- it would not have been above 200,000 tons if the cotton crop had not been damaged so severely (Table 1.7). By 1984-85 the targeted deficit will have increased to 397,000 tons (the difference between consumption requirement of 892,000 tons and production of 495,000 tons). Valuing the deficit at the average weighted palm and soy/bean import prices of January-May, 1975 ($ 450), the foreign exchange bill for the required imports will be $ 178.7 million in 1984-85 -- an increase of $ 44.6 million over the year 1976-77. If the deficit is valued at the average weighted import prices of soy/bean/and palm oil for the period April-June 1977 ($ 658) ,the foreign exchange cost of financing edible oil imports will increase from $ 196 million in 1976-77 to $ 261 million by the year 1984-85. Assuming that production does not move off of the present plateau and remains at about 300,000 tons of edible oil, the deficit will be 592,000 tons in 1984-85. The cost in foreign exchange, at the average weighted palm & soy/bean oil prices used above, will be $ 266 and $ 390 million respectively.

The sluggish production and the dependence on imports emphasizes the need for Pakistan to launch a vigorous oilseed developmental program. The development of its own supplies of vegetable oil is not an impossible task. Considering the many choices of crops that are available, and the many crop environments of Pakistan, it should only be a matter of combining the two in a satisfactory way .

CHAPTER - 2

INCREASING PRODUCTION OF INDIGENOUS OILSEED CROPS

This chapter considers general measures to increase production of indigenous oilseed crops — details are given in appropriate appendices. No consideration will be given here to increasing oil yield during processing, since that is discussed Chapter 5.

Cottonseed

Cottonseed oil is the major source of raw material for ghee manufacture. It is grown in all provinces of Pakistan, but mainly in Punjab (75-80%) and Sind (20-25%). Though the acreage of cotton increased from 4.56 million acres in 1973-74 to 5.02 million acres in 1974-75, the overall production of cottonseed dropped from 12,96,000 tons in 1973-74 to 12,48,000 tons in 1974-75. The downward trend which continued into 1975-76 can be attributed primarily to heavy rains and unprecedented floods in some years, shortage of irrigation water, and heavy insect attacks in others.

The climatic condition of the entire cotton belt in Pakistan is ideally suited for its cultivation. However, waterlogging and salinity and gradually decreasing soil fertility, poor cultural practices, insufficient supply of certified seed, and inadequate plant protection cause the low yields per acre.

The Government has taken steps to improve the situation by the following measures: adequate provision of certified seed, fertilizers and pesticides; training of farmers in improved production technology; provision of easy credit facilities; and offering an attractive price. Government anticipates that these measures will increase acreage and yield per acre such that the production of cottonseed will be 21,81,000 tons in 1984-85.

Rapeseed and mustard

Rapeseed (sarson and toria), mustard (raya) and taramira were grown on 1.1 million acres in 1974-75 with a total production of 2,44,000 tons of seed. These crops are grown throughout Pakistan, with the acreage of each being estimated to be about the same. The average yield at about 6 md/per acre for rape and mustard is miserably low considering the high yield potential of the present varieties. Yields of taramira are still lower, at 2-3 md per acre, partly because of low potential and partly because it is grown in poor locations. Its oil is also extremely pungent and not suitable for ghee manufacture, but is extensively used in the crude form by the rural population. Oils from rape, mustard and taramira are inferior in quality because of high contents of erucic acid and sulfur compounds (glucosinolates). Due to the acute shortage of suitable oils for ghee manufacture during the last few years, the ghee industry has used a small percentage (usually 5-7%, but occasionally to 15%) blended with cottonseed oil and imported soybean and palm oils. The quality of the ghee, however, has been adversely affected. The sulfur compounds, which flavor mustard, rape and taramira oils, impact a toxic property to the meal which limits its use in livestock feeds. Canadian and European scientists have developed varieties of rapeseed free of both erucic acid and glucosinolates (double-zero types) which are rapidly replacing the old varieties. The double-zero varieties produce an oil and meal comparable to those from soybeans. Research is under way to develop such types in Pakistan.

Even though the oils of rape, mustard and taramira are not suitable for hydrogenation, Pakistan could use much more than is being produced. Realizing this, Government has already made provisions in the 5th Six-Year Plan for correcting the constrains on production by providing: Better quality seed; pesticides and other inputs; and improved production technology. The objective is to raise yields from 6 to 8 md per acre, and to produce 5,12,000 tons of seed by 1984-85.

The Working Group feels that one additional incentive is necessary to achieve production targets. That incentive is for Government to guarantee a reasonable floor price to growers. It should be announced each year well before the planting season and effectively administered.

Groundnut

Introduced to Pakistan in 1949-50, and first grown in Rawalpindi Division, groundnuts are now grown in Punjab, Sind and parts of NWFP. The area under groundnut increased gradually to 53,000 acres in 1965-66. Acreage increased rapidly to 84,000 acres in 1966-67, and to 1,25,000 acres in 1967-68. Due to unfavourable prices, acreage dropped to 86,000 acres in 1968-69. Since 1970-71, acreage has ranged between 75,000 and 100,000 acres. A USAID team of groundnut experts visited Pakistan in 1971 and identified the following problems:

1) Lack of a short-season variety that would permit double cropping with wheat.
2) Non-availability of certified seed.
3) High harvesting costs.
4) Serve damage by rats and wild boars.
5) Lack of capital by the farmers to purchase the seed, fertilizers, and pesticides.
6) Lack of marketing standards, which allows the marketing of groundnuts that are green and/or high in moisture, leading to mistrust between buyer and seller.
7) Widely fluctuating prices which fail to provide a sustained incentive to the grower.

Most of these problems continue to hamper the production of groundnut. Arrangements for the production of certified seed of improved varieties do not exist nor are there proper marketing or storage facilities for the produce. For the past few years, however, PASSCO has been supplying a small quantity of good quality seed which is procured from progressive growers.

Though the entire produce of groundnut at present is consumed as roasted nuts, and none is available for oil extraction, this crop needs special emphasis because of its high oil content and yield potential. In order to obtain increased yields of high quality groundnuts, an intensive extension and developmental programme should be launched to provide:

1) Certified seed of short-duration varieties and other necessary inputs;

2) Information on latest production technology and protection from pests and disease;
3) Bullock-drawn groundnut diggers; and
4) Better market procedures and attractive price support.

Sesame

The yields and acreage of sesame have remained more or less static for the past 25 years. The average yield is a mere 3.9/md per acre, not too different from the situation in many other countries. It is grown for the seed, and not for oil. For the present it offers very little potential as an oil crop, though the oil is of very high quality.

The Working Group does not recommend a programme of development for sesame. It does recommend, however, that it receive serious research attention. Researchers should draw on germplasm resources available in research stations in other countries. One promising source is the University of California at Riverside, California.

Increasing production of indigenous crops

The Working Group feels that rape, mustard and groundnut are so well established that their production does not merit special contractual arrangements between the farmer and the developmental organization. It is felt that a guaranteed floor price, availability of certified seed, and provision of other necessary inputs will do much to increase production.

There will be exceptions where some form of contractual arrangement will be necessary. Some of these would be:

1) Seed production fields of improved varieties obtained locally or from other countries.
2) Varieties with special oil or meal characteristics that require special handling to ensure maximum increase, freedom from mixtures, and adequate isolation from existing types.
3) The introduction of an indigenous crop to a new area.
4) The introduction of new methods of producing a crop.

5) Where farmers or farm organizations request a contractual arrangement.

Where contractual arrangements are made, they should be handled like new crops (Chapter 3).

Price incentives

Price should be stable and high enough to encourage the farmer both to grow the crop, and to strive for maximum yields. The prices that the Working Group recommends (see Chapter 4) are:

Rapes (toria and sarson)	Rs. 75-80/md	Moisture not above 6%
Mustard (raya)	Rs. 75-80/md	Moisture not above 6%
Taramira	Rs. 65-70/md	Moisture not above 6%
*Groundnut	Rs.100-110/md	Moisture 15%

The prices are not out of line with prevailing market prices. Groundnut, because it is being used as an edible nut, brings much higher prices than that suggested. The important feature of floor prices is the stability that they introduce.

Seed of improved varieties

The farmer should have convenient access to certified seed of improved varieties. Hence the developmental agency shall have to arrange for the production of such seed in quantities sufficient to meet anticipated requirements (see Appendix A).

Advisory

The major source of advisory help will be the established Extension Service. However, the developmental agency should provide the following:

a) Up-to-date farmer publications, to be distributed mostly through the Extension Service, but also directly and through meetings and training sessions.

b) Notices in writing or by radio of procedures the farmer should adopt in emergencies, e.g. an insect attack, an unseasonal rain, etc.

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*The prices would be increased proportionately when the moisture content is less than 15%.

Equipment

A major bottleneck to groundnut production is the lack of suitable equipment for digging the plants and for removing the seed from the pods. The threshing of rapes and mustards should be a simple matter by mechanical means.

The developmental agency should import and/or develop key equipment for indigenous crops, and demonstrate their effectiveness in production areas. Such equipment should be provided in limited amounts on a rental basis to farmers, enough to encourage farmers or groups of farmers to purchase their own equipments. Worldwide search should be made for suitable equipment. Help of IRRI-Pak Equipment Design Centre for Pakistan at Rawalpindi and the GOP Appropriate Cell at Islamabad could be sought in this connection.

Demonstrations

Improved varieties and/or production practices should be demonstrated through cooperative efforts of the developmental agency and local extension personnel. The leadership should come from the developmental agency.

Cooperative with the extension service, the developmental agency should call field days and meetings to teach the lessons of the demonstration.

Other facilities

In situations where indigenous crops are grown on a contractual basis, the developmental agency should offer the same facilities provided for new crops (Chapter 3).

CHAPTER – 3

INTRODUCTION AND DEVELOPMENT OF NEW OILSEED CROPS

In actual fact there are very few examples of strictly "new" oilseed crops. The term, however, has been widely used for any oilseed crop introduced on a commercial basis for the first time to an agricultural area.

Considering the many environments of Pakistan, it should be possible to find situations where new oilseed crops will do well. In Pakistan programmes for the promotion of new crop have not been sustained and have not considered all facets of the developmental process. New oilseed crops that merit serious evaluation as commercial crops in Pakistan are sunflower, soybeans and safflower.

The development of a new crop requires a viable combination of research, development, extension, and product disposal. Failure has usually followed neglect of one these components. Often development requires support by Government.

Research requirements

Research has a major role to play in the successful introduction of a new crop. Research on new crops considered here is sufficient to indicate that they have potential in Pakistan. However, more work must be done to provide a basis for detailed recommendations on production practices. Such research should:

1) Identify areas where the crop is adapted.
2) Identify among introduced varieties those that are adapted to different areas where the crop has potential, or develop such varieties locally.
3) Develop production practices suitable for the agricultural situation in Pakistan.
4) Introduce or develop machinery to facilitate, and lower costs of production.
5) Identify pests and develop measures for their control.

Research priorities and implementation are discussed in some detail in Appendix B and in the appendices dealing with the separate crops. Of concern is the extent to which a developmental agency should become involved in research. Because Pakistan has well developed oilseed research programmes at the provincial research institutes, and because a cooperative national oilseed research programme is in the final phases of development, the Working Group feels that an oilseed developmental agency in Pakistan must develop a modest research programme oriented towards rapid solutions of problems that block or complicate production of oilseed crops. As a minimum there must be a senior research officer with a small staff. His responsibilities are given in chapter 6.

The working Group recommends strongly that the developmental agency provide a generous budget to support selected research projects both in its own research organization and elsewhere in Pakistan. Such research support has been vital to the success of developmental programmes on other crops in Pakistan and to developmental programmes on oilseed crops in other countries. To identify the best use of research support the senior research officer should work closely with the Oilseed Research Coordinator of the Agricultural Research Council.

Development of new crop production

Experience with other crops in Pakistan (Appendix K) and with oilseeds in other countries has proven the need of a developmental agency. Without the best efforts of such an agency on a sustained basis, new crops will not become established. Successful development has involved both public and private agencies, sometimes in joint efforts.

For the present situation in Pakistan it is recommended that the developmental agency be a semi-autonomous government corporation— a separate division of the Pakistan Edible Oil Corporation. Besides having a research unit as described above, it must have authority, management, field staff and facilities to provide the following:

1) Floor prices for new oilseed crops.

2) Contracts with growers.
3) Inputs into production.
4) Advisory services to the grower.
5) Equipment on a rental basis.
6) Procurement centres.
7) Transportation of seed to a crushing plant.
8) Facilities for increasing seed of recommended varieties.
9) Training for staff.
10) Publications for farmer use.

Floor prices. Floor prices must be sufficient to cover costs of production and provide the grower with an incentive to grow a crop new to him (Chapter 4). As the grower gains familarity with a new crop and his yields improve, the floor price may be scaled down. For the potential new crops the working group recommends floor prices as follows:

Sunflower.............Rs. 110/md.
Soybean ....Rs. 100/md.
Safflower.............Rs. 100/md.

Contracts. A contractual arrangement with growers has many advantages. From the point of view of the grower it permits him to know in advance that he has a market, a floor price, and assistance in growing the crop. On the other hand the developmental agency can plan production and provide for handling and disposal of seed well ahead of harvest.

Inputs. Inputs into production will include any or all of the following: credit; planting seed; fertilizer; pesticides; and equipment on a rental basis. It is important that the inputs be provided only on the basis that the cost will be deducted from returns to the growers; they should not be provided free of charge.

Advisory services. Advisory services are absolutely necessary to the successful development of a new crop. The advisor gives the grower confidence in his first efforts to grow a crop, and leads him into the use of the best production practices. The advisor benefits because he can learn better production practices from farmer experience, he can estimate yields and probable production well ahead of harvest, and he can identify pests and take steps to control them well ahead of time. The advisor should be the contracting agent.

Equipment. Equipment provisions will need to be the same for new crops as for established crops (see page 14). There is even a greater obligation on the developmental agency to provide equipment on a rental basis.

Procurement centres. The developmental agency should establish centres to which the farmer can bring his seed after harvest and be paid. The centres should provide adequate storage and handling facilities.

Product evaluation. The procurement centres should be staffed and equipped to measure quality in terms of moisture content, foreign matter, and admixtures. Discounts in price for percentages of those items should be established each year prior to harvest. If feasible, grades should be established.

Transportation. Transportation of seed from procurement centres to crushing plants should be provided by the developmental agency.

Facilities for producing seed. Ensuring the availability of the best quality seed of recommended varieties is so important, that the developmental agency must be organized and equipped to do it. New crops present special problems and special requirements that are difficult to provide by established governmental agencies. Half of the newly established seed corporation should also be obtained. Details are given in Appendix A.

Training. Annually, and more often than that during the first few years, training sessions should be held for all staff, particularly field staff. Training sessions should include researchers and extension officers and progressive farmers.

Publications. Leaflet-type publications in the local language should be prepared as new information becomes available. In an emergency, such as the appearance of a disease or damaging insect, it should be possible to issue leaflets in two days at most.

Publicity. Wide publicity should be given through press, radio and radio visual programmes. Documentry films should be prepared and widely exhibited.

Extension

The established extension service is heavily involved in many activities and will not be able to give new crops the attention that they require. However, because of their knowledge of the local situation, they should be encouraged to participate in new crop establishment. They should be involved in demonstration type tests in farmer's fields. Maximization schemes similar to cotton maximization programme already in operation should be developed for oilseeds.

Product disposal.

Obviously the disposal of the oil will not be a problem in Pakistan for the forseeable future. But other products from oilseeds may be difficult to dispose of — these include the meal and cake, and the hulls.

Oilseed meals. Livestock feeders usually have a strong prejudice against a new oilseed meal or cake, and ask for discounts in the price. A developmental agency must take the required action to increase consumption of the meal and cake of a new crop. This may require the preparation of leaflets giving full information on the meal, or it may require support of research to measure its feed value. A change in the texture or color of the meal may be all that is necessary to change a prejudice. Every effort should be made to produce an oilseed meal acceptable in international markets.

The developmental agency should initiate and support research on oilseed meals leading to their increased use in food products. Much of the technology has already been worked out for soybeans and sunflower. What is needed most is adaptation of the technology to food products used in Pakistan.

Hulls. Hulls of safflower and sunflower present a disposal problem. In most countries the hulls are removed prior to crushing the seed for oil— this increases oil yield, reduces the volume of material being crushed, and reduces wear on the expellers. Then they are ground and mixed with the meal. Alternative uses of hulls should be explored.

CHAPTER 4

COMPARATIVE ECONOMICS OF OILSEED CROPS

Generally speaking, except for soybean none of the new oilseed crops directly competes for land resources with other major crop activities in pakistan. Sunflower is a zaid-rabi and also a zaid-kharif crop. As a zaid-kharif it only offers some direct competition to maise crop. Other than that it can very easily be sandwiched between the major crop activities. Safflower is claimant of mainly marginal lands that offer limited yield prospects for major rabi crops. Still in some areas it may take some acreage away from wheat. Groundnut performs well in areas with Sandy loamsoils, both under medium rainfall and irrigated conditions without offering any meaningful threat to the major summer crops.

Keeping these points in view we have considered the economics of oilseed crops together with some other crops that may directly or indirectly be affected in case the area under oilseed crops is expanded. The most relevant crops in this regard are wheat, rice and maize. While working out the economics of these crops we have assumed that above average level of modern inputs will be used and the yield levels corresponding to these inputs realised. These assumptions are realistic as the resource requirements for achieving the implicit input use levels can be met by an average farmer either from his own sources or through borrowing. The yield levels assumed are also within logical limits. Prices of inputs are drawn from some empirical studies based on 1975/76 data. In the case of wheat, rice, maize, and seed cotton the support prices and for the rape-seed, mustard and groundnut, the going village level prices for the year 1976/77 have been used. The prices of new

Contd.../

Table 4.1 - Cost of production (Rs/Acre) of oilseed and some of the competing crops

Inputs	Seed Cotton	Ground-nut	Rapeseed and mustard	Sun-flower	Saff-lower	Soy-bean	Wheat	Rice	Maize
Labor	170	292	120	237	239	216	119	125	196
Capital:									
Bullock labor	282	110	100	105	100	100	214	271	167
Seed	20	135	10	12	20	75	38	6	10
Fertilizer	146	59	111	109	106	111	111	114	111
Plant protection	71	60	50	54	36	36	-	77	30
Interest on investments in capital inputs	63	33	24	25	24	26	51	61	31
Water charges (Abiana and tube-well water costs)	45	-	15	12	12	12	16	46	12
Land rent	370	250	250	200	100	200	337	233	200
Total	1167	939	680	804	637	776	886	933	757

Table 4.2. - Comparative economics of oilseed and other crops

Corp	Yield/acre (Mds.)	Price/md (Rs.)	Cross returns per acre(Rs.)	Cost of production per acre (Rs.)	Net return per acre (Rs.)	Rate of return on inputs(net of family labor)
Seed Cotton	12	132	1584	1108	212	47% *
Groundnut	14	90	1260	909	351	46%
Rapeseed and mustard	11	75	825	645	180	31%
Sunflower	10	96	960	774	186	30%
Safflower	8	96	768	622	146	30%
Soy-bean	9	100	900	716	184	30%
Wheat	23	37	851	676	175	22%
Rice	25	46	1150	842	308	39%
Maize	25	32	800	677	123	20%

* In the new cotton policy, effective April 19, the prices of various grades of seed cotton have been raised to between Rs. 132 - Rs. 160 per maund. In the case of long staple cotton varieties the rate of return will be more than 70 per cent.

oilseed crops namely, sunflower, safflower and soybean have been imputed guaranteeing rates of return comparable to other crops under consideration.

As the data presented in Tables 4.1&4.2 reveal, the already established crop activities are bringing rates of returns on inputs (net of family labour) to the farm enterpreneur ranging between 20 to 47 percent.

Groundnut at the going market prices and above average yield level is the most rewarding crop activity offering 46% rate of return on investments, followed by rice and rapeseed and mustard.* Although maize and wheat crops enjoy the benefit of seed technologies but due to the relatively low level of support prices net returns on these crops range between 22 and 20% respectively. The rate of return on sunflower, safflower and soybean at the imputed prices comes to 30%. The comparative economics of these crops is obviously subject to variations in crop yield and the level of the support or the open market prices. It can safely be conjectured that in the beginning years, the growers may not be able to fully comprehend the agronomics of the newly introduced oilseed crops and thus may not achieve the yield levels assumed in Table 4.2. For ensuring favorable returns on these crops attractive support prices will have to be guaranteed. Our analysis suggests that the

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* However, in the new cotton policy effective April, 1977, the prices of various grades and varieties of seed cotton have been raised from Rs. 110 to between Rs. 132 to Rs. 160 per maund. At these price levels the rate of return on investments in cotton crop production has become most attractive and will now range between 47-73 per cent.

price of these crops should at least be between Rs.96 and Rs. 100 per maund. At the going price of Rs.200 per maund of edible oil, the oil processing concerns can afford to give only a price of Rs. 87 for a maund of sunflower seed and Rs. 72-73 for safflower and soybean seeds. The public sector will therefore have to extend subsidy to the oil processors so as to enable these concerns to lift farmers produce of the new oilseed crops at the suggested support price. This subsidy will thus be Rs. 9 per maund for sunflower, Rs. 24 for safflower, and Rs.28 for soybean.

Under the new cotton policy, seed cotton prices have been increased by 10 per cent. The growers will now be receiving a guaranteed price of Rs. 132 - 160 per maund for various grades and varieties of seed cotton; This upward revision in the price of seed cotton necessitates comparable increases in the support prices of sunflower, soybean and safflower. Even a 10 percent increase will imply a per maund price of Rs. , - ' for these oilseed commodities. Subsidy burden will have to be adjusted upward making it Rs.19 per maund for sunflower, Rs. 38 for soybean, and Rs.34 for safflower. Keeping a logical balance between incentive to farmers and subsidy burden on the exchequer, the group suggests the gollowing support prices: sunflower Rs 110/md; and soybean and safflower Rs 100/

It needs little emphasis that price support subsidy will most probably be required during the course of promoting these crops. Once these crops get established in our croping system and the yield levels improve further subsidy support can gradually be withdrawn. Subsidy burden can also be kept within meaningful limits by rationalising edible oil prices and improvement in extraction and processing efficiencies.

CHAPTER 5

OIL SEEDS AND OIL PROCESSING

Production and Requirement

This has been discussed in detail in Chapter 1.

Cottonseed ranks number one as a source of edible oil in Pakistan. Annually a little over one million tons of seed is available for crushing after allowing the feed and seed requirements.

Rapeseed and mustard grown mainly for oil hold the second position with an annual production of nearly 0.26 million tons from which 80,000 to 95,000 tons of oil is produced.

Small quantities of groundnut and sesame are also produced. The entire production of groundnut is consumed as roasted nuts and nothing is available for oil extraction, while a small portion of sesame production is crushed.

Oil Processing Methods and Capacities

Oil extraction is done by expellers, solvent method and kohlus. Estimated amounts of oil extracted by different processing equipment are given in Table 5.1.

The total crushing capacity in the country is estimated as under:-

Method	'000 Tons
1- Low Pressure Expellers	2.5 (300 days working)
2- Solvent Extraction	0.429 (300 days working)
3- Kohlus	.018 (60 days working)
	2.947 million tons

In addition to the above capacity five more oil mills, four of them equiped with french expellers and one with Desmet-solvent, located at Hyderabad, Nawabshah, Shahdadpur, an unknown place and at Lyallpur were in existance according to one report. Each of these mills reportedly has a capacity potential of 250 tons per day cottonseed. Their present status and actual capacities could not be ascertained.

Table 5.1 Estimated amounts of oil extracted from oilseeds by different processing equipments ('000 tons, 1973-74)

	Cotton oil	Rape oil	Sesame oil	Groundnut oil	Total	
					'000 ton	%
Expellers	126	59	2	1	188	81
Solvent Plants 1/	15	10	-	-	25	11
Kohlu	-	16 2/	2 2/	-	18 2/	8
Total	141	85	4	1	231	100

From FAO Commodity Policy Study, 1975.

1/ The expeller production that enters into the data on cotton oil production from solvent plants is added to expellers.

2/ Assuming 100 working days per year for the kohlu. Some reports estimate 60 working days per year, while others estimate 10% of oil production. An intermediate figure has been adopted.

Expeller Method

Different types of expellers, mostly country made, are presently being used by the oil processors in Pakistan. The most common ones are the low pressure screw type called 'Lahore Type' with rated capacities of 3,4 and 7½ tons of cottonseed per day. For rapeseed because of double or triple pressing the effective capacity is about half that for cottonseed. These expellers are capable of expelling about 12% crude oil from the 20 per cent available in the cottonseed.

There are different estimates of the average daily crushing capacity of these expellers. BOM(Sind) estimated 3 to 3.5 tons of cottonseed as the average daily crushing capacity of a low pressure expeller. Various sources report that there are 2429 low pressure expellers in Pakistan, out of which 1570 are in the Punjab and 575 in the Province of Sind.

Taking the estimates of 2429 expellers as a basis together with the Ministry of Industries estimates of one million tons cottonseed crushing in 120 days crushing season, (in 1973-74 901,000 tons out of total 1,099,000 tons cottonseed processed was crushed by low pressure expellers) the daily crushing capacity of expellers comes to 3.5 tons of cottonseed, the same as estimated by BOM(Sind). Thus the total capacity of the low pressure expellers, assuming 300 days working, can be estimated at 2.5 million tons. The assumption of 300 days working of low pressure expellers is rather heroic as it is impossible to run these expellers round the clock for such a long working season because of technical and storage facility constraints. Assuming that in addition to crushing nearly 1 million tons of cottonseed in 120 days these expellers also process about 0.2 million tons of rapeseed and mustard would imply an additional 47 working days or a total working period of 167 days in a year, indicating their total crushing capacity as 1.2 tons for cottonseed and rapeseed combined or 1.4 m. tons for cottonseed.

Table 5.2 shows the number and location of expellers and also the amounts of cottonseed produced in each district and its availability per expeller. The spatial dispersal of the expellers is also

Table 5.2 Cottonseed produced and available per Expeller districtwise.

Name of District	Cottonseed Produced in 1973-74 (in '000' Mds.)	Number of Expellers	Cottonseed Produced in the District Available per Expeller (in '000' Mds)
Gujrat	140	7	20
Pindi	-	15	-
Sialkot	40	-	-
Jhelum	-	6	-
Gujranwala	110	27	39
Sheikhupura	160	51	31
Lahore	390	111	28
Lyallpur	1,460	398	37
Sargodha	920	94	90
Jhang	660	4	165
Mianwali	100	-	-
Sahiwal	5,990	223	280
Multan	9,180	603	153
Muzaffargarh	790	-	-
Dera Ghazi Khan	720	48	150
Bahawalpur	1,160)	50	558
Bahawalnagar	1,630)		
Rahimyarkha	1,790	180	99
Sukkur	850	79	107
Khairpur	80	29	321
Jaccobabad	30	-	-
Nawabshah	1,320	24	55
Larkana	-	-	-
Hyderabad	2,220	165	135
Tharparkar	3,300	28	1180
Sanghar	3,050	31	984
Dadu	50	6	83
Thatta	-	-	-
Karachi	-	220	-

Source: IACP Survey.

irrational with the result that bulk of the cottonseed from major producing districts is transported over long distances for processing. Some of the expellers are installed at the site of the ginning factories while a large number are installed as small independent oil mills generally having 3 to 4 expellers (Table 5.3). Most of the expeller mills are reported to be old and do not have delinting and decorticating equipment, resulting in low extraction rates and production of cake with high residual oil, lint and hulls.

Solvent Extraction Method

Out of the 14 extraction plants, thirteen are in operatable condition (Table 5.4). Eight of these are located in Sind while the remaining five are located in the Punjab. Only eight solvent mills are equipped with delinting, decorticating and pre-pressing facilities. Some of these are equipped with high pressure modern Anderson type expellers for pre-pressing with capacities of 8 to 18 tons per day. The crushing capacity of the eight solvent plants operatable on cottonseed is 1280 tons per day while the five plants which lack facilities for cottonseed processing are operatable only on oil cake or on rice bran. The installed capacity of these five units is 275 tons cake per day. The eight extraction units operatable on cottonseed have for the past few years mostly operated on rapeseed cake or have been lying closed. Some of these however operate their expellers only, leaving the solvent units idle mainly on account of economic considerations.

Due to technical bottlenecks 10 out of 13 units cannot work for more than 190 days on cottonseed. Each lack one or the other facility to be fully equipped for 300 days run. Table 5.5 shows existing equipment and capacity).

Solvent extraction is the most efficient method for maximum oil recovery from oil seeds. In addition it gives valuable byproducts such as cotton linters and extracted meals rich in protein. Solvent extraction units in the country are not operating to their full capacity. It is necessary that the bottlenecks faced by these units be

Table 5.3 Basic Information seed and processing by subsector and their performance on cottonseed 1973-74.

	Estimated number of of mills	Average daily seed capacity per mill ton/day	Theoretical yearly capacity 000 ton — Operating days in a year: 120 days	Theoretical yearly capacity 000 ton — Operating days in a year: 315 days	Estimated actual seed throughput '000 ton	Corresponding number of actual operating days	Estimated average extraction ratio %	Actual production of washed cottonseed oil '000 ton	Actual production of washed cottonseed oil %
All expeller mills	410 1/	14 1/	688	1 806	658 1/	115 1/	12.0 1/	79	56.0
Large expeller mills	10	100	228	600	245 2/	129 2/	13.0 2/	32	22.7
Solvent extraction 3/			287	753	200		15.0	30	21.3
Prepress solvent	11	163	(215)	(564)	(90)	50	16.6	(15)	(10.6)
Large expeller	(4)	150	(72)	(189)	(110)	183	13.6	(15)	(10.6)
Total	x	x	1 203	3 159	1 103	x	(12.8)	141	100

From FAO Commodity Policy Study 1975

Calculated, assuming an average of four expellers per small mill.

The actual throughput is divided over small and large expellers (their aggregate throughput is known) by estimiting for each an approximate average extraction rate. The resulting production estimates correspond to a number of working days for each subsector that is consistent with available indications.

The statistics given on solvent extraction imply that part of the reported oil must come from expellers working parallel with the solvent plants. The amount actually solvent-extracted and expelled in this sector were estimated by using average extraction rates for each process; the amount of seed as well as the resulting oil were known.

Note: According to a GOP estimate the number of expeller oil mills is 127 and number of expellors as estimated by IACP is 2429.

Table 5.4

List of solvent extraction plants in Pakistan.

	Name of the Solvent Plants	Operateable in Cottonseed tons /24 hours of C/S	Operate on Cake Tons/ 24 hr. of Cake	Remark
	A-Sind:			
1.	Bengal Oil Mills, Karachi	100	-	
2.	Burma Oil Mills, Karachi	Not in Working Condition		Govt. Owned
3.	Taj Oil Mills, Karachi	-	50	
4.	Burjor Ardeshir Industries Ltd. Kotri			
5.	M/S Haji Dossa. Hyderabad	100	-	
6.	Cake and Oil Products Ltd. Nawabshah	100	-	
7.	Mehboob Ind. Sukkur	-	25	
	B- Punjab:			
8.	Solvex, Multan	130	-	
9.	Sheikh Fazal-ur-Rehman & Sons Ltd. Multan	200	-	Govt. Owned
10.	Universal Oil Mills Ltd, LHR	-	50	
11.	Kohinoor Oil Mills Ltd. LHR	200	-	Govt. Owned
12.	Extraction (Pak) Ltd. Lyl.	-	100	
13.	Grace Ind. Kabirwalla	200	-	
14.	Burewalla Oil Mills, Burewalla	200	-	
		1,280	275	

Source: I:P & S Dept. IACP report on cottonseed processing and handling 1975.

Table 5.5 Existing solvent extraction plants, capacity & equipment.

Plant a/	Existing Equipment				Cottonseed Capacity		
	Seed House	Delinting Equipment	Extraction Equipment	Refining Equipment	Present Capacity	Potential 190 Day Run	300 Day Run
					Long Ton Per Day		
Bengal	b/	x	x	x	100	100	—
Taj	—	—	x	x	---	---	100
Burjor	—	—	x	-	—	---	100
Dossa	—	x	x	x	100	—	100
Mehboob	—	—	x	x	—	—	50
Cake & Oil	—	x-	x	x	150	—	150
Solvex	—	x-	x	x	130	—	130
Rehman	—	x	x	x	200	—	200
Burewalla	—	x	x	x	250	—	250
Grace	—	x c/	x	x	100 c/	—	200
Kohinoor	d/	x	x	x	150	—	150
Universal	e/	x	x	x	100	100	—
Pakistan Limited	e/	x	x	x	200	200	—
					1480	400	1430

a/ An additional plant known as the Burmah Oil Mill has processed oilseeds by the solvent method but was in the process of being dismantled at time of field visits by the Experience, Incorporated team.

b/ No space available for seed storage.

c/ Total capacity of extractor is 200 tons but delinting equipment willhhandle only 100 tons per day at present.

d/ Seed house at the plant but needs conveyors, etc.

e/ These plants are not located in heavy cottonseed production areas and thus should be limited to 190 days on cottonseed and allocate the remaining time to rapeseed or rape cake.

Source: Experience Incorporated report.

removed as quickly as possible. Numerous reasons are given for the low capacity operation and closing down of most of the solvent units. Working group strongly recommends that every effort should be made to put the solvent plants into operation and to encourage full utilization of existing capacities.

Kohlus

Kohlus are mostly bullock driven, though some power driven kohlus are also in use. They produce about 8 to 10 per cent of the total edible oil. Mostly rape and mustard seed is processed by this method. There are different estimates of the number of these kohlus, the most often quoted figures is between 15000 to 16000 units located mostly in the villages. A kohlu has a crushing capacity of nearly 1.5 maunds (55 kg) of rapeseed per day (8 hrs), with an extraction rate of about 28 to 30 percent oil, from the available 38 to 40 per cent.

Improvement in Processing Efficiency

Several studies have been conducted on oil extraction processes in Pakistan. An exhaustive study was conducted by the UN/FAO Commodity Policy Study Team on Oilseeds, Edible Oils, Oilcakes and Meal in 1975. Recently a study sponsored by the Federal Ministry of Industries under USAID programme has been conducted by a firm of consultants, Messers Experience Incorporated*. This study is mainly based on cottonseed because of its importance as a major source of edible oil in the country.

Besides the edible oil, cottonseed provides valuable by-products such as cake/meal and linters. It is therefore necessary that the potential cottonseed offers should be exploited to the maximum. The consultants have therefore, in addition to suggesting overall improvement in the oil processing system of cottonseed, identified the sources of losses (un-realized potential gains) in the existing system which are associated with:-

1- Improper agronomic and crop culture practices at the farm level;

2- Inefficient ginning and defective storage.

3- Inefficient extraction and refining.

* The IACP has also conducted an exhaustive study on the subject which has been duly considered while preparing this chapter.

1- Improper agronomic and crop culture practices

The Government in the Ministry of Agriculture is making sustained efforts to maximize the seed cotton production by varietal development and improving agronomic practices. This is expected to increase availability of cottonseed for oil processing. Immediate steps are needed by the agency responsible for providing edible oils in the country to eliminate the losses occuring at sources identified in 2 and 3.

2- Inefficient ginning and defective storage

Losses during ginning are not of great significance. However, some loss of oil can be prevented by improving the ginning efficiency. The roller ginning equipments are old and in run down condition. This results in some damage during ginning. Only 10% cotton is ginned by roller gins.

Lack of storage facility at the farms, the ginning mills and the oil mills is the important factor responsible for large losses of edible oil.

Due to biological activity in the cottonseed on account of improper handling and storage the formation of free fatty acids increase, rendering increased quantity of oil inedible (turned into soap stock) and reduce the quality of residual cake/meal. Major factors responsible for the conversion of edible oil into acids are moisture, high temperatures and lack of cooling and aeration in storage.

3- Inefficient extraction and refining

It is estimated that more than 50,000 tons of cottonseed oil is annually lost on account of inefficient extraction by the expeller method and converstion of edible oil into soap stock. There are also considerable losses of oil in rapeseed processing. The existing practice is that the kohlus or the low pressure expeller mills crush the rapeseed and sell the extracted cake with about 9% residual oil content to the solvent plants. Since the cake cannot be treated immediately due to time-lag between expelling and solvent extraction, FFA contents rise causing deterioration in oil quality and increase in refining losses. The quality of cake/meal is also rendered inferior.

Refining losses of oil increase proportionately with the increase in FFA. Different studies give the following loss estimates:-

FFA in crude oil	Refining losses
1.0%	(normal) 6.6%
2.0%	9.6%
4.0%	15.6%

The Pakistan Central Cotton Committee and Punjab University estimated that an average FFA content of 5 per cent is equal to a loss of 35,000 metric tons of edible cottonseed oil.

Whole seed crushing by expeller also causes loss of linters a valuable by-product which has a big export potential. This loss is estimated by the technologists at 9% of the seed weight, i.e. 90,000 tons of linters for one million tons of undelinted cottonseed crushed

Experts estimate 15.6 per cent potential loss of cottonseed oil on account of inefficient expelling method used in Pakistan. One study estimated the difference in cottonseed expeller pressed and decorticated solvent yields at 122 lbs of crude oil. Another study estimates this difference at 63 lbs of crude oil per ton of seed crushed. Assuming 1 million tons of seed crushed by low pressure expeller, the annual loss of oil at this rate would be about 28,584 tons. (Table 5.6)

The total availability of cottonseed for crushing in 1976-77 is estimated at 1.243 million tons. This is expected to grow to 2.516 million tons in 1984-85. If the proposed action plan for the production of new oilseed crops becomes a reality the actual production of new oilseeds is expected to be 417,855 tons. Thus total production of edible oilseeds in 1984-85 will rise to 2.934 million tons. In addition there will be considerable tonnage of rice bran and industrial oilseeds such as castor and linseed needing extraction capacity.

Table 5.6 Product yield and material balance (a)/ — four processing systems

	Lahore Expeller	High Pressure Expeller	Pre-Press Extraction	Direct Extraction
	----------------Pounds----------------			
Total Product Balance				
Total Oil	441	441	441	441
Hulls (excluding oil content)	440	440	440	440
Linters (excluding oil content)	195	195	195	195
Meal (excluding oil content)	1076	1036	1036	1036
Manufacturing loss	52	92	92	92
Net clean seed	2204	2204	2204	2204
Foreign material	36	36	36	36
Total	2240	2240	2240	2240
Balance				
Oil in hulls and linters	10	10	10	10
Oil in meal/cake	69	43	6	13
Crude oil extracted	362	388	425	418
Total	441	441	441	441
Product Yields				
Hulls	445	445	445	445
Linters: 1st cut	55	55	55	55
2nd cut	145	145	145	145
Washed oil	329	353	387	380
Soapstock b/	33	35	38	38
Meal/cake	1145	1079	1042	1049

Examples which reasonably represent the relative yield to be expected from cottonseed with a 20 percent oil content in the clean seed. Actual yields vary because of cotton variety, growing season conditions, etc.

Based on a 9 percent refining loss.

Source Experience Incorporated report.

safdar*

The consultants estimate that by modernizing the existing solvent plants, 10 units out of the 13 could process an additional 2,25,000 tons seed per year, by expanding the crushing period from 190 days to 300 days (Table 5.5 & 5.7). They have further recommended the installation of 4 new direct solvent extraction plants each of 400 tons capacity.

Report of Working Group on Food, Beverages and Tobacco Industries 'Industrial Sub-Sector for 5th Five Year Plan' reveals that the Punjab Industrial Development Board in 1975-76 recommended the establishment of 15 new solvent extraction units each of 300 tons daily capacity while the Board of Management (Sind) favoured establishment of fully integrated plants having complete delinting, decorticating, pre-pressing, solvent extraction units with continuous refining, each with capacity around 150 tons of cake per day. A directive was issued by the Federal Government in 1975-76 for settingup two solvent extraction units one in Sind and one in Punjab on top priority basis.

The Oilseeds Strategy Working Group is of the views that before a decision is taken to install direct solvent extraction plants, it would be necessary to conduct a detailed financial and engineering study of the possible alternatives i.e. (a) *direct filtrex solvent extraction (this latest method reportedly removes the organic sulphur compounds from rape and mustard, making the oil from these seeds fit for hydrogenation) (b) direct solvent extraction (c) pre-press extraction and (d) high pressure expellers. Comparative economics of the 3 systems i.e, b,c & d are shown Table 5.8.

With the change from expeller to solvent extraction the problem of the disposal of extracted meal will arise which will need to be solved by removing the farmers and cattle owners biases against meal. This will require concerted efforts and can be achieved by practical demonstrations and effective motivational programmes. The extracted meal can profitably be converted into animal and poultry feed. Other necessary ingredients for a balanced feed preparation are available in the country. Cattle feed has a big export potential. That can sustain an expanded feed manufacturing industry. It is desirable that the installation of composite extraction feed plants should be considered.

*Mustard Seed Processing. Bland Protein Meal, Bland oil, and Allyle Isothiocyanate as a By-product. Journal of the American Oil Chemists Society, August 1962 Vol.39, No.8, PP 372-377, and Fitration-Extraction cost on seed: Industrial & Engineering Chemistry June 1957 pages 920-929. Direct Extraction Sunflower Seed by Filtrex-Extraction, AICS-Vol. XXXVI, No.11 pp 454-457.

Table 5.7 Additional capacity available by modernization of solvent plants and estimated costs.

Units under the control of Ghee Corporation of Pakistan Ltd:

Name of Unit	Amount (million Rs)	Additional tons annual capacity
Rahman & Sons Ltd, Multan	9.018	22,000
Kohinoor Oil Mills, Lahore	2.475	17,050
Total:	11.493	39.050

Units under the control of Cotton Trading Corporation:

Haji Dossa, Hyderabad	4.509	11,000
Burewala Oil Mills, Burewala	9.018	27,800
Total:	13.527	38.500

Units under the control of private sector:

As regards solvent plants in the private sector are concerned their financial requirements have been assessed as follows:

Name of Unit	Amount (million Rs)	Additional tons annual capacity
Taj Oil Mills, Karachi	22.066	30,000
Burjoir Aredeshir Ind. Ltd, Kotri	20.073	30,000
Mehboob Ind. Ltd, Sukkur	12.746	15,000
Cake and Oil Products Ltd, Nawabshah	9.018	16,500
Solvex (Pak) Ltd, Multan	4.509	14,300
Grace Ind, Kabirwala	21.135	41,000
Total:	89.547	146,800

Regarding Bengal Oil Mills, M/S. E.I. have indicated that no space available for putting up seed House. The Universal and Extraction (Pak) Ltd. Not located in heavy cottonseed production areas and thus their operations limited to 190 days in a year.

Source: Experience Incorporated Report.

Table 5.8 Annual operating statement and quantities, 500 ton per day plants.

	High Pressure Expeller		Pre-Press Extraction		Direct Extraction	
	Quantity (Tons)	Rupees (000)	Quantity (Tons)	Rupees (000)	Quantity (Tons)	Rupees (000)
Sales						
Cottonseed Oil	23,640	Rs.128,696	25,920	Rs.141,108	25,440	Rs.138,495
First Cut Linters	3,675	6,501	3,675	6,501	3,675	6,501
Second Cut Linters	9,705	30,386	9,705	30,386	9,705	30,386
Hulls	29,850	12,179	29,850	12,179	29,850	12,179
Soapstock	2,340	1,594	2,550	1,737	2,550	1,737
Meal	—	—	69,780	47,520	70,245	47,837
Cake	72,255	68,859	—	—	—	—
Total Sales		248,215		239,431		237,155
Cost of Cottonseed	150,000	196,050	150,000	196,050	150,000	196,050
Operating Costs:						
i) Direct						
Labor (3 shifts)	(500 men/day)	3,600	(550 men/day)	3,960	(500 men/day)	3,600
Maintenance		3,094		3,674		3,285
Power	3,800 HP	2,399	3,650 HP	2,304	3,200 HP	2,020
Steam	500 lb/ton	188	1,200 lb/ton	450	1,000 lb/ton	375
Water		31		59		55
Solvent		—		1,455		1,455
Bags		675		675		675
Other Supplies		115		115		115
Office and Other		127		127		127
Total Direct		10,229		12,819		11,707
ii) Indirect						
Supervision	110 men/day	1,914	115 men/day	2,001	110 men/day	1,914
Maintenance		3,094		3,674		3,285
Power	4,250 HP	1,098	4,000 HP	1,033	3,650 HP	943
Laboratory		238		238		238
Insurance		1,849		2,205		1,971
Taxes		16		16		16
Depreciation		12,325		14,697		13,140
Miscellaneous Other		300		400		300
Total Indirect		20,834		24,264		21,837
Total Operating Costs		31,063		37,083		33,544
Net Profit(Loss)	Rs.	21,102	Rs.	6,298	Rs.	7,241

From: M/s Experience Incorporated report.

CHAPTER 6

IMPLEMENTATION OF THE OILSEED PRODUCTION STRATEGY

The Government of Pakistan in 1974, after a study of the critical shortage of vegetable oil, directed the Federal and Provincial Departments of Agriculture and various Provincial Industrial Development Boards and the nationalized ghee industry to intensify research and developmental activities for rapidly increasing edible oil production.

In May, 1976, the Government of Pakistan created two corporations, both registered under the Companies Act of 1913, to implement a programme of increased production of edible oils. These corporations are:

1- Ghee Corporation of Pakistan (GCP), for the purpose of reorganizing and developing the nationalized ghee industry along modern scientific lines.

2- Pakistan Edible Oil Corporation (PEOC), which has two functions:

(a) To develop a system/channel for increased supply of edible oils to vegetable ghee units and other users of edible oil; and

(b) To promote and to encourage cultivation of edible oil bearing seeds in Pakistan and to set up organizations, centres, farms, etc., for accelerated development.

The Working Group has concerned itself mainly with the implementation of the functions of PEOC, and not with GCP, and has given primary consideration to development of increased oilseed production.

We have inquired into the operation of various research and development organizations in Pakistan and feel that the Pakistan Tobacco Board is a useful model. It has functions somewhat similar to PEOC, and has operated effectively since 1968. Following that inquiry the Working Group has made its recommendations under the following headings:

1- Edible vs. industrial oilseed crops.
2- Separation of the functions of PEOC.
3- Responsibilities of the Production and development Division.
4- Organization of the Production and Development Division.
5- Regional Production and Development Units.
6- Area Production and Development Units.
7- Concentration of oilseed production.
8- Production targets.
9- Research Unit.
10- Oilseed crushing plants.
11- Company involvement in oilseed production.
12- Financial support.

Edible vs. industrial oilseed crops

Because both castor and linseed are established crops in Pakistan, though grown on small acreages, the Working Group feels that they should come under the purview of PEOC. There has been considerable interest in castor, particularly because it is a major crop in some areas of Baluchistan and Sind where little else will grow. Linseed is important in some areas as a winter crop after rice. Both would benefit from the services provided by PEOC in terms of provision of planting seed, advice on production, orderly marketing, and processing.

Separation of the functions of PEOC

The two functions of PEOC are quite different, one focusing on the acquisition of vegetable oil and its orderly flow to industries that use it, and the other focusing on development and production of oilseeds. It is important that these two functions be under one management, as in the Tobacco Board, which will permit integration of production with processing and marketing. However, it is strongly recommended that the two functions be under separate and almost entirely autonomous divisions. Development and production should not be subordinate to oil procurement and vice versa.

Responsibilities of the Production and Development Division

The development and increased production of oilseeds will be a difficult but not an impossible task. The responsibilities of the Production and Development Division will be to:

1- Prepare oilseed development and production programme and implement them.
2- Coordinate with ARC on the oilseed research programme's existing or planned.
3- Coordinate with oilseeds research and extension activities of Provincial Governments.
4- Conduct, promote and fund research contributing to increased oilseed production.
5- Provide for high quality seed for planting
6- Recommend floor prices.
7- Promote participation of private enterpreneurs in oilseed development and/or processing.
8- Prepare publications.

Organization of the Production and Development Division

The recommended organization of the Production and Development Division of PEOC is patterned after that of the Tobacco Board with differences determined by: (a) the dispersed nature of oilseed production; (b) the present inactivity of private or public oilseed processing companies in fostering oilseed production; and (c) the well developed oilseed research programmes already underway in Pakistan.

An outline of the proposed organization is given in chart form in Fig. 6.1. Details of the staff requirements, equipment, and other facilities are given in Appendix I.

The officer in charge of the Division should be a Director with status equal to other Directors of the Board. The management of the Production and Development Division will be vital to the success of the entire undertaking. It is absolutely essential that the authority and the salary of the Director be such that it will attract the best talent. He should have a good general knowledge of: agriculture in Pakistan; all phases of oilseed production and marketing; research as it relates to development; and extension. He should have proven ability in administration.

The Working Group recommends strongly that the Director and main office of the Oilseed Production and Development Division be at or near Islamabad, and not at Karachi. Advantages are: (a) close proximity to the major barani areas where the Working Group feels that oilseed crops will become important; (b) close proximity to the Agricultural Research Council and the Pakistan Agriculture Research Centre which will facilitate and improve the research component of the Division's activities; and (c) close proximity to ministries having inputs into oilseed production and development.

Regional Production and Development Units

Four regions for oilseed production are recommended, a Southern Region, which includes Sind and Baluchistan, a Central Region, which includes the plains area of Punjab, a Northeastern Region which includes Rawalpindi Division and Sialkot Districts, Azad Jammu Kashmir, and a Northwestern Region which includes all of North West Frontier Province. Main offices of the regions should be at Hyderabad, Multan Islamabad and Peshawar. In each region there will be a variable number of area production and development units.

The roles of Production and Development Units in the four regions will be similar, but differing in detail depending on the region. The staff and logistic support should be sufficient to carry out the following roles:-

1- Carry out promotional programmes on oilseed crops to attract farmer interest.

2- Issue contracts for the production of new oilseed crops.

3- Arrange and provide inputs in cooperation with existing channels to contract growers as needed.

4- Recommend and provide for farm equipments as needed.

5- Provide an advisory service for new crop production and as required for the production of established crops, and seek cooperation of the existing government Extension Service.

6- Set up procurement centres for oilseeds with facilities for storage, product evaluation, measurements of moisture content and dockage, and prompt payment to farmers for seed delivered.

7- Arrange for transportation of oilseeds to crushing plants.

8- Recommend on the need for, and the location of, processing plants.

9- Collaborate with the Senior Scientist Research in the production of certified seed.

10- In cooperation with the Senior Scientist Research, provide for field demonstrations and research trials.

11- Provide for training programmes.

The officers in charge of regional Production and Development Units should be well qualified men and should have a detailed knowledge of the agriculture of their regions.

Area Production and Development Units

Area Production and Development Units will be the primary units. They will consist of one officer in charge and two field assistants. Each member of the unit will have well defined area responsibilities with the officer in charge having responsibility for the entire area. The number of these units will vary with the region and with the stage of oilseed development.

The area production and development units will have two functions, one concerned with the development of increased acreages of oilseed crops, and the other with procurement. Both are equally important. Experience in Pakistan, and elsewhere also, indicates that it is often easier to develop an acreage of a new crop than to arrange procurement. Procurement involves selection of procurement sites, grading or evaluation of seed received, prompt payment, storage and transport.

It is recommended that production and developmental units be initially located as follows:

Southern Region	Central Region	NE Region	NW Region
Badin/Thatta	Rahimyar Khan/ Bahawalpur	Gujranwala/ Sialkot	Swat/Mardan/ Malakand Agency
Hyderabad	Bahawalnagar/ Sahiwal	Jhelum	Peshawar
Mirpurkhas/Sanghar	Lahore/Sheikhu-pura	Mianwali/ Sargodha	D.I.Khan/Bannu/ Kohat/Kurrum Agency
Dadu/Larkana	D.G. Khan/ Muzaffargarh	Rawalpindi/ Campbellpur	Hazara.
Sukkur/Jaccobabad	Lyallpur/Jhang	A.J.K.	
Khairpur/Nawabshah	Multan		
Nasirabad/Pat Feeder			
Sibi Quetta			

The officer incharge and his assistants should have motorcycles for transportation.

There should be constant and close communication between regional and area officers. Responsibility for this will rest with the officers incharge of regional units.

Concentration of oilseed production

The concentration of oilseed production will have an important bearing on the requirements in each region with respect to field staff, procurement centres, and interest of oil mills in developing oilseed production. Production and development should be encouraged to take place in selected areas so that the field staff and procurement centres can be used more efficiently. The new crops and groundnuts will probably develop in this manner (see details in separate appendices) about as follows:

Soybean. Initially this crop will be confined as a barani crop to northern areas of Pakistan, and as an irrigated crop in both northern areas of NWFP and in southern areas of Sind Province. Its water requirement in southern Sind is estimated to be 30 acre inches which is 20% lower than cotton. Because soybeans are sown in June they can be used on land intended for cotton but which could not be planted in April and May when cotton should be sown. Unlike cotton the soybean can be harvested in time to permit planting of wheat. In barani areas of northern Pakistan it will partly replace barani maize, millet and sorghum. One advantage of soybean is its low requirement for applied nitrogen, a consequence of the Rhizobium nodules that develop on the roots.

Sunflower. This crop has wide adaptation, and will develop in many areas. Concentration will be greatest in barani areas of northern Pakistan because there will be only a few competing crops in the Kharif season. Sunflower will be a late-sown rabi crop in the same areas. Being a short season crop (90-100 days) sunflower will enter some cropping systems as a "catch crop". For example, if sown in southern Sind in nearly February it can be harvested in May, in time for a cotton crop to be sown. Also in Bahawalpur Division where cotton follows cotton a large acreage will be available for sunflower in the spring between cotton crops. It will be competitive with maize as an irrigated crop in many areas of Punjab and NWFP.

Safflower. This crop will be widely distributed also, but will be concentrated in rice areas and salaba lands (areas adjacent to rivers which have high water tables because of seepage or flooed waters). In rice areas it will be grown between rice crops on dubari land where it will replace low yielding field peas. On both salaba and dubari lands it will be grown on residual moisture. It appears promising in barani areas where its wild relative, pohli, does well.

Groundnuts. With adequate inputs of equipment, groundnuts should develop in all irrigated and barani areas with light textured soils.

For the first two years oilseed development should be confined to selected irrigated and barani areas (Table 6.1). In succeeding years production should be extended to the entire country. The sequence of development in each area will be adaptive research, demonstration and commercial development. The time involved in each phase can be one or two years, or commercial production may follow only one year of adaptive research or demonstration plantings.

Even within the selected areas listed in table 6.1, programmes of oilseed development should be concentrated in selected villages and/or areas. An area development unit of three persons should be able to manage an area 10 miles square or 100 square miles.

Production targets

Production targets are discussed in detail in appendices, and are summarized in Table 6.2. The plan will achieve increases in total acreages of oilseeds from 1,337,000 acres in 1977-78 to 2,592,000 in 1984-85, an increase of about 100%. Even with that increase in acreage,

Table 6.1 Areas where new oilseed crops and groundnut that should be developed in the first two years

Division or Area	Crops	Stage of development
Hyderabad Division	Sunflower Soybeans Safflower	Commercial Commercial Commercial
Sukkur Division	Sunflower) Safflower) Soybeans	Demonstration Commercial Adaptive research Demonstration
Baluchistan High land with 10"-15" rainfall sub-montane areas, and irrigated pat and Nasirabad Sub-Districts	Sunflower) Safflower)	Adaptive research Demonstration Commercial
Bahawalpur Division (Bahawalpur and Rahimyar Khan Districts)	Sunflower	Demonstration Commercial
	Safflower	Adaptive research Demonstration
	Soybeans	Adaptive research Demonstration
Multan Division (Multan, Dera Ghazi Khan and Muzaffargarh Districts)	Sunflower	Demonstration Commercial
	Safflower	Adaptive research Demonstration
	Soybeans	Adaptive research Demonstration
Lahore Division (Sialkot and Gujranwala Districts)	Sunflower,) Soybeans &) Safflower)	Adaptive research Demonstration
Rawalpindi Division (Jhelum, Cambellpur, Rawalpindi & Mianwali Districts)	Sunflower	Demonstration Commercial
	Soybeans	Adaptive research Demonstration
	Groundnut*	Demonstration Commercial
	Safflower	Demonstration Commercial
Azad Jammu and Kashmir and Hazara Division (Selected Areas)	Sunflower	Adaptive research Demonstration
	Soybeans	Demonstration Commercial
Swat and Malakand Agency	Soybeans Sunflower	Commercial Adaptive research Demonstration
Peshawar and Mardan Districts	Sunflower	Adaptive research Demonstration
	Groundnut*	Commercial
Kurram Agency, Dera Ismail Khan (Selected Areas)	Sunflower	Adaptive research Demonstration
	Groundnut*	Commercial

* On sandy soils.

Table 6.2. (a) Production targets for Oilseed Crops in Pakistan
(Acreage in 000s, and Production in 000s of metric tons)

Crop and Item	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85
Rapeseed								
Acreage	1200	1248	1300	1350	1405	1460	1520	1690
Seed Production	269	303	340	378	394	437	454	512
Available for crushing	242	273	306	341	254	393	409	461
Oil production	84	95	107	119	124	137	143	161
Meal production	147	166	186	207	216	293	249	281
Sunflower								
Acreage	3.05	10.5	25.2	48	86.	135	195	228
Seed production	.9	3.2	9.7	18.6	38.5	60.4	102	119
Available for crushing	.9	3.09	9.2	17.7	36.5	57.4	96.8	.113
Oil production	.38	1.2	3.7	7.	14.6	22.9	38.7	45.27
Meal production	.39	1.3	3.9	4.7	15.3	25.1	40.6	47.5
Soybean								
Acreage	11	22	39	52	110	165	231	264
Seed production	4.2	8.5	17.4	23	58.5	86	129	147.8
Available for crushing	3.6	7.2	14.8	19.7	37.5	73	109	125.6
Oil production	.76	1.5	3.1	4.15	7.8	15.3	23.	26.3
Meal production	2.8	5.7	11.31	15.73	29.68	57.9	86.8	99.2
Groundnut								
Acreage	120	125	130	135	140	145	160	200
Seed production	67.2	72.4	77.7	83.2	88.9	94.8	107.6	134.5
Available for crushing	-	-	-	20.8	22.2	23.7	26.9	33.6
Oil production	-	-	-	6.8	7.3	7.8	8.8	11.1
Meal production	-	-	-	7	7.5	8	9	11.4

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Table 6.2 (a)

Crop and Item	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85
Safflower								
Acreage	3	10	22	45	80	125	180	210
Seed production	.7	2.3	6.4	13	31	48.5	69.9	81.5
Available for crushing	.6	1.9	5.4	11	26.4	41.1	59.4	69.3
Oil production	.2	.6	1.8	3.7	8.9	13.9	20.2	23.5
Meal production	.2	.7	1.9	4.0	9.5	14.8	21.3	24.9
Total								
Total Acreage	1337	1415	1516	1630	1821	2030	2286	2592
Total Seed Production	342	389	451.6	516	611	726	862	994
Available for crushing	247	284	326	392	476	588	702	802
Oil Production	86	98.86	115.82	141.19	162.9	197	233	251
Meal Production	150	173.7	203	240	277	345	353	439
Cotton								
Seed Production	1282	1410	1538	1666	1794	1922	2050	2181
Available for crushing	1090	1299	1308	1417	1525	1634	1743	1854
Oil Production	140	158	176	194	212	230	248	165
Total Oil all crops	226	256.6	291	335	374	427	481	516

Assumptions:

Yield increasing as follows from 1977-78 to 1984-85

Rape & Mustard	6-8 md/acre	
Sunflower	8-14 mds/acre	
Soybean	10-15	"
Safflower	6-10	"
Groundnut	15-18	"

oil production will not provide the anticipated vegetable oil needs in Pakistan (Table 6.3). Indeed, the oil production targets will only hold imports at a level of about 375,000 tons.

The working Group feels, however, if the new crops catch on, that production will exceed targets. Most likely to exceed the targets is sunflower, a crop that shows considerable potential. Groundnuts could increase to more than 300,000 acres if suitable diggers and hullers become available and varieties and cultural practices are improved.

The increase in acreage should not displace other crops to any great extent because it is expected that intensification in cropping systems will permit more acreages of crops in the same land areas. Every effort in this strategy has been made to include oilseed crops into the cropping systems where no crops or very low yielding crops are grown. In addition Government plans to make available 116 million acre feet of additional water which will put an additional 1.34 million acres under cultivation during the period 1976-81.

Research Unit

Basic to the development of expanded acreages of oilseed crops is a strong programme of research (see Appx B & chapter 3). While the established research institutes are providing both new and better varieties and information on production practices, they are not reaching farmers as rapdily as they should. The Working Group strongly recommends the development of a Research Unit that will have four primary functions:

1) To carry out or fund research

2) To provide for nuclear, foundation and certified seed production in cooperation with Provincial Seed Corporation.

3) To provide laboratory facilities for both the Research Unit and Production and Development Units.

4) To provide information on pest control.

Table 6.3 Comparison of anticipated vegetable oil production and consumption (000 of tons)

Year	Anticipated production	Anticipated consumption	Anticipated deficit
1977-78	226	570	344
1978-79	256	612	356
1979-80	290	667	377
1980-81	332	713	381
1981-82	370	758	388
1982-83	420	804	384
1983-84	471	850	379
1984-85	520	892	372

Field Research Unit.

The research programme will be field oriented and adaptive in nature. It will identify superior varieties for different areas using facilities of the Research Unit in cooperation with Production and Developmental Units. In this undertaking the Research Unit should seek the cooperation of established research agencies in the provinces. Where adapted varieties are unavailable, it should develop them.

Improved production practices will require research, supplemented by farmer experience. Again, established research agencies can provide assistance.

The Working Group is strongly of the opinion that the Research Unit should be small in size but staffed by first rate scientists. It will be far more economical to selectively fund research being conducted by established research agencies than to develop a large unwieldy research organization. By selectively funding research, the Research Unit can obtain the research information it needs, whether it relates to variety development, production practices, utilization of byproducts, development of equipment and economic studies. Because the range of research interests will cover such a wide field, it is imperative that the Senior Research Scientist incharge of the Unit be a leading research leader on oilseeds.

A research farm of 25 to 30 acres will be required which should be situated in the Rawalpindi area near to the Headquarter of the Director, Production and Development. There whould be facilities for supplying some irrigation water to the farm. There should be a field building, an office building, and the necessary field and laboratory equipment for first-rate research. A botanist should be in charge, assisted by an agronomist/physiologist.

Off-station research can be done at seed farms and in farmers' fields in cooperation with Production and Development Units.

Laboratory Unit

The laboratory facilities should permit the following analyses: oilcontents; protein contents; fatty acids; and soil measurements such as p^H, phosphorus, nitrogen and potassium. chemist should be in charge.

Pest Control Unit

This Unit should be housed with the laboratory. There should be two officers incharge, one a pathologist, the other an entomologist.

Seed Production Unit

This is an extremely important activity and has been described in Appendix A. Under its direction there will be: four nuclear seed farms at different locations in Pakistan; and storage facilities and equipments to handle 543 tons of seed initially and 12,000 tons by 1984-85.

Oilseed Crushing plants

The Working Group is confident that crushing plants operating now and planned for the future for cottonseed will be adequate for the needs of other oilseed crops in the same area. It anticipates, however, that there will be a need for a crushing plant in northern Pakistan, probably near the groundnut area of Campbellpur. Plan for, and construction of crushing plants should follow the development of sufficient oilseed production to justify construction.

Company involvement in oilseed production

With some crops companies have given strong leadership to their development (Appendix K). Tobacco companies were successfully involved in the development of increased production of tobacco before the Tobacco Board was formed and continue to be so involved. Rafhan has a successful history of developing increased production of maize. Lever Brothers of Pakistan was involved in oilseed development for several years.

Companies extracting oil from oilseeds have much to gain from programmes of oilseed development. Not only can they increase the volume of crush, but they can schedule year-round operations by judicious selection of crops. If Pakistan increases its consumption of liquid oils, the availability of oils from different crops will enhance market opportunities.

PEOC should give strong support to companies with any interest in developing acreages of oilseed crops. Support should be in the form of:

1- Information on oilseed crops and their production - it should include publications.

2- High quality seed at cost of production.

3- Service type analyses at nominal rates.

4- Inclusion in training sessions.

Exploitation of other indigenous sources of edible oils

In order to over come the problem a number of other measures shall have to be taken which include exploitation of potential of: (a) rice bran, (b) poli weed (c) Olive and (d) other agricultural wastes such as tobacco seed etc., for oil extraction.

(a) Rice bran

Rice bran for edible oil is considered a fragile material. Unless the oil is extracted within 24 hours or less after the bran is milled it turns into soap stock. Rice bran plants require 50 tons or more of fresh bran daily for economic operation. With the establishment of centralized rice milling plants by the Rice Milling Corporation and large volume of bran becoming regularly available now the feasibility of edible oil extraction from this source should be seriously considered.

(b) Poli-weed.

Poli (Carthamus oxycantha) a noxious weed is infesting millions of acres in the country. The seed of Poli contains nearly 30% good quality edible oil. All efforts to eradicate this weed have proved insufficient. It is a large reservoir of edible oil which presently goes waste and is rendering valuable arable land unfit for cultivation. This source could be tapped with advantage, thus getting rid of the weed and providing good edible oil at the same time.

A publicity campaign should be launched to mobilise the rural population in the Poli infested areas so that they are ready to harvest its seed when it matures.

An attractive price for the harvested Poli seed should be offered well in advance of the harvest season.

(c) Olive.

Olive is one of the high quality edible oils. It is rich in vitamin 'A'. The fruit contains from 22 to 28% oil depending on the variety. An olive tree bears 10 to 15 seers of fruit on an average; the acre yield on the basis of 100 plants/acre is reportedly about 25 maunds of fruit and 5 maunds of oil.

Successful experiments are reported to have been conducted on olive culture at Rawalpindi and Kheri Murat (Campbellpur District). Suitable varieties have been selected and progeny gardens have been established at the above two stations. These gardens are reported to be in full bearing stage now.

Wild olive (Olea cuspidata) plantation on over six lac acres is found in Murree Hills, Soan Valley Azad Kashmir, Swat, Malakand Kurram Agencies and Quetta Hills. Efforts should be made to convert the wild forest plantation in the above areas into fruit and oil bearing olive (Olea Erupa) plantations. This would not only become a permanent source of edible oil supply for the country but would also contribute substantionally towards uplifting the economically very backward areas.

Olive plant propagation nurseries are reported to have already been established by the Government at Pail, Chua Saidan Shah and Kheri Murat in Punjab and Peshawar and Swat in NWFP with the seeds and cuttings obtained from the two progeny gardens.

A programme for the development of olive plantations should be chalked out in collaboration with the Forest and Agriculture Department and more nurseries should be developed for supplying plants to the Government Sector as well as to the private land owners in the above areas.

Tobacco Seed.

Tobacco seed contains 38% oil which is of high quality and fit for human consumption. The feasibility of exploiting this source should also be studied.

Appendix 'A'

SEED MULTIPLICATION

It is necessary to provide the farmers with seed of the highest quality which should have high yield potential, high germination capacity and be free from diseases and impurities. In western countries there are established seed companies specializing in certified seed production who participate in crop development programmes by taking responsibility for the production and distribution of certified seed. In the absence of such a facility in Pakistan it becomes incumbent upon the organization entrusted with promotion of any new crop to arrange the production and supply of certified seed according to requirements, area allocations and future planning.

Classes of planting seed and their production.

Seed production involves a number of different classes. Nuclear seed is that of a new variety which is maintained in its original state by the breeder or his representative. Foundation seed with seed produced from nuclear seed, and is usually grown on government seed farms. Certified seed is grown from foundation seed or certified seed and may be grown on government seed farms or on private farms under contract.

Production of nuclear and foundation seed is a highly specialized job which has to be done under strict control of specialists. A phased programme for the production of certified seed should be followed to cope with the increase in demand. The developmental agency for oilseeds should limit itself to the production of nuclear and foundation seed. Experience shows that private enterprise and the profit motive provide the best chances of success for developing certified seed production, therefore progressive farmers in different ecological regions should be selected who should be willing to produce the certified seed on contract under the guidance and control of specialists of the agency on terms and conditions which should be settled in advance. Such farmers (contract certified seed growers) should be given liberal terms. In India certified seed growers get Rs.30 for 100 kg over and above the market price of commercial crop.

There should be an efficient team of specialists to guide and supervise the seed multiplication in order to produce high quality seed which must conform to the specifications for seed certification. The contract seed growers should be provided all facilities including necessary inputs at cost in addition o the foundation seed.

Oilseeds are highly susceptible to climatic changes and lose their viability quickly, hence the necessary seed drying, cleaning, grading and processing equipment and storage facilities equipped to regulate temperature and humidity should be available.

Seed production farms

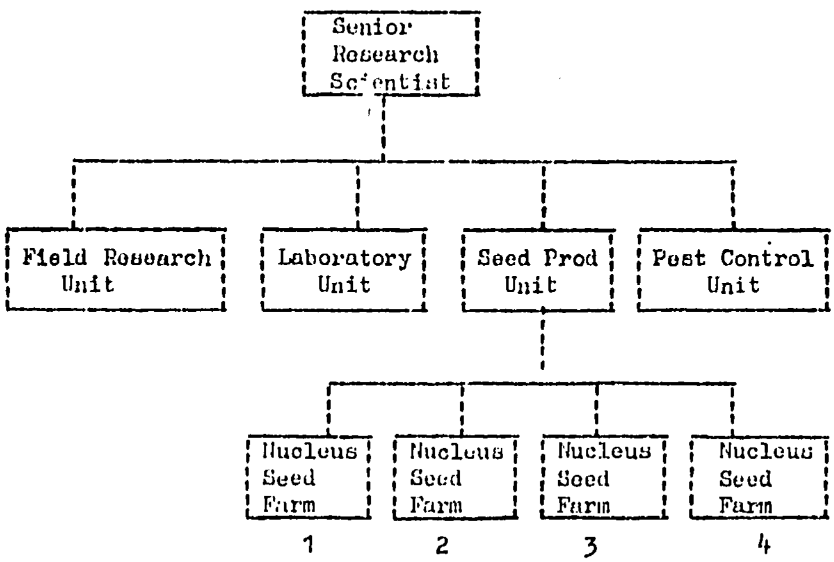
Nuclear and foundation seed stocks raised under temperate climatic conditions is healthier and produce better results. Land for nuclear and foundation seed farms may be aquired from the government or from the private owners on long lease in the following localities for different crops as follows:

Location	Crops	Farm Size
Swat or Azad Jammu Kashmir	Soybeans and Sunflower	25 acres
Jhelum or Campbellpur District	Groundnut, Soybean and Sunflower	50 acres
Nawabshah District	Rapeseed, Mustard and Safflower	50 acres
Multan Division	Rapeseed, Mustard and Safflower	50 acres

Certified seed requirement

The estimated certified seed requirement for 8 years to cover the planned targets of sunflower, soybean and safflower and also for partial converage of groundnut and rapeseed are shown in Table A.1. Certified seed for rape and mustard and groundnut will be produced and supplied to farmers for only a small acreage each year. This will spread from farmer to farmer if its performance is good. For the varietal improvement and maintenance of desired characters in the oil bearing seed crops sophisticated laboratory equipment such as NMR and GLC would be needed which must be provided in the main laboratory.

Fig. A-1



Staff

Nucleous Seed Farm

1-	Seed Farm Superintendents (Botanist-Breeders)	4
2-	Plant Pathologist	1
3-	Farm Assistants (Tech)	4
4-	Chowkidars	4

Certified Seed with Zonal warehouse for Storage of Farmers Produce

1-	Warehouse Supdts.	4
2-	Seed Analyst(Qlty Control)	4
3-	Machine Operator	4
4-	Chowkidars	4

Table A.1. Certified Seed Requirements(1977-1984-85) and Cost Estimate.

Crop	Year	Acreage to be sown	Seed Rate Per Acre	Quantity required (ton)	Seed cost per ton*	Total Dollars	Total Rupees
Sunflower (at 6 lb/A)	1977-78	3050	6 Lbs	9	$ 4000	$ 36000	
	1978-79	10500	"	29	-	$116000	
	1979-80	25200	"	69	Rs. 3350		231150
	1980-81	48000	"	131	"		438850
	1981-82	86000	"	234	"		783900
	1982-83	135000	"	367	"		1229450
	1983-84	195000	"	531	"		1778850
	1984-85	228000	"	621	"		2080350
Soybean (at 60 lb/A)	1977-78	11000	60 Lb's	300	Rs. 3080		924000
	1978-79	22000	"	599	"		1844920
	1979-80	39000	"	1062	"		3270960
	1980-81	52000	"	1416	"		4361280
	1981-82	110000	"	2994	"		9221580
	1982-83	165000	"	4491	"		13832280
	1983-84	231000	"	6287	"		19363960
	1984-85	264000	"	7185	"		22129800
Safflower (at 25 lb/A)	1977-78	3000	25 Lb's	34	"	34000	
	1978-79	10000	"	114	"		34770
	1979-80	22000	"	250	"		75500
	1980-81	45000	"	511	"		154322
	1981-82	80000	"	908	"		274216
	1982-83	125000	"	1418	"		428236
	1983-84	180000	"	2042	"		616684
	1984-85	210000	"	2382	"		719364
Groundnut (at 60 lb of kernels/A)	1977-78	5000	60 Lbs Kernel	187	Rs. 5358		1001946
	1978-79	10000	"	274	"		2002892
	1979-80	20000	"	448	"		4005784
	1980-81	30000	"	722	"		6008676
	1981-82	40000	"	886	"		8011560
	1982-83	50000	"	1160	"		10014460
	1983-84	60000	"	1334	"		12017352
	1984-85	70000	"	1782	"		14020244
Rape & mustard (at 6 lb/A)	1977-78	5000	6 Lb's	13	Rs. 2700		35000
	1978-79	10000	"	26	"		70000
	1979-80	20000	"	52	"		140000
	1980-81	30000	"	78	"		210000
	1981-82	40000	"	104	"		[illegible]
	1982-83	50000	"	120	"		[illegible]
	1983-84	60000	"	146	"		394000
	1984-85	70000	"	172	"		[illegible]
Summary	1977-78	27.50		543			2636.3
	1978-79	53.5		1042			5112.2
	1979-80	[illegible]		[illegible]			[illegible]
	1980-81	[illegible]		[illegible]			[illegible]
	1981-82	356.		5126			26573
	1982-83	525.5		7556			25791
	1983-84	726.		10340			34171
	1984-85	[illegible]		12142			39414.

*Prices per ton are based on Rs./md prices as follows: Sunflower 125/- Soybean 115/- ; Safflower 115/- ; Groundnut 200/- (Kernel) ; and Rapeseed &mustard 100/-

APPENDIX—B

RESEARCH NEEDS IN AN OILSEED DEVELOPMENT PROGRAMME

Considering the needs for research to support an oilseed development programme, Pakistan must do a great deal more. Realising this the Agricultural Research Council has developed a national cooperative Research Programme which will be supported in part by funds from a Developmental Loan provided by the U.S. Government. A general discussion of research will be given here, with details for the separate crops to be given under appropriate chapters.

<u>Strengths and weaknesses in research programmes</u>

Most of the research work on oilseeds has been done, and will continue to be done at the research institutes of the provinces. Important inputs of the provinces are the buildings, the land and leadership. Their resources are such that only limited research at the institutes would be possible within their existing finances. Expanded research work at institutes and off-station research and regional research at outlying stations would be possible only if additional financial support is made available.

Research work at the provincial institutes will continue to be quite different in terms of emphasis. Crop priorities are different, and within crops provinces often have different objectives in breeding programmes and production research. This is as it should be.

Where provincial research institutes have developed expanded oilseed programmes, there has been a strong interest in variety development, or variety evaluation in the case of new crops. Production research, independent of, or integrated with, breeding programmes has received less emphasis. There is a need to demonstrate the potential of established and new oilseed crops at the level of the farmer. Also because of inadequate transportation research on some crops cannot be done in areas where the crop is adapted -- e.g., there is very little work being done on groundnuts in areas with sandy soil. Also, there is a need to strengthen schemes that will provide for rapid increase and distribution of seed of new varieties. Finally, the link with extension and through extension to the farmer is not as well developed as it should be.

Not only do research stations have inadequate transportation for off-station work, they also lack field, laboratory and office equipment. With better equipment research would improve in quality and efficiency.

The level of training of many researchers at provincial research institutes is not as high as it should be. At present levels of competence it will be difficult to develop an expanded and strong research programme.

Universities and research agencies other than oilseed crops and economic crops sections at provincial research institutes are not involved sufficiently with oilseed crops. Utilization laboratories should step up their involvement with research on all products of oilseed crops.

Finally, integration of oilseed research nationwide is inadequate. There is insufficient exchange of information, seed, and personnel.

The Cooperative Oilseed Research Programme is designed both to eliminate the weakness of current research programmes, and to encourage more research and/or development agencies to work on oilseed crops.

Objectives

The primary objective of this project is to increase the production of edible oil in Pakistan such that the country is self-sufficient. This will be achieved in large part by increasing the yielding ability of oilseed crops so that they are more competitive economically with other crops, thus leading to an expansion in the area of production. To a lesser extent increased edible oil production will be achieved by increasing the amount of oil recovered from the seed. A second objective is to improve the nutritional value of vegetable oils in Pakistan, at the same time improving the nutritional value of the oilseed meal and cake left after the removal of the oil. Research and/or developments that will contribute to the above two objectives are:

i) Introduction or development of improved varieties of established oilseed crops.

ii) Introduction and evaluation of new oilseed crops.

iii) Improved production practices, including both soil and water management.

iv) Better control of pests.

v) On the farm testing of improved varieties and production technology to demonstrate the full potential of oil seed crops.

vi) Improved procedures to increase, to maintain purity, and to distribute seed of improved varieties.

vii) Improved integration of oilseed research in Pakistan involving different disciplines and different institutions.

viii) Better integration of research, extension and operation of the oilseed processor, particularly in oilseed development schemes.

ix) Improvements in farm equipments for all phases of oilseed production from seedbed preparation through harvest.

x) Economic studies of cropping systems including oilseed crops.

xi) Improvements in oilseed extraction procedures such that more oil is recovered.

xii) Increased use of oilseed meals with low contents, either alone or as an ingredient of feed concentrates.

xiii) Improvements in the quality of oilseed meals to meet international standards.

The first eight objectives will be achieved in large part by strengthening the research capabilities of the provincial research institutes and the Pakistan Agricultural Research Centre (PARC) in manpower, vehicles, equipment and support budget. The remaining five objectives will be achieved through grant-in-aid support to any research agency submitting an acceptable research proposal.

Any viable oilseed research program will require the cooperation of the oilseed chemist and biochemist. Their services are required to make analyses, more particularly difficult analyses requiring costly equipments and a high level of technical training. Also, the oil chemist and biochemist will be involved in the development of improved analytical tehcniques, and in monitoring analytical procedures at research institutes. Because of the importance of their role it is intended that a service type laboratory be developed at PARC to do at least those analyses that require expensive equipments -- one example is to use a nuclear magnetic resonance machine to measure oil content. Also needed is the cooperation of a utilization laboratory. With this in mind this programme will provide support to the Pakistan Council of Scientific and Industrial Research in Lahore. Analyses that can be provided by the oilseed section of that laboratory include: measurements of fatty acid content of oil; measurements of amino acid content of protein in oilseed meals; and measurements of toxic substances, e.g., levels of glucosinolates in rapeseed and mustardseed meals.

a) Crop priorities

The project must be selective of oilseed crops for research emphasis, at least over the next five years because of the scarcity of funds for research and the large number of oilseed crops. In order of decreasing priorities the oilseed crops are as follows:

i) Cruciferous crops (*Brassica juncea*, *B. campestris*, *B. napus* and *Eruca sativa*)

ii) Sunflower (*Helianthus annuus*)

iii) Soybeans (*Glycine max*)

iv) Groundnuts (*Archis hypogea*)

v) Safflower (*Carthamus tinctorius*)

vi) Sesame (*Sesamum indicum*)

vii) Castors (*Ricinus communis*)

viii) Linseed (*Linum usitatissimum*)

Provincial differences exist in crop priorities. For example, NWFP will give higher priority to soybeans than to sunflowers.

The project does not exclude research on other oilseed crops, where modest amounts of human and financial resources are involved. It excludes research on tree species such as the coconut palm, olives and tung. Research on these three crops may be undertaken in coming years.

b) Priorities within crops

Research will be structured to have results over three time periods:

i) The first and second years.
ii) The third to fifth year.
iii) The sixth to tenth year.

Highest priority will be given to research giving immediate results in terms of increased production. To a large extent this will be application through demonstration of the best production technology using the best varieties now available. It will involve the demonstration (or determination) of the best plant population, the best place in the cropping system, the best use of fertilizers, and the best methods of pest control. It will also include schemes to get superior varieties into commercial production quickly without loss of purity.

Research with benefits to commercial production within a three to five-year period will also involve the application of the best known technologies. It will include the development or introduction of new and better techniques and equipment.

Research returning benefits five to ten years hence will not be neglected. Such research will include, but will not be limited to breeding programmes.

Financial support for research

Financial support has been provided by provinces and by the Agricultural Research Council. Support from ARC will be augmented greatly through a US Developmental Loan, the support to continue for a five year period. The latter support is intended to complete some research with a high priority and to increase research capability in terms of equipment and training of staff such that good research will continue past the 5-years support period.

Cotton in Pakistan

Pakistan is the ancient home of cultivated cotton. Until 1914, Asiatic or "desi" cotton (Gossypium arboreum) was grown. Beginning in the 19th century, efforts to grow upland cotton (G.hirsutum)were unsuccessful, partly because they quickly became contaminated with local types. The first successful variety (4F) was released by the Agriculture College at Lyallpur in 1914. Thereafter, the upland types rapidly replaced local types, particularly in irrigated areas. Today the proportions of upland and desi cottons are 90% and 10% respectively.

Production of cotton since 1974 is given in Table D.1 The bulk of the production is in Punjab and Sind Provinces, most of it irrigated. Inspite of the generally good environment for cotton, yields of seed cotton are very low. Reasons are:

a) Much of the cotton area is adversely affected by waterlogging and salinity.

b) Fertilization practices are inadequate

c) Good quality seed of improved varieties is grown on only 20% of the cotton area, much of the balance being sown to mixtures.

d) Broadcast plantings are used on 70% of the acreage resulting in patchy stands and difficulties in weed and insect control.

e) Inadequate plant protection measures.

f) Severe flood damage in 1975 and 1976.

g) Prices that did not attract sufficient farmer interest.

Tablo D.1 Area, production and yield per acre of cottonseed and cottonseed oil in Pakistan

Commodity and area	Years (agerages) 1947-48 to 1949-50	1950-51 to 1954-55	1955-56 to 1959-60	1960-61 to 1964-65	1965-66 to 1969-70	1970-71 to 1974-75	1974-75
Area of production (000s of acres)							
Punjab	1,973	2,188	2,375	2,476	3,136	3,607	3,822
Sind	820	952	1,057	976	1,043	1,119	1,189
NWFP	6	11	10	7	6	6	8
Baluchistan	-	1	1	-	-	1	-
Pakistan	2,799	3,152	3,443	3,459	4,185	4,733	5,019
Cottonseed Production (000s of tons)							
Punjab	263	346	387	514	705	912	866
Sind	123	185	195	189	262	264	381
NWFP	(b)	1	1	1	1	1	1
Baluchistan	-	-	-	-	-	(b)	-
Pakistan	386	532	583	704	968	1,277	1,248
Cottonseed yield (maunds per acre)							
Punjab	3.6	4.3	4.4	5.7	6.1	6.9	6.2
Sind	4.1	5.3	5.0	5.3	6.8	8.9	8.7
NWFP	2.4	2.7	2.2	3.2	4.2	4.3	4.3
Baluchistan	-	-	-	-	-	-	-
Pakistan	3.7	4.6	4.6	5.5	6.3	7.3	6.8
Cottonseed oil production (000s of tons)							
Punjab	34.2	45.0	50.3	66.8	91.6	118.6	112.6
Sind	16.0	24.0	25.4	24.6	34.1	47.3	49.5
NWFP	-	(b)	(b)	(b)	(b)	(b)	(b)
Baluchistan	-	-	-	-	-	-	-
Pakistan	50.2	69.1	75.8	91.5	125.8	166.0	162.2

Source: Agricultural Statistics of Pakistan 1975

1/ Assumes that the seed is 13% oil.

(b) Below 500 tons.

70

b) Increase the oil content of the seed. Plant breeders focus their attention, as they should, on lint yield and lint quality. Because the oil content of the seed will vary over a range of 15 to 22.5%, it is important that oil content be made one measure of the quality of a variety. There appears to be no evidence that high oil content is associated with low lint yields or inferior lint quality. For every increase of 1% in oil content, 100,000 tons of seed will yield 1,000 tons of oil, all of it recoverable.

c) Increase the seed/lint ratio: Cotton breeders have stri striven to increase the lint/seed ration. In actual fact, the ratio is unimportant. What is important is the yield of each component. Breeders should focus on increasing the yield of both lint and seed per acre and thus evolve varieties which will give the greatest returns per acre both in terms of lint and seed.

d) Improved cultural practices: Considering the environment of Pakistan, including the potential soil/water/climate relationships of the cotton growing area, yields should be two or three times higher as compared to the present levels. Greater efforts should be made to: i) reduce wastage of seed at planting, ii) use line seeding preferably on raised beds iii) increase plant populations; and v) use improved fertilizer application practices.

e) Pest control: Improved system of/integrated pest control, including combination of chemicals, predators, and cultural practices must be used.

affected by several practices both on the farm and as the seed moves to the oilseed processor. Such losses are due to:

a) Wet seed cotton, due either to early picking while there is dew on the lint or deliberate sprinkling of water on the seed cotton after picking - this raises the amount of oil lost the FFA.

b) Exposure of seed cotton to adverse weather, both on the farm and at the ginneries where storage facilities are inadequate.

c) Inadequate storage at the oilseed processing plants necessitating extended storage of cotton - seed at the gins in exposed conditions.

d) Diversion of nearly 25% of the total seed productions towards uses usch as seed and animal feeding.

At the processing plant there is a major loss of oil because the equipments remove only about 80% of the oil present (the extraction rate is 12% instead of 16% or even higher). Pakistan has sufficient processing facilities, including both expelling and solvent type, to draw down oil content to 0.5%. The reason for not doing so is simple; it is more profitable to continue with present practices. Factors contributing to the uneconomic practice of removing all the oil are:

a) The high cost of removing the last 1% of oil by the solvent process.

b) Inadequate storage facilities at processing plants.

c) Preferences and higher prices for the oilseed cake containing 5 to 7% oil.

d) Low fixed price of Rs. 200/md for vegetable oil.

vegetable oil needs. Assumptions are: recovery of oil from the seed is 11.0% seed yield is 0.27 tons per acre; consumption in 1975-76 is 438,000 tons of oil and in 1979-80 is 660,000 tons. On these assumptions the needs would be:

Tons of	1975-76	1979-80	1984-85
Tons of seed	3,982,000	6,000,000	892,000
Acreage	14,740,000	22,222,000	33,000,000

It is obvious that cotton with prevailing seed yilds and oil recoveries, cannot be expected to supply the vegetable oil needs of Pakistan.

However, because of the present importance of cotton, and because the Nation will continue to increase cotton production because of fibre needs, it is important in any oilseed strategy to consider measures that will 1) increase oil yield per acre, 2) decrease losses during storage and ginning and 3) decrease losses during oil extraction and refining.

Increasing yield of oil per acre

a) Improve the quality of the seed for planting. Most farmers get their planting seed from gins, with only 20 to 25% of the seed coming from official gernment sources. There is little or no testing of planting seed for germination. By improving the quality of planting seed, there would be some saving in the amount that should be planted. More attention to planting seed would ensure that the corrent variety is sown, and that it is pure and not mixed with another variety.

refining. The only use of such "lost" material is in the manufacture of soap stocks and other industrial products. "Prime" seed in the U.S. has a maximum of 1.8% FFA, which results in a refining loss of 6.75 to 9.0% FFA increases under the following conditions:

i) High moisture levels in the seed
ii) Seed broken or injured in some way
iii) High temperatures
iv) Seed immature

Some of the loss to FFA occurs when seed cotton is stored on farms or at a collection point before ginning particularly if theseed cotton is immature and damp when harvested and stored Slight losses occure in the seed cotton at gins. Most of the increase in FFA occurs in the cotton seed at the gins because the storage period may be quite long, and storage conditions satisfactory though limited in volume, thus there is very little increase in FFA.

Losses during ginning because of seed damage are of little consequence. There has been a rapid shift from roller to saw gins in recent years, such that over 90% of the cotton is ginned by saw gins.

Decreasing losses during oil extraction:

Assuming that cottonseed contains 20% oil, the yield of oil per long ton of cottonseed from different processing equippmts will be:

Solvent extraction	424.8 lb
High pressure expellers	388.4 lb
Low pressure expellers	326.5 lb

... ... yields of oil can be achieved by using equipment giving high yields of oil. Several factors, however, have discouraged the use of such equipment. They are:

1) Inadequate storage space for seed: Enough seed should be stored to permit a run of 300 days for solvent extraction and high pressure expellers, and storage space should permit aeration of the seed and monitoring of seed temperatures. This would decrease the amount of seed in unsatisfactory storage at gins.

2) Farmer preference for oil cake: For livestock feed, farmers prefer an oilcake containing 4 to 7% oil and the linters and hulls. Actually the oil-free meal is a better feed concentrate. Only when the export demand for meal was good and prices were high in international markets, could solvent plants operate profitably.

The largest market for the hulls has been the expeller operators. They blend hulls with whole cottonseed and pass them through the expellers, thus increasing their yield of oilcake -- and further reducing oil yield because the hulls absorb oil.

Decreasing losses during refining:

Most of the low pressure expeller mills use the batch, or "open kettle" process of refining. This is true also of some of the high pressure or solvent extraction plants. It is more efficient to use the continuous refining process using contrifuges which allow a net saving for prime crude oils (FFA less than 1.8%) of 1.5 to 2.5% over the batch process. It is estimated that the refining loss in Pakistan is 15.67%.

Effects on production of oil:

The importance of raising seed yield per acre and oil recovery may be realized by computing its effect on total oil production (Table D.2) assuming that 5,000,000 acres of cotton are grown. It is apparent that an increase of seed yield by 1/100 ton/A will increase oil production by 6,000 tons, and an increase to one-half tons of seed per acre will increase total oil production to 275,000 tons. For every 1% increase in oil recovery at current yield levels, 14,000 extra tons of oil are obtained. A combination of one-half ton of seed per acre and oil recovery of 15% would give 375,000 tons of oil, more than double the current production.

Table D. 2: Production of oil from cottonseed in Pakistan under assumed levels of seed yield and oil recovery, assuming that 5,000,000 acres are grown.

Seed yield per acre in tons	Oil recovery %	Production in tons
0.27	11	148,000*
0.27	12	162,000
0.27	15	202,000
0.28	11	154,000
0.28	15	210,000
0.30	11	165,000
0.30	15	225,000
0.40	11	220,000
0.400	15	300,000
0.50	11	275,000
0.50	15	375,000

* Approximating production in 1973-74

RAPESEED AND MUSTARD

SPECIES OF THE CRUCIFER(MUSTARD) FAMILY

Species of the Crucifer family have long been important as a source of vegetable oil, particularly in countries of south Asia where they have been grown as winter (rabi) crops. The term "Crucifer" relates to the flower which has four petals position like a cross. Classified as rapeseed species are *Brassica campestris* and *B. napus*, and as mustard species *B. juncea*, *B. nigra*, *B. carinata* and *B. hirta*. Of importance among these in Pakistan are *B. campestris*, locally known as sarson (a full rabi season type) and toria (an early zaid kharif type), and *B. juncea*, locally known as raya. A species of another genus, *Eruca sativa*, locally known as teramira, is grown in Pakistan, India and Iran. Very often the term rapeseed oil has been use in world statistics to refer to all oils from the mustard family.

World importance

Table D.I gives world production of rapeseed oil. World production is about 7 million tons of seed and over 2 million tons of oil, making rapeseed the 5th most important oilseed crop, after soybean, sunflower, groundnut, and cottonseed. India, China, Pakistan and Bangladesh, countries that have a long history of rapeseed production, continue to produce large amounts. During and after World War II production in Europe increased greatly, in many cases with initial and continued state assistance. Production in Canada became important in 1956, and has increased since then. Production in Canada is mostly for export, whereas much of that in Asia and Europe is for local consumption.

In many countries, including Pakistan, rapeseed oil is consumed mostly as an edible oil without refining (in the crude form). In Europe and Canada the oil is refined and deodorized and may be hydrogenated for use in margarines and shortenings.

Table D.I. World production of rapeseed and rapeseed oil.(000s of metric tons).

Country	Rapeseed Average 1970-74	Rapeseed 1975[2]	Rapeseed 1976[3]	Rapeseed oil Average 1970-74	Rapeseed oil 1975	Rapeseed oil 1976
Bangladesh	111.8	110	120	35.2	35	38
Canada	1492.6	1635	894	508.4	419	589
Chile	59.6	56	75	18.8	18	24
China[4]	1115.4	1395	1400	351.4	439	441
Czechoslovakia	94.6	115	100	34.2	41	36
Denmark	65.6	115	90	23.4	41	32
France	664.6	532	520	23.2	192	187
Germany,East	227.6	250	270	82.0	90	97
Germany,West	241.0	199	243	86.8	72	87
India	1696.8	2211	1800	534.6	696	567
Japan	18.2	7	6	5.6	2	2
Pakistan	274.0	277	289	86.2	87	91
Poland	525.2	707	600	189.0	255	216
Sweden	292.4	327	295	105.2	118	106
Others	269.6	305	323	85.6	104	110
Total:	7149.0	8241	7025	2385.6	2609	2623

[1]Based on assumed crush and extraction rates.
[2]Preliminary. [3]Forecast. [4]People's Republic; Revised series of Economic Research Service, USDA.

Source: See Table 1.1.

A characteristic feature of the oil of most species of the mustard family is high levels of erucic acid in the seed oil. Erucic acid complicates hydrogenation, and is claimed to have some adverse effects on health. Canadian and European plant breeders have had remarkable success in producing varieties with less than 1% erucic acid, thus producing an oil that is chemically like soybean oil. They have increased erucic acid in other varieties to over 55% making the oil more valuable for certain industrial uses.

The oil contents of the different species are as follows:

sarson and toria, 40%; raya, 40%; and taramira, 33%. Yellow-seeded varieties have higher oil contents than brown-seeded varieties.

Rapeseed meal has a protein content ranging from 40% to 46%.

The amino acid composition of the protein is comparable to that of soybean. Unfortunately the meal has high levels of glucosinolates, which contributes a hot principle and pungency to the meal. Because of the glucosinolates, the meal has limited use in livestock rations. Canadian plant breeders have removed the glucosinolates genetically, so that now there are varieties available that are very low in both glucosinolates and erucic acid (these are known as 0-0, or double 0 types).

Production in Pakistan

Combined production data for all cruciferous species are given in Table E.2 Over a period of more than 25 years the area of production has not changed greatly, averaging around 1.25 million acres. About 50% of the total production is in Punjab Province and 25% in Sind Province. Rape and mustard, however, are grown in essentially all areas of Pakistan.

Yields have been low, averaging 5.8 md/A for the period 1970-71 to 1974-75. This compares with a yield of 13.2. md/A for wheat for the same period. There has been a generally upward trend in yield over a period.

Table D.2. Area, production of seed, yield per acre, and oil production of rapeseed and mustard in Pakistan. 1

Years	Acreage 000s	Seed production 000s tons	Yield md/A	Oil Production 000s tons[2]
1947-48 to 1949-50	1,028	166	4.4	56.4
1950-51 to 1954-55	1,182	179	4.1	60.9
1955-56 to 1959-60	1,377	233	4.7	79.2
1960-61 to 1964-65	1,190	217	4.9	73.8
1965-66 to 1969-70	1,169	225	5.2	76.5
1970-71 to 1974-75	1,283	275	5.8	93.5

[1]Source: Agricultural Statistics of Pakistan, 1975

[2]Assumes that the seed is 34% oil and all of it is processed of 25 years. One reason for the low yields is that the cruciferous crops are considered to be marginal, so they are put on the poor locations. Because there is an element of risk in their culture, due to choice of location on the farm, and due to frequent damage from insects coupled with uncertain markeet prices at harvest, farmers are reluctant to invest in inputs such as fertilizers, necessary to raise yield levels. Transfer of production technology from research institutes to the farmer has not been too effective.

The distribution of area of production by provinces is given in Table D.3. The major areas growing rape and mustard are Multan, Bahawalpur and Sukkur Division. For Pakistan as a whole between 2/3 and 3/4 of the acreage is irrigated.

Prices of mustard and rapeseed(Table D.4) have fluctuated from year to year, but there has been a trend upward since 1971. The average price of rapeseed was slightly higher than mustard seed during

Contd...P/5.

Table D.3. Acreage of repeseed and mustard by districts. Average for 1974-75 and 1975-76.

Division	Irrigated	Nonirrigated	Total
Punjab			
Rawalpindi	8,841	91,213	100.054
Sargodha	85,945	50,993	136.938
Lahore.	73,766	7,064	80,830
Multan.	158,948	24,562	183,510
Bahawalpur	183,233	10,300	193,533
Total Punjab	510,733	184,132	694,865
Sind			
Sukkur	-	-	188,572
Hyderabad	-	-	83,161
Total Sind	-	-	271,733
NWFP			
Peshawar	3,522	38,094	441,616
Malakand	5,225	39,420	44,645
D.I. Khan	10,292	32,988	43,280
Total NWFP	19,039	110,502	129,541
Baluchistan			
Sibi	33,486	6,674	40,160
Kalat	2,394	-	2,394
Total Baluchistan	35,880	6,674	42,554
Total Pakistan	565,652	301,308	1,138,693

Source: Government of Pakistan Final Estimate of Rapeseed and Mustared, 1975-76.

(Rs/md)

Table D.4. Average prices of rapeseed and mustard , 1971 to 1975

Year	Rapeseed	Mustard seed
Average , 1966-70	38.2	36.6
1971	41.7	41.9
1972	30.4	32.4
1973	48.1	48.0
1974	60.2	65.8
1975	82.5	87.4

Source: A. & L.P.M. & Grading, Karachi via Agricultural Statistics of Pakistan, 1975.

1966-70, with the opposite situation prevailing from 1971 to 1975.

Botanical features affecting the success of the corp.

To save space only those botanical features are considered which govern the success of the corp. These are the features that determine where it fits in the corpping system and how it is handled in breeding programs.

Growing season. The crucifers are grown in two seasons. During zaid kharif, from September to December, toria (a type of *B. campestris*) and Poorbi Raya , an early maturing version of *B. Juncea* are grown. The advantage of these types is that they will mature early enough in some locations to permit a December seeding of a rabi corp, such as wheat.

Most of the crucifers, however, are grown during the period October to April. These include sarson, raya and taramira. Planting date and variety are chosen to project flowering past the coldest period of the winter when freezing temperatures will injure the flowers and young pods.

Pollination. Pollen is distributed by insects mostly, but also by wind over short distances. Raya, Japanese rape, and B trilocularis are largely self-pollinating, though up to 20% cross-pollination may occur. The other species are self-incompatible.

Seed pod. The seed pods (siliques) are elongate and divided into two compartments (loculi) by a thin wall (false septum). Strains with three or four loculi have been found, and some breeders feel such types are higher yielding. Crucifers as a group shatter their seeds very readily when they mature, making it necessary to harvest the plants before they are fully ripe and transport them to the threshing area. Greater resistance to shattering is an important breeding objective.

Seeds. Seeds are spherical and consist of a seed coat and embryo separated by a very thin endosperm layer. Because they are small they must not be sown deep into the soil. Often where wheat and cruciferous species are sown in the same field, the crucifers will be sown in the bottom of a shallow furrow - the seeds are at about the same level as the seeds of wheat, but much closer to the surface of the soil.

Seed coats may be black, brown, reddish-brown or yellow. Yellow seed coats are thin, consequently are associated with higher percentages of oil and protein, and lower percentages of fibre. The seed coat is mucilaginous in nature, which is considered an advantage because it will absorb moisture quickly and germinate more readily in soil that has low levels of soil moisture.

Environmental requirements

Climate. As a group, plants of the mustard family require cool temperatures, hence they are zaid kharif or rabi crops in Pakistan and summer crops in Canada and northern Europe. Raya and taramira are more tolerant to both cold(freezing temperatures) and high temperatures than sarson. High temperatures hasten development, and may reduce seed size and oil content. In the flowering stage the crucifers are readily damaged by frost

After the onset of flowering dry atmospheres are preferred, because at that stage of development the plants are susceptible, to white rust and Alternaria black spot.

Soil. Mustards and rapes prefer loam soils with good drainage and neutral pH. Raya is more tolerant of salinity than the rapes.

Experience in Canada indicates that rapeseed (B.campestris and B.napus) produce a toxin or growth inhibitor that leaches from the straw left in the field after harvest. Following crops of cereals are reduced in height, dry weight, root formation, and yields. After one year the toxic effect disapperas. Because in Pakistan very little of the residue is left in the field after harvest, it is un-likely that toxins will be a problem.

Water. 2-3 irrigations depending upon the soil and weather conditions.

First irrigation is generally delayed till the appearance of the inflorescence.

At flowering & pod formation the crop should not suffer from moisture stress.

Cold waves and frosts accuring during flowering and pod formation of Sarson & Raya cause damage to flowers & pods. The feild should be kept moist during this period.

Place in the cropping system. Toria and Poorbi Raya, because they can be grown during the zaid kharif season, are not strongly competitive with other crops. In fact they may use land that might otherwise be idle. For this reason they merit serious consideration in programmes to expand acreages of cruciferous crops. Generally zaid kharif cropping has been limited to irrigated soils. Wheat-Toria-Cotton is a populer rotation.

Sarson and raya are main Rabi crops and strongly competitive with wheat, Thus a significant change in area structure under Sarson and Raya is not expected.

Sarson and raya may be grown mixed with wheat, in which case the plants of sarson and raya are harvested when they are green as fodder for Livestock. Some plants are usually left to provide seed.

Rape and mustard should not be grown on the same land year after year to avoid accumulation of diseases and pests.

Varieties.

	Potential yields. Mds.per acre. Mds. per acre.		
	Punjab	Sind	NWFP.
Raya L-18	40	25-30	--
Poorbi Raya	28	--	--
Toria	24	15-20	--
Sarson.	23	--	22
Tarmaira.	16	--	--

Varieties are divided into two groups compatible and (ii) in-compatible. Varieties Toria Selection 'A' Brown Sarson Selection'A' and Taramira Selection 'A' fall under the incompatible group while Raya and Japan rape, D.G.L. under the campatible group. The varieties under the incompatible group are constantly improved through group breeding methods. The seed stocks rapidly deterirate and re-quire replacement every alternate year with certified seed for which facilities are almost lacking.

A reasonable purity in the compatible group can be maintained for a number of years without replacement of seed stocks. Varieties Raya L-18 PR, 7, 8-9 and Poorbi Raya belong to this group.

Seed Rate. When sown by a hand drill the seed rate of 1.5 seers may be considered quite sufficient. If sown by broadcast the rate may be increased to

2 to 2.5 seers depending on the moisture condition of the soil. For a better stand seed treatment with a suitable fungicide is recommended.

FERTILIZER:

Generally no fertilizer is applied to these crops. Mostly marginal lands are devoted to their cultivation. Fertilizer at the rate of 75: 50 : 0 NPK can be used with advantage. Half of nitrogen and full dose of phosphorous should be applied broadcast at the time of preparatory cultivation. The remaining half of nitrogen should preferably be applied when the crop is in full bloom. Rapeseed and mustard have high requirements for nitrogen.

IRRIGATION:

The first irrigation is generally delayed till the appearance of the inflorescence. Two to three irrigations are generally required to crop maturity. Preferably light irrigation should be applied nearing maturity to avoid lodging. The crop should bot be starved of irrigational water during pod farmation. Toria is exclusively grown under irrigation while raya and sarson can be grown both under irrigation and rainfed. Taramira is highly drought resistant and thrives well under drought conditions.

HARVESTING AND THRESHING:

The time of harvesting has a great influence on yield as well as seed quality. The crop should be harvested as the signs of maturity appear. Heavy losses are caused due to shattering if harvesting is delayed. The crop should preferably be harvested early in the morning when dew is on the plants. The harvested crop is loosely stacked to avoid blow off due to heavy winds. Brassica napus varieties are highly shattering. The moisture content of the seed is the right measure of the harvesting time of the crop. Under mormal condition the moisture content of the seed should be about 20 percent. If the crop is harvested before actual maturity the quality of the seed is effected. The decrease in oil-content is also more pronounced.

Threshing of the crop should be carried out when weather is dry. The seed should be winnowed, sundried and stored. The moisture content of the seed at the time of storage should be about 7-8 per cent.

PESTS AND DISEASES:

Although there is a long list of pests of rapes and mustard yet two of them are most serious. Bagrada picta) painted bug is the earliest to make appearance and attacks young plants. In the event of heavy infestation the entire crop may be wiped out. The effected plants show signs of stunted growth and crumpled leaves. Sevin dust, 2 tba.i. is very effective for its control.

Brassica aphis is the most serious pest which is mainly responsible for poor yield. No

Plant protection cover is provided by the farmers or government agency. It has been is observed that systemic grannualar insecticides like Temik, Thimet, Solvirex when applied through broadcast at the time of preparatory tillage at the rate of 20 Lbs. per acre provides protection to the crop for about two months against sucking insects. Dimecron, or Metasystox (100% sprayed @ 6-8 oz per acre provide effective control.

The crop also suffers from white rust and Alter naria leaf-spot. The screening of genetic stock for resistance to these diseases is in progress so far no success has been achieved.

PRODUCTION TARGETS:

Production targets on national basis are indicated in chapter 6 Table 6.2.

Since this maximum potential of the existing varieties is quite high, therefore with the application of modern production technalogy it would not be difficult to raise the national average yields by atleast two maunds.

Assuming that the annual acreage is equally divided among toria, sarson, raya and taranira significant increase may be expected in the production by adopting suggested methods. Table E-5.

TABLE E-5.

	Production 'Tons'				
	Ist Year	2nd year	3rd Year	4th year	5th Year
i) Expected increase in yield through replacement of toria with Poorbi Raya assuming Poorbi Raya gives 50% higher yield over toria and replacement is made at the rate of 20,000 acres each year.	7200	14400	21600	28800	36000
ii) Expected increase in yield of toria through improved agronomic practices at 2 mds/acre assuming 60,000 acres are provided improved agronomic practices each year.	32148	72000	81600	86400	96000
iii) Expected increase in yield of Rabi Brassica, raya and sarson types through improved agronomic practices at 2 mds/acre assuming 120,000 acres are provided improved agronomic practices each year.	64296	163200	172800	182400	192000
iv) Expected increase in yield through replacement of taramira with B-Carrinata of 2000 acres every year among assuming 100 per cent increase in yield areas and average yield is 3 maunds/acre	480	960	1440	1920	2400
v) Expected increase in yield of taramira acreage of 300,000 at 2 md. per acre assuming 60,000 acre are provided improved agricultural practice, each year.	38400	40800	43200	45600	48000
Total:-	142524	291360	320640	345120	374400

APPENDIX-E

Groundnut (Archis hypogaea L.)

World Importance.

Groundnut is widely grown in tropical, sub-tropical regions and certain areas with warm temperate climate. Large portion of the world harvest is consumed as roasted salted nuts and for confectionary and the rest is crushed for oil.

It contains about 50% oil (shelled kernel basis) which is considered to be the best cooking medium because of its high smoke point. It is widely used as a liquid cooking oil and in the preparation of vegetable ghee, margerin, shortening and salad oil. In USA it is used for the preparation of peanut butter.

Its cake/meal after oil extraction has a protein content of nearly 55% and is extensively used in poultry and livestock feed. The meal processed under sanitary conditions can be used in a wide variety of ways to supplement human diet.

World production is shown in Table E-I.

In Pakistan groundnut is grown in Punjab, Sind and parts of NWFP. It was in-troduced in this country in 1949-50 and the first commercial crop was reported to have been planted on 1,000 acres in Rawalpindi Division of the Punjab, from where it spread to Sind and NWFP. The acreage increased slowly and steadily to 58,000 acres in 1965-66. The next two years saw a rapid increase i.e. 84,000 acres in 1966-67 and 1,25,000 acres in 1967-68 with an average yield around 15 Md./acre but due to violent price fluctuation and unfavourable market trends that followed, the acreage dropped to 86,000 in 1968-69 and to 75,000 acres in 1970-71. Since then the acreage has fluctuated between 77,000 acres to 100,000 acres depending on market prices and trends of the previous year

Contd...P/2.

Table E-I World production of groundnuts and groundnut oil[2] ('000' of metric tons)

	Groundnut			Groundnut Oil.		
	Average			Average.		
	1970-74	1975	1976	1970-74	1975	1976.
Argentine	320.8	375	338	96.8	113	102
Brazil.	777.2	335	460	199.4	86	118
China	2586.0	2800	2800	403.6	433	449
India	5485.4	6800	6250	1320.6	1230	1636
Indonesia	415.0	450	450	26.8	29	29
Mali.	136.0	100	125	33.0	29	24
Niger	190.4	25	125	52.4	27	3
Nigeria	724.0	300	550	201.8	73	24
Senegal	735.0	1210	1100	167.0	237	318
U.S.A.	1487.8	1750	1761	131.0	62	36
South Africa	363.6	257	151	87.4	154	130
Sudan	421.6	450	525	101.4	157	165
Others.	3322.6	3494	3525	405.4	430	434
Total.	16965.4	18346	18160	3226.2	3061	3469

Peanuts in shell. [2]Based on assumed crush and extraction rates. [3]Preliminary. [4]Forecasts for northern hemisphere crops. [5]Peoples Republic estimated by USDA.

India is the leading producing country followed by China. In U.S.A. Sudan and Senegal the production trend has been high.

In 1975-76 the area was reported to be 1,20,000 acres under this crop mainly in Rawalpindi Division, in the high rainfall barani contiguous districts of Jhelum, Rawalpindi and Campbellpur with a production of about 50 thousand tons.

Groundnut besides providing an excellent ground cover to protect the land from erosion in Rawalpindi Division, affords additional employment to rural masses of the area when they have no other work to do especially during the period from October to December when this crop is harvested. It is a legume and is important for maintaining soil fertility. It also provides excellent hay.

Contd....P/2

Distribution of acreage division wise, according to one estimate is as in table below:-

Table

** Year 1974-75

Rawalpindi Division	83.5%
Sergodha Division	3.6%
Bahawalpur Division	4.8%
Hyderabad, Kheirpur	3.28%
Peshawar Division	2.45
Total:	100%

Rainfed	83.25
Irrigated	16.75

Environmental requirements.

Groundnut is warm season crop like cotton and cannot withstand frost. It is mainly grown under rainfed conditions in areas with a rainfall in the range of 15 - 40 inches. The best crop is raised in areas with 40 inches rainfall. Dry weather near to maturity is ideal for ripening and harvest.

The crop prefers soils with PH value 7 to 7.5 Acid soils need adjustment or correction of the PH. with the application of lime or calcium.

Groundnut sowing starts after mid March and continues upto break of the monsoon towards end of June or early July. The Spanish types under irrigation are ready for harvest towards end July while under rainfed conditions the

Contd.....P/4.

Source: 1) Prod. and area. Agri. Statics of Pakistan 1975 Government of Pakistan Ministry of Food, Agriculture and Cooperatives.

2) Survey of the possibilities of development of groundnut cultivation and extraction of groundnut oil in Pakistan by Transport Consultants & Surveyors for GOP, Planning Commission, Economic Research Section- April 1976.

Virginia types are harvested from October through December. In fallow land it is sown with the help of moisture conserved from spring rains. The ensuing months of May and June are mostly dry, therefore, due to low soil moisture conditions the plant growth is slow but with the advent of monsoon rains it starts growing luxuriantly and pod setting starts, During the warm and humid monsoon season (July-August) 10 to 30 inches of rainfall is received which carries the crop successfully through to maturity. (Irrigated crop is located in Sanghar and Khairpur, (Sind) and in Bahawalpur, Sargodha and Peshawar Division).

VARIETIES

The following three varieties originally selected at the Punjab Agricultural Research Institute, Lyallpur are currently grown in all the three Provinces. These are long duration varieties, planted from mid March to April and harvested in October-November.

Variety	Growth Habit	No. of days for Maturity
No.45	Spreading(Virginia type)	220-230
No.334	-do- (Virginia type)	210-220
B-4(Banki)	Bush type(Virginia)	180-200

No. 45 a bold seeded Virginia runner type was the first variety released for large scale cultivation in 1954. This variety had a large percentage of pops and the shelling percentage was low. In the year 1972 variety No.334 runner Virginia type was released. Being low in FFA value and high in shelling (75 -80%) and better kernel yielder it soon captured area from variety 45 and is now the most widely grown variety. Soon the digging problem became acute as labour became more scarce and expensive. To overcome the situation a Virginia bunch type variety called Banki was released in the year 1973. This variety had all the good qualities of variety 334, its digging was less labourious and cheaper, this variety gained ground and its seed is in heavy demand

Contd...P/5.

Experiments on Spanish varieties mostly of US origin are in progress in Punjab. Varieties Argentine, is showing great promise. In the irrigated research plots yields as high as 45 maunds acre have been obtained. The variety matured in 135 days, under rainfed conditions the late planting of Spanish varieties Argentine and Star in the month of July have also been successful. Yield nearing 12 maunds/acre was found possible just in 90 days.

The irrigated crop experiment was planted towards end of March and harvested in early August. It was found that the crop fits very well in the rotation 'groundnut - maize - wheat/Rabi oilseeds'.

In Sind also considerable research work has been done as the ARI, Tando Jam on groundnut varietal improvement and selection as a result of which a variety called Tando Jam No. 16 has been evolved and recommended for cultivation under irrigated conditions. This variety reportedly produced yields of 34-35 maunds/per acre in irrigated research plots.

In the NWFP research, on groundnut is carried out at the ARI Tarnab. Over a dozen entries of spreading as well as bunch type erect strains are under study. An erect variety No. a 1-2 is reported to have produced yields of 29.34, 26.16 and 35.36 maunds/acre in trials under irrigated conditions at Pir Sabak. Dera Ismail Khan and in Swabi tehsil respectively. Varieties No. 45 and No. 334 developed at the ARI Lyallpur are commercially grown in NWFP at present. These varieties gave the following yield results in trials under irrigated condition conducted at Mansehra, D.I. Khan and Pir Sabak.

Variety	Location of Trial	Yield Acre/Mds.
334	Mansehra	34.5
33e	Pir Sabak	29
No.45	D.I. Khan	15.7
No.45	Pir Sabak	34

Contd...P/6

Considerable work on the improved production technology has been carried out in the three groundnut growing provinces at different Research Stations.

International Crops Research Institute for the Semi Arid Tropics, 'ICRISAT' an Agricultural Research Centre financed by a world scientific body has been establis hed at Hyderabad in India. According to the Charter of this Centre all UN member countries are entitled to technical assistance on the improvement of various crops particularly on Groundnut. This organization could be a source of improved production technology and germplasm of high yielding early maturing cultivars which may prove adaptable to our conditions. High yielding varieties maturing in only 90-120 days are said to be available and under cultivation in the neighbouring country. Recently the USDA/ARC Oilseeds Advisor in Islamabad, visited 'ICRISAT' in India to study the working of the Centre.

Place in cropping system.

Over 83% area is rainfed. There is tremendous scope for manifold increase in its acreage. The bulk of rainfall is received during its crop season which guarantees success harvest. Best yields are obtained when groundnut follows maize. It is also grown after pulses and millets. Considerable acreage is planted after harvesting wheat, subject to the presence of s-oil moisture.

Spanish varieties are showing promise for irrigated areas because of their adaptability in the intensive cropping pattern " cotton-groundnut-maize and grouns, maize, wheat/ Rabi oilseeds".

The Agronomy Department of the University of Florida is also arranging to organize International Groundnut Variety performance trials in Pakistan. This will surely help in selecting valuable germplasm.

Contd.P/7.

Source: Survey of the possibilities of development of groundnut cultivation and extraction of groundnut oil in Pakistan by Transport Consultants & Surveyors for Govt. of Pakistan, Planning Commission, Economic Research Se-ction- April 1976.

Soil.

Selection of land is very important. A light coloured, loose, friable sandy to sandy loam with a moderate amount of organic matter and balanced supply of nutrients may be considered as an ideal soil.

It would grow luxuriantly in heavy soils also but such soils interfered with neces-sary beg penetration of the fruit stalk into the surface. Harvesting/digging of the nut in such soils is xpensive and pods get discolcured and losses are also high.

Sandy and sandy loam soils are preferred because the crop is easily harvested.

Sandy loam soils of Chakwal, Gujranwala, Fatehjang and Khairpur districts, Swabi in Mardan and parts of Mianwali, Piplan, Kallurkot, Bhukkar and the interior of the Thal in Mianwali district, Dera Ismail Khan, Bannu and Kohat districts are most suitable for groundnut cultivation. A high level team of USAID experts comprising Soil Scientists, Agronomists, Plant Pathologists and Economists identified over 350,000 acres as suitable for its cultivation.

In Bhakkar tehsil of Mianwali District (Thal Project area), groundnut was success-fully introduced as irrigated crop in early sixties but the harvesting problem and competition from sugarcane stood in the way of its ex-pansion. The Sugar Mill at Darya Khan started production during the early period of groundnut introduction when the crop was just getting out of the teething troubles. Sugarcane besides being comparatively eas-ier to grow offered much higher and guaranteed returns ; The attention of the farmers was therefore diverted. The area under groundnut from 9203 acres in 1969-70 decreased to 2450 acres in 1974-75. Similarly the irrigated acreage in Bahawalnagar has decreased.

Large tracts of land in D.I. Khan, Bannu, and Kohat districts are suit-able for extensive cultivation of this crop but low rainfall and in-adequate irrigation facilities did not permit this so far.

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Nutrient requirement.

Soil testing is important for good soil management. The soil should be rich particularly in calcium and phosphoric acid.

It requires nitrogen to give a good start in the early stages of growth. Generally no direct fertilization is done to groundnut crop if the previous crop has been heavily fertilized. 20 lbs N and 60 lbs P_2O_5 may be considered sufficient. If soil is sandy and the rainfall is in plenty an equivalent amount of N may be applied as a second dose.

Groundnut being a legume it obtains nitrogen from the atmosphere through symbiosis with nitrogin fixing bacteria (Rhizobium Sps.) like soybean. Effective inoculation of the seed prior to sowing can assure greater yields. Inoculation of groundnut seed in Pakistan is unheard of. Whenever this point is raised the answer comes, that our farmers are planting groundnut since 1949, year after year in the same acres, the nodule bacteria are therefore sufficiently developed in the soils in groundnut growing areas. There is no question that many soils contain varying amount of nodule bacteria, but when w e give this explanation to the world scientists, there comes a big question, that is: Are the nodule bacteria in the soil in your groundnut growing areas capable of producing maximum yields'. The fact is that the carry-over bacteria are not dependable and the researches in other countries have indicated that only about one-fourth of all soil nodule bacteria are beneficial. Therefore, in-order to obtain maximum yields it would be beneficial to inoculate the seed w-ith effective strains of Rhizobium Sps. be-fore planting.

SEED PREPARATION:-

Mechanical seed shellers are not available so far. Hand shelling is done and is quite laborious and also expensive. Sixty Ib pods for the spreading type and 82 Ib for the Spanish and Virginia bunch types provide sufficient seed for an acre for a desired population . The optimum populations

Contd..P/9.

of different varieties are as follows.

Variety	Kernal weight kilo.	No. of Kernel per kilo.	Estimated plant population.
No.334	13	2300	29000
Banki.	13	2300	58000
Argentine.	18	3300	58000

In order to get a good stand the seed should be treated with suitable fungicides.

PLANTING

In rainfed areas the planting starts towards end of March and continues up to first monsoon showers. Reduced yields are obtained from late sowings. The best period is from mid-March to end of April. Under irrigation second fortnight of March is considered optimum.

The seed is planted either through dibbling or through 'Kera' behind the plough depending on the acreage to be planted. For smaller areas dibbling may be better as it can have a better control on plant population. The rows may be marked with a marker and seed dibbled 2-3 inches deep.

Plant population is very important for spreading varieties the furrows are spaced two feet apart and plants spaced 1 foot in furrows. For bunch types furrows may be 1.5ft wide and plants spaced 6 inches. Almost the entire acreage is planted on Flat.

Pests and Diseases

Dr.W.K. Bailey, Leader of the USAID team of experts in 1971 pointed out the following common diseases of groundnut :-

Leaf spot.

Stem rot.

Root Rot.

Seedling death or stunting

Seed decay after planting.

Collar or Crown rot.

He suggested practical procedures for suppressing some of the diseases by chemicals, cultural practices and crop rotation - for others he reported no effective control was known.

In Pakistan our Crop Specialists have so far reported the occurance of the following diseases :-

Tikka - leaf spot (Cercospora), a Fusarium wilt ants, hairy cater pillar and wild boars cause considerable loss of yields.

Groundnut

Harvesting

It is considered a problematic crop because of indeterminate fruiting character of the plant, labour intensive harvesting, drying curing and storage. Manual harvesting is laborious, expensive and difficult. The Crop must be harvested and nuts dug out of the ground at the right time and quickly dryed, cured and stored. Some work was done by the Agricultural Engineering Section at the ARI Lyallpur to develop tractor and

and bullock drawn diggers which have not proved sucessful when tested in the field.Recently an Agricultural Engineering Centre has been setup in Pakistan at Rawalpindi by " IRRI-PAK" under International Cooperation Programme - this Centre with the backing of world wide knowledge on the improvization of agricultural machinery might be able to suggest suitable implements for groundnut planting and harvesting.

*Report of USAID groundnut study team (1971) revealed that due to improper harvesting methods about 80% pods are detached from the plant which makes it necessary to sift through the soil by hand, increasing harvesting costs. Besides the improper method and manner of harvesting greatly increases the drying and curing problems. (In one of the fields visited by the team which had been vacated by groundnut crop and was being ploughed, the number of pods being exposed indicated 300-400 pound per acre.) Because most of the pods are already separated due to improper harvesting method, those remaining on the plant are removed and all carried to house where they are spread on the ground for drying,to be heaped up at night and spread out again the following day. This procedure is responsible for rotting of the pods,contamination by harmful moulds (Aflatoxins) and also for most of the groundnut being marketed fresh and undried.

The team recommended that inorder to encourage marketing of properly dried and cured groundnuts, the farmers should be guided to harvest the crop

at the proper maturity stage (before much pod shedding takes place) and to dry and cure the pods in the fields by inverting the lifted plants so that the vine is on the ground and the pods are exposed to the sun and wind while resting on the vine mass. This way the pods will dry to about 10% moisture in 5-7 days depending upon weather conditions.

For harvesting inrigated crop of Spanish types at the Research Stations in Punjab the fields are flooded a day earlier and the crop is harvested by pulling the plants and shaking. After this the plants are placed in the sun for two to three days and stacked for curing. The stacks are so built so as to protect from rain. When vines dry and become brittle the pods are seperated by shaking.

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* Source: 1. Pakistan Oilseeds Study Phase 1, US-AID Baily, W.K. Leader Peanuts Investigation,

2. Recommendations for increased groundnut production in West Pakistan US-AID Mission to Pakistan. March 24, 1971

* Country wide survey on groundnut potential by U.S. team of experts in 1971 further revealed the following

primary problems :-

1- Lack of short season variety to permit double cropping with wheat.

2- High harvesting costs.

3- Destruction of growing crop by rates and wild boars.

4- Lack of capital by the farmers to purchase the seed, fertilizer and pest control materials necessary to produce the crop.

5- Lack of control of diseases.

6- Lack of marketing standards allows the marketing of green peanuts, providing a basis of mistrust between the buyer and seller.

7- Widely fluctuating prices do not provide an incentive to the producer.

While short season varieties have now become available the Banks are advancing loans to farmers on easy terms for inputs, other problems continue hampering the production of groundnut.

Arrangements for the production and supply of quality seed of improved varieties to the farmers do not exist nor are there proper marketing or storage facilities for the produce.

The present average yields are low considering the potential of 25-40 maunds per acre.

I Inorder to obtain increased yields of high qulity groundnut, an intensive farmers training programme should be launched and they should be assured an attractive floor price and provided with :-

a) necessary technical know how on improved cultural practices and protection from pests and disease.

b) certified seeds of short duration varieties and other necessary inputs.

c) technical know how on harvesting of the produce.

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* Source: Recommendations for increased Groundnut production in West Pakistan - March 24,1971 USAID,Drs. James L. Butler Ray O. Hammons, Dornard A. App and Kenneth H. Garren.

In Punjab and NWFP, an Agriculture Development Project has been launched for Barani areas by the respective Provincial Governments in collaboration with US Aid Mission, besides work on other barani crops, this project envisages improvement and development of groundnut cultivation. Large number of experimental and demonstration plots will be laid out in a phased five years programme to study and demonstrate the improved production technology of this crop. In Punjab arrangements have been made to layout several hundred demonstration and fertilizer experimental plots. Varietal study plots are also being planted in the rainfed areas of Lahore DDA Circle where groundnut is now being introduced.

The efforts made in this direction under the Barani area development project would be helpful in developing groundnut in all rainfed areas.

Different views have been expressed on the economic feasibility of oil extraction from groundnut in Pakistan. A recent study conducted by a firm of consultants on the feasibility of groundnut as an oil crop, for the Planning Commission, has estimated the cost of oil at Rs.528/- per maund.

The groundnut must be shelled or dehulled before oil extraction.for maximum recovery. Solvent extraction plants in Pakistan do not have necessary equipment for dehulling groundnut.

As an alternative to oil and meal production from groundnut, it is suggested that the whole dehulled kernel should be defatted, the oil thus obtained marketed as pure oil for cooking purpose and the defatted nuts after roasting and salting sold in the market. The crop would thus serve a dual purpose. Food technologist and Chemical Engineers may be consulted on the subject.

<u>Research Needs</u>

1.Screening tests on Spanish types for yield should be carried out both under irrigated and rainfed conditions under different ecological zones to locate potential groundnut areas.

2. Production practices for Spanish types need to be standardised for irrigated and unirrigated areas.

3. Engineering research should be intensified for better type bullock drawn diggers and other tools e.g., graders, hand shellers, planters and pickers. In the presence of labour saving equipment, the acreage and production are bound to increase. This will also lower the cost of production.

4.Germplasm needs to be built up through collection from diverse sources and breeding programme strengthened.

5.The research stations need to be equipped with laboratory type graders, shellers, moisture meters germinators,etc. These will accelerate research activity and also increase efficiency.

6.Genetic segregates should be procured from ICRISAT and U.SA through the courtsey of U.S.AID,Mission in Pakistan.

9. Research on the eradication of wild bore and rodents should receive priority.

7. Provision of growth chambers will speed up research .

Production Targets

For the present Groundnut should be given more more emphasis in the areas where it is already being grown because of its special soil requirement. Northern rainfed areas of Punjab should received preference where a production maximization programme should be launched by the Provincial Department of

Agriculture under the Barani Areas Agricultural Development Project.

All out efforts should be made to remove the constraints in the development of this crop, which are fully described in this chapter.

The supply of certified seed of groundnut is already being handled by the Pakistan Agricultural supply Corp., This organization should extend their activities in regards and arrange to produce and supply to farmers atleast 25,000 maunds of shelled, treated and certified seed of the varities recommended by the PARI, Oilseeds Research Directorate.

The specialists of the ARG and PARI should extend full support to the Barani Agricultural Development Project who should arrange to guide and assist to ensure the planting of atleast 20,000 areas each year under improved varieties following scientific cultural practices. This would increase the present average yield from 15 maunds/acre to 20 maunds/acre.

The Provincial Department of Agriculture should also arrange large scale introduction of short season Spanish types in the irrigated areas. Pakistan Edible Oils Corporation Ltd., would supplement their efforts by providing price support.

Pakistan Edible Oils Corporation would supplement their efforts by providing price support and ensuring quick disposal of farmers produce.

With the implementation of this programme the groundnut production would be as shown in Table E - 2.

Table D-5

1977-78 to 1984-85   **000'Tons**

reatment	Ist year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year
ected increase in ld through replacement toria with Poorbi Raya ming Poorbi Raya s 50% higher yield toria and replacement ade at the rate of 00 acres each year.	7.2	14.4	21.6	28.8	36.0			
cted increase in yield oria through improved nomic practices at s/acre assuming 60,000 are provided improved omic prectices each	72.0	72.0	81.6	86.4	96.0			
cted increase in yield bee Brassica, raya and n types through im- d agronomic practices mds/acre assuming 00 acres are provided ved agronomic practi- ach year.	38.4	163.2	172.8	182.4	192.0			
pected increase in through replacement ramira with B-Carrinata 00 acres every year assuming 100 per cent ase in yield areas and ge yield is 3 maunds/acre.	.48	.96	1.44	1.92	2.4			

Treatment	Ist year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year
v) Ecpected increase in yield of taramira acreage of 300,000 at 2 md. per acre assuming 60,000 acre are provided improved agricultural practice, each year.	38.4	40.8	43.2	45.6	48.0			
Total	156.48	291.4	320.6	345.0	374.5			

Table E -2. **Groundnut production Targets.**

Acreage '000
Production Tons '000

	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1985-86	
Normal anticipated acreage and production projections:									
1. Acreage:	120	125	130	135	140	145	160	200	
2. Prod:	67.2	72.4	77.7	83.2	88.9	94.8	107.6	143.5	
3. Availability for crushing:	-	-	-	20.8	22.2	23.7	26.9	33.6	(25%) + 4
4. Additional production as a result of maximization programme @ 5 md/acre.	-	32	48	64	80	96	112.	128.	(All for crushing)
5. Total Seed Prod.	104.4	125.7	147.2	168.9	190.8	219.6	271.5		
6. Total seed available for crushing.	-	32	48	85	102	119.7	139.	161	(2+4)
7. Oil Production 33%.	-	10.56	15.84	28.	33.7	39.5	45.9	53.	

Note: 1977-78 season would be utilized making arrangements for seed etc., for crop year 1978-79

SUNFLOWER (HELIANTHUS ANNUUS L.)

HISTORICAL PERSPECTIVE

The origin of sunflower is controversial. Some American writers claim that it originated inNorth America and it was taken to Spain by the Spanish explorers from Central America in the middle of the 16th century whence it spread along the trade routes to Italy, Egypt, Afghanistan, India, China and Russia. According to some European authors, it originated in the southern part of the United States and Mexico where it was found growing as a weed and the Spaniards took it to Spain from where it spread throughout Europe. Both the American as well as the European authors however agree on one point and that is that the North American Indians were already using the seeds of wild sunflower as human food, the plant for medicinal purposes and the flowers for ceremonial decorations etc., for several centuries before the colonization of the new world.

Archaeological excavations in Pakistan at Bhanbore, now called Port Qassim, revealed that sunflower was known to the ancient inhabitants of Benbhore in the Indo-Pakistan Sub-Continent many centuries before the Spaniards found it in America. *One of the interesting finds is an 8th century mould excavated from the ancient Bhanbore site depicting a frieze of elephants with sunflower.

The time and place of its first cultivation as an economic plant is also uncertain but as an oilseed crop its cultivation is known to have begun in USSR in the 19th century from where it spread to eastern European countries, Turkey and Argentina. It is now finding its way into almost all countries of the world both north and south of the equator.

Sunflower breeding commenced in USSR in 1912 at the All Union Research Institute of Oil Crops at Krasnodar where most of the developmental work was carried out and a very efficient method of single plant/seed selection for high oil content and disease and pest resistance was evolved. As a result its oil content increased from 28.6% in 1940 to nearly 57% in 1976. It has now become the second largest source of edible oil in the world.

* BANBHORE Pub. by Department of Archaeology, Govt. of Pakistan. First Edition 1960 2nd Ed. 1963.

The seeds from low oil varieties which are high in both energy and protein are consumed as human food as whole roasted nuts and nut-meats, besides extensive use as bird food. Larger seeded types are generally used for such purposes. These are not at present grown in Pakistan.

There is a wild, weedy version of Helianthus annuus, which crosses very readily with the domesticated version. It is heavily branched, and produces small heads that shatter their small seeds rather readily. Also in the same species are branched ornamental types with flower colors ranging from yellow, through orange, to purple. There are many other species in the genus Helianthus

The production of oil type sunflower increased from 6 million hectares in 1950 to nearly 10 million hectares in 1972 and is continuing to expand. It is grown in Russia and eastern European countries, and in Australia, Angola, Canada, Chile, Ethiopia, France, Iran, India, Italy, Kenya, Morocco, Mexico, Philippines, Spain, South Africa, Tanzania, USA and Uruguay.

In Pakistan, until 1960, sunflower was known and grown only as an ornamental plant. Research on the oil type sunflower commenced in the country in mid-sixties and has been continuing ever since. Researches at the research institutes in all the provinces as well as extensive field trials conducted under farmers' conditions have confirmed that sunflower is an ideal crop for bridging the gap of edible oil because of the following advantages:-

1- It has high yield potential

2- It is a short period crop. It matures in 90 to 100 days and could be grown twice per year in the irrigated plains, without clashing with the major crops of wheat and cotton.

3- Being extremely drought resistant it can also be successfully grown in barani areas.

4- It is comparatively hardy crop and no major insect pest and disease problem has so far been noticed in the country. Birds, however, like sunflower seed very much and cause damage if not protected.

5- As a catch crop in irrigated areas it provides additional farm income.

6- It is rich in edible oil and protein. Oil content ranges between 35 to 50% on dry seed basis.

7- Oil from sunflower can be expelled or extracted with the equipment already existing in the country. It can also be expelled by the village kolhu or Ghanis.

8- The meal or cake, after oil extraction from decorticated sunflower seed, is rich in digestible protein and free from toxic elements which makes it extremely useful for poultry and livestock feed.

Yields reported by research stations in different ecological regions of the country are shown in tabular form below:-

Research Station	Yield lbs/acre
ARI Tandojam, Sind	1152
ARI Sariab, Quetta, Baluchistan	902-1804
PARI, Lyallpur, Punjab	2162
Lever's Research Station, Rahimyar Khan	2100
Forest Research Station, Azad Jammu Kashmir (under extreme drought)	986
ARI Tarnab and Swat, NWFP.	1175-3066

Views of the leading oilseeds research scientists of different provinces in the country are given below:-

Sind

1. Sunflower crop has been found to fit in the cropping pattern of Sind as catch crop because it is short duration and matures in 90 to 100 days. As an autumn crop, if planted in August, it would mature in October before planting of wheat. It would require 2 to 3 irrigations in this duration. As a spring crop which is more suitable for northern Sind, the sowing would be done in early February and the crop would mature by mid-May, before planting of cotton. This crop in both the seasons does not clash with any other crop. The farmers are therefore expected to accomodate this crop in their crop rotation. (Oilseeds Botanist, ARI, Tandojam).

2. It should be possible for farmers to achieve yields of 15-20 maunds/acre given a reasonable agronomic technique and seeding at the right time. This significantly increases rotational possibilities as sunflower

fits in very well as an additional crop in a cotton-cotton rotation. In areas where intensities are low there is usually plenty of land available but water is a limiting factor. With sunflower, this need not be so as the crop is grown between Rabi and Kharif when water is available. (Extension Advisor/SCARP, Khairpur).

Punjab

The sunflower crop can successfully be introduced in the irrigated and 'Barani' crop husbandry of the province with great advantage to the farmers. Oilseeds Botanist, PARI Lyallpur.

N.W.F.P.

There is a great scope for sunflower cultivation in this region, but most of the farmers don't know where to sell their produce. (Economic Botanist, ARI Tarnab).

Baluchistan

Sunflower is extremely drought resistant and offers great potential for cultivation in different ecological zones of the province. Under dryland conditions, in our research, it has outyielded the irrigated plots.(Economic Botanist, Sariab).

Azad Jammu Kashmir.

We obtained an average yield of 12 maunds/acre in our experiments without fertilizers, and under extreme drought conditions the results have been encouraging. The current year (experiments in 1971) has been unusually dry and all crops suffered from drought. According to our observation the sunflower seed produced in Azad Kashmir contains more oil as compared to the original seed used for trials. (DFO Research Division, Muzaffarabad).

It is evident from the above that sunflower could be grown as an irrigated as well as a barani crop in most parts of the country during spring, summer and autumn. This fact has also been confirmed by large scale field trials. Besides growing well in the irrigated plains, it is also an ideal crop for barani areas where it can give much higher returns as compared to certain low yielding crops already grown. Researches in Swat Valley of NWFP and in Azad Kashmir have shown that sunflower has considerable potential under rainfed conditions and its commercial cultivation can help in improving the farm economy besides contributing to the increased production of edible oil.

Sunflower is also a good honey plant. In Swat Valley about ten thousand village families are engaged in bee-keeping. There the production of honey per colony which is dependent on the wild flora is much lower than the yields per colony obtained in other countries where sunflower is grown. Sunflower can thus be of great help in increasing honey production.

Botanical features affecting success of the crop.

Growing Season

Oil type varieties with 120-160 days vegetative period from emergence to maturity in their countries of origin in temperate zones mature in 85-100 days under Pakistan conditions. Results todate indicate that in large areas of Pakistan sunflower may be grown at two zaid crop seasons of the year without interfering with the cropping patterns in vogue or without clashing with major crops.

In the high rainfall barani areas of Rawalpindi Division in Punjab Province, in Swat, Hazara and AJK sunflower can be successfully grown as a Kharif crop planted with the advent of monsoon. Also as a spring crop it can be grown in the 10-15" rainfall barani zones of Baluchistan including the sub-montane regions of Nuski and Kohlu, the areas irrigated from Bolan and Nari rivulets near Dadher-Sibi, and as Zaid Kharif planted in August in the irrigated areas of Patt feeder and Nasirabad sub-divisions.

Stems and leaves

Cultivated sunflower has a straight non-branched stem, the height depending on the variety and growing conditions. There also exists some correlation between thenumber of leaves, the height of plant, and length of vegetative period. The most active period of growth is from bud formation to the full opening of the flower. During this stage the plant is growing 1.0 cm to 1.5 cm daily.

Root

*The sunflower has a clearly pronounced primary or taproot and strongly developed net of secondary roots and rootlets. On black soils inUSSR which conserve moisture to greater depths, the main root of sunflower penetrates as deep as 2.5 to 3 meters. On such soils, when the plant reaches a height of 70 cm, the roots penetrate to a depth of 100 to 120 cm, and at the beginning of ripening of the disc when the plant attairb a height of 143 cm the main root had penetrates to a depth of 246 to 280 cm.

Under irrigated conditions in poor sandy soils it becomes a surface feeder. Study of its root system under such conditions revealed that the main root was only 30 cm to 45 cm deep while the lateral or secondary roots had spread laterally only 15 to 20 cm in all directions from the tap root when the plant height was 1.5 to 2 meters.

Under normal soil and moisture conditions its roots develop rapidly during the period from bud formation to flowering. The growth of roots in young plants significantly outstrips the stem growth. The thick net of rootlets spreads to 25 to 30 cm in surface layers of the soil, and the spreading reduces with the depth. Sunflower because of its extensive root system is capable of drawing moisture from great depths.

Flowers

The inflorescence is a composite, commonly called a capitulum or a head. The head of the oil type sunflower is composed of hundreds of tiny individual flowers packed closely together. The outer flowers in the head are called ray-florets while the inner flowers are called the disc-florets. The ray-florets are strap-like, yellow in color, and make up the "petals" of the head. They are pistillate (having no stamens) or neuter (sexless), and produce no seed.

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* BENESKAY, G.R. (1960) Agr. & Bio Pecul of S/F

*The disc-florets are pipe shaped and occupy the central region of the head and are bisexual. These florets are protandrous, i.e. their stamens ripen earlier than the carpels. They start opening in one to four whorls (circles) daily from the periphery inwards. The whole inflorescence or flower head then takes 8 to 10 days for full development or for opening of all the disc-florets. In some heads a few disc-florets may open on the same day as the ray-florets, but such florets do not form a complete circle around the periphery and may be confined to one side of it only. The upper part of the disc-floret widens and ends with five teeth. The colour of the corolla depends on the variety, and may be light yellow, brown or dark voilet.

When the disc-floret opens, its staminal filament elongates rapidly. The anther tubes appear above the corolla and dehisce on the first day pushing the pollen out from the upper end. The bifid (two-lobed) stigma which during this period is situated under the anther tubes now starts emerging with folded lobes and stands high above the pollen sacs. The lobes of the stigma separate by next morning exposing their receptive surface after which it is ready to receive pollen. After pollination/fertilization the lobes of the stigma curve down in about two hours. Then in about 8 hours they wind spirally, and in about 24 hours, fade and recede into the pipe of the corolla. If the pollination/fertilization fails the stigma will not drop in the pipe and will wither and dry protruding high above the corolla, in which case the seed will be empty, i.e. without kernel.

The pollen of sunflower is sticky and heavy, so the wind plays a comparatively small part in pollination. The stigmatic lobes do some times pick up pollen from the same floret, usually without causing fertilization. Thus sunflower is highly cross-pollinated and dependent on insects for transfer of pollen. However, some plants are self-pollinating, and some recently developed hybrid varieties are mostly or entirely self-pollinating.

Nutation

As long as the stem is growing the bud will nutate to 60° to 90° west in the evening and 50° to 70° or more east in the morning. When anthesis begins, nutation ceases and theheads face towards the east or north-east.

* PUTT, E.D. (1939) observation on morphological characters and flowering processing insunflower.

**BENESKAY, G.R.(1960) Flg. Process S/F. YNNIMK USSR.

Stage of Ripening

This is divided into two parts, spread over a period of 40 to 45 days. During the first 20 to 25 days oil formation takes place.

Seed and seed setting

*Pollination studies have confirmed that a complex relationship exists between sunflower and the honeybee. ** The percentage of seed set, i.e. seeds with kernels, is directly oorrelated with the visiting frequency of the bees. The seed is a fruit made up of a hull containing a single seed.

The hull is composed of three layers (membranes): 1) the epidermis; 2) the cortex or cork layer; and 3) the phytomelanin layer. There are coloured pigments which give colour to different layers of the seed coat. The third or phytomelanin layer, which is hard and contains carbon, is found between the cortex layer and the rigid portion of the fruit. It is the armour layer which provides protection against insect damage to the seed. The hull may be of many colors including:

1- Dark seed with gray stripes: all the layers are present and have colour pigments.

2- Gray seed with white stripes: the epidermis is transparent and phytomelanin layer is absent.

3- Black or dark stripes: only the epidermis and cortex are present.

4- Brown seed with or without stripes; the cortex is transparent.

5- Dark violet: the epidermis and cortex are transparent, but phytomelanin is coloured.

6- Silver or white: all layers are transparent, and the phytomelanin layer is absent.

Receptacle. The base of the head to which the flowers are attached contains 9% protein, and 4 to 8% fat and other valuable properties.

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* BENESKAY, G.R. (1960) Flg. process in sunflower. Agr. & Bio. Pec. in Helianthus annus L. VNNIMK, USSR.

**Kushnir, L.G. Bio. Effect of S/F Pol. by various methods Dikl.TSK ha 36:81-88

***FREE. J.B. Pollination Requirement of Sunflower 21-7-70. 958.

Seed yields. Seed yields range from 500 to 3000 kg/ha in temperate regions of the world and in the semitropical and tropical countries (including Pakistan) yields have ranged from 400 to 2000 kg/ha. Low yield levels are usually caused by improper cultural practices and lack of insect activity at pollination.

Oil yields. *Open-pollinated varieties and hybrids available from temperate zones yield 40 to 50% oil in their countries of origin but when grown in sub-tropical, and tropical countries the oil yields are lowered by about 5% due to high temperatures which cause reduction in the growth period.

Environmental requirements:

Soil. Sunflower does well in a wide range of soils but it thrives best on moisture retentive loamy soils. Salinity stricken and impervious soils are not suitable. Observations indicate that the plant is fairly tolerant to alkalinity, as it has grown in soils with pH 8.5.

**It has no ill effects on the soil. Instead it offers the advantage of improving soil fertility through the return of plant residues after crop harvest.

Climate. Varieties which normally mature in 120 to 145 days in temperate regions are ready to harvest in 85 to 90 days in Pakistan and other sub-tropical and tropical regions. The shortening of vegetative period under tropical conditions, though beneficial, causes some lowering of oil content. Varieties with oil content from 40-50% in temperate regions have 35-45% oil content in Pakistan.

*** Temperature effects the fatty acid composition also. Linoleic acid reaches values up to 70% in a cool climate, but only 35% at high temperatures.

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* Sunflower growing , Unilever -

** Sunflower prod & Marketing, Gri.Bul. 25, North Dakota state University.

*** Sunflower - Unilever.

Wind. Sunflower when grown under irrigated conditions suffers from lodging if high winds occur when the field is wet and the crop is in bloom. Earthing up helps in preventing lodging.

Water. Sunflower could be classified as one of the most drought resistant plants as it is capable of withdrawing moisture from the soil from greater depths because of its extensive root system. Twenty days before and 20 days after the beginning offlowering is the most critical period; drought or moisture stress during this phase can cause loss of yield. The plant can survive heavy moisture stress as long as the top 3-4 leaves remained turgid.

A complex irrigation experiment in Baluchistan at the Sariab Agricultural Research Institute revealed that nonirrigated plots (the moisture available in the field was from 6 to 8 inches of winter rainfall conserved on flat land) produced a better stand and higher yields as compared to irrigated plots.

In USSR yields of over two tons per hectare have been obtained with adequate pre-planting moisture and 250 mm of rainfall received prior to flowering.

Place in the Cropping system. Sunflower can be safely termed as a catch crop because of its short vegetative period of 85-100 days and its suitability as a Zaid Rabi and Zaid Kharif which enables its cultivation without causing displacement of any major crop. There are varieties with still shorter maturity periods of 65-80 days which could be introduced with greater advantage.

Sunflower can be included in a wheat-cotton rotation. It can also be safely grown where cotton follows cotton. Usually the land remains follow between the main crops. In areas where cotton cultivation has been discontinued due to a rise in the water table sunflower can prove a welcome cash crop.

Maize, however, is its strongest competitor in irrigated areas of Punjab and NWFP as in other parts of the world. Under barani conditions because of its strong penetrating root system, drought resistance, and low fertilizer requirements, sunflower tends to outyield maize with its shallow roots and high nutrient requirement. Thus it can be a good alternative crop to improve the poor farm economy of the barani areas.

Like other crops it requires good crop management practices. In USSR a five-year rotation is followed, but in Turkey sunflower follows sunflower. It is always preferable to follow a 3 to 4 year rotation to avoid the danger of fixation of diseases, such as Verticillum wilt, downy mildew and Sclerotina root rot. In US, because of the availability of disease resistant varieties, shorter rotations are being followed:

Varieties:

A number of high-oil varieties and hybrids have been tested in Pakistan:

Name of variety:	Origin & Description
Peredovik	Russian origin. Open-pollinated Havily dependents on bees for pollination. High yield capacity and high oil content.
Vniimk 8931	Russian origin. Open-pollinated Dependent on bees for pollination Drought resistant. High oil content.
Armavirec	Russian origin. Open-pollinated. Dependent on bees for pollination. Early maturing. Similar characteristics of Armavir and Armaviretz.
Issanka	French origin. Open-pollinated but fairly self-competible. High oil and seed yield.

HK -HC 1	USA origin. Open-pollinated Fairly self-compatible. Low Oil. High seed yield and widely adapted.
Record	Rumanian origin. Open-pollinated. Fairly self-compatible. High oil and seed yield.
HS 52 & HS 53	Rumanian hybrids. Fairly self-compatible. Early maturing. Uniform stand. High oil and seed yields.
GCR 101 & GCR 104	South African. Open-pollinated. Dependent on bees for pollination High oil-content and seed yield.
HS 18 (Rumanian)	Rumanian hybrid. Fairly self-compatible. High oil and seed yield. Uniform stand. Maturing earlier than HS 52 & HS 53.
INRA 65 6501, (French) INRA 4701, -do- AIRELLE, -do-	French hybrids. Short-statured, sturdy and early maturing. Uniform High oil and seed yield. Resistant to lodging.
REMIL -do-	Non-shattering. Cytoplasmic hybrid.
BIG TOP	Hybird USA origin. Fairly self compatible. capable of pollinating without reliance on bees.
SUN HI 301	Hybird USA origin.
SUN BRED 212	-do-
SUN GRO 380	-do-
IS 891	-do-

Production of varieties in Pakistan. Most open-pollinated varieties tested by us and grown commercially on a small scale during the past have been found self-incompatible necessitating the use of honeybees or manual pollination to bring about cross-pollination.

Furthermore the seed available in the country at present is that of open-pollinated varieties which has been multiplied for several generations without proper selection, and is not suitable for crop raising.

Sunflower is a predominantly cross-pollinating and the uniformity in plant height, maturity and oil cotent deteriorates rapidly unless the seed is produced each season under controlled conditions. Out-bred plants grown from open-pollinated varieties are highly variable unless recurrent selection for uniformity in different desired characters is rigidly carried out. This is time-consuming and needs four to five crop seasons to produce the Super Elite seed which could be multiplied for raising a uniform stand.

Scientists in several countries with greater sophistication in plant breeding have been continuously at work and have recently succeeded in eliminating in large part the problem of variability and self-incompatibility by evolving single-cross hybrid varieties. These hybrid varieties use cytoplasmic or genetic male sterlity and a fertility restorer gene discovered recently. France, Rumania and US have started commercial scale production of sunflower hybrids which are self-fertile, virtually homogenous, and produce high seed and oil yields. Production of hybrid planting seed by using the cytoplasmic male sterlity factor is cheaper and easier than the process using genetic male sterlity. It is important that a programme should be started to develop inbred lines for the production of single-cross hybrids. Also self-compatible open-pollinated varieties should be develpped locally.

Production practices.

Seeding methods. In irrigated ~~areas~~ deep tillage with a mouldboard plough or a disc plough is bebeficial for initial breaking. After pre-irrigation (deep soaking or "Rauni") when the soil becomes wokable (or comes to "vattar"). a seed bed is propered by ploughing four or five t mes. This pulverizes the soil to a state of fine tilth and brings up the moisture to the surface to ensure uniform germination and good stand. The seed is best sown in rows with a drill, at a depth of not more than 2 inches.

Seed rate and plant spacing. For open-pollinated varieties the seeding rate is 6-8 lb/A depending on the germination percentage and seed size. For hybrids it is 4-5 lb/A. Under irrigated conditions a plant population of 20,000 to 25,000 per acre is optimum, while under barani conditions it is 10,000 to 15,000 plants per acre. The optimum plant specing for open-pollinated sunflowers is 30 inches between rows and 9 inches between plants, or 24 inches between rows and 9-12 inches between plants. For hybride the otpimum row distance should be 36 inches with 9-12 inches between plants. Once the 1000-seed weight and germination percentage of a given batch of seed are known, the seeding ra te per acre for a desired densitycan be easily calculated. It is necessary to use 15 to 20% additional seed to make up for the loss of seed and seeding as a result of poor emergence in the field. Excess and weak seedlings should be thinned out to obtain.

the required uniform plant to plant distance necessary for optimum growth, The best stage of thinning is before the first irrigation " the seedling by then would have developed two or three pairs of true leaves". Thinning should be combined with weeding and hoeing. Earthing up or ridging is beneficial. It helps in preventing lodging and also conserves moisture. Closer planting results in small heads and small seeds whereas with wide rows and increased plant distance sunflower compensates by producing large heads and large seed.

Fertilizer requirements. Sunflowers respond well to fertilizers when the soil is deficient in essential nutrients. Pakistani soils are universally deficient in nitrogen, phosphorus and organic matter. Studies in Noviasd indicated that for the production of 2980 kg/ha of seed the sunflower extracted the following amounts (in kg/ha) of major nutrients from the soil from emergence to maturity: N, 165.6; P, 50; and K, 214. These are the minimal amounts which must be available to the crop to produce the above yield. Table below shows the NPK assimilated from the cotyledon stage to maturity.

Table Accumulation of dry matter and assimilates, N, P, and K in sunflower. Average for 2 years*.

Stage of development.	Plant part.	Absolute dry matter kg/ha.	Extraction (kg/ha)		
			N	P_2O_5	K_2O
Cotyledon	Root + stalk	1.41	0.045	0.021	0.040
	leaf	2.67	0.140	0.057	0.075
Total:		4.08	0.175	0.078	0.115
10 pairs of leaves.	Root	170.0	1.8	1.21	5.0
	stalk	850.0	9.2	6.20	37.65
	Leaf	650.0	33.1	6.63	19.63
Total:		1670.0	44.1	14.04	62.38

Full maturity	Root	850.0	4.1	1.2	12.0
	Stalk	3800.0	27.3	5.3	80.0
	Leaf	1643.0	22.6	5.9	33.4
	Head	1660.0	17.4	6.1	61.9
	Seed	2980.0	94.2	32.2	27.0
Total		10933.0	165.6	50.7	214.5

*Source: Sunflower in Novisad Research Institute, Yogolavia Engineers: T.Vrebolov and Vina Nikolic.

In view of the fact that nutrient requirement will differ from location to location it is not possible to make general recommendations. However, in most cases it has been observed that under irrigated conditions an application of 75 lb of N, 50 lb P_2O_5 and 50 lb K_2O has produced good results. Twently five pounds of N and the entire amount of P and K are applied before planting. This is available from 1 bag DAP and 1 bag potassium sulfate. It is best applied by seed cum-fertiliser drill as a combined operation with seed sowing. The remaining 50 lb of N is applied as a side dressing with the second irrigation at approximately the bud formation stage.

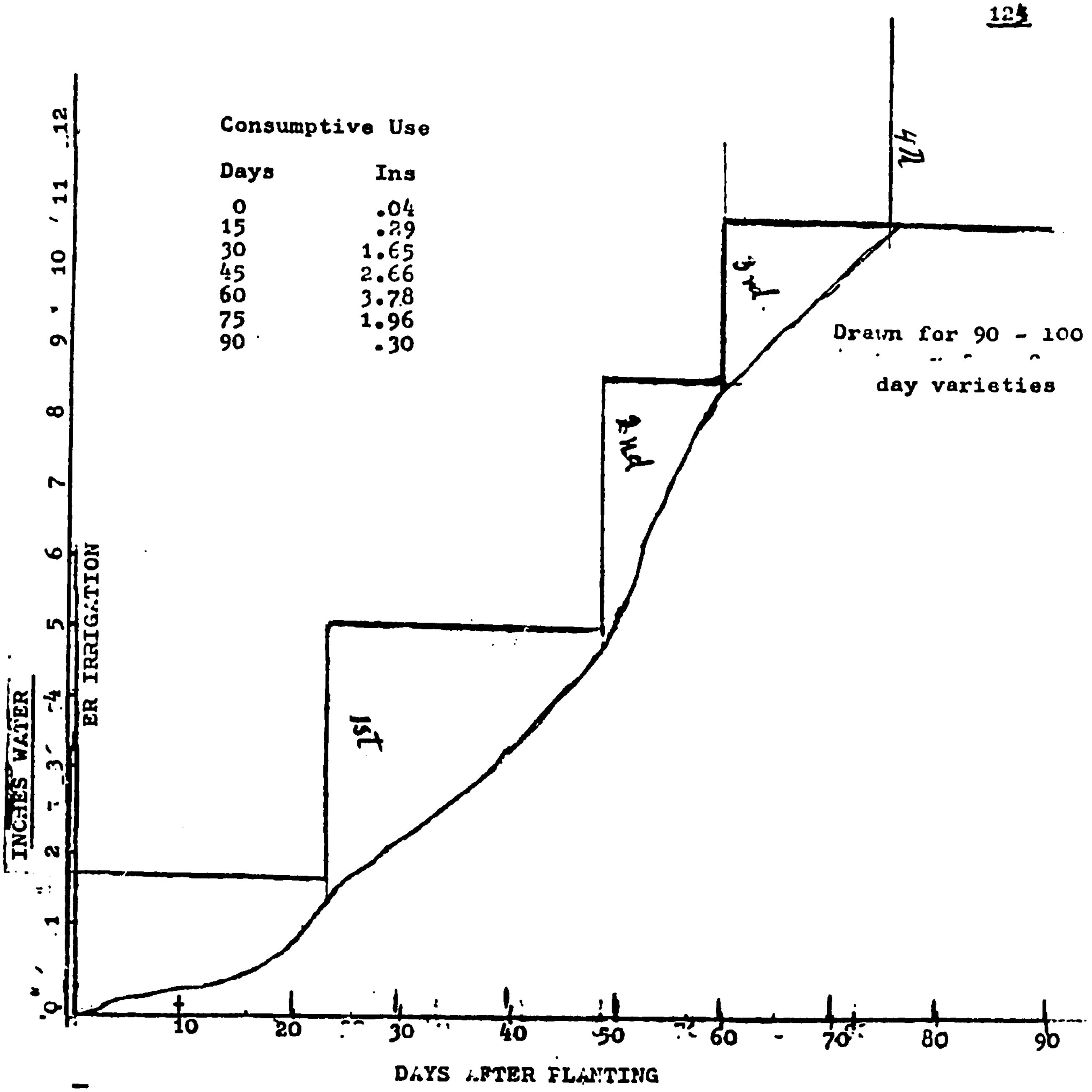
Though the soils of Pakistan have considerable postassium content, still it is found helpful for sunflower growth to apply a small amount of this nutrient to alleviate the antagonistic effect of Ca Co3 and alklinity.

Hoeing, Weeding and Earthing up. Hoeing is very beneficial; it destroys the weeds breaks the crust, and help in moisture conservation and root aeration. First hoeing should be done when the plants have develped 2 to 3 pairs of leaves and may be combined with the thinning operation. Earthing up under irrigated conditions helps both to conserve moisture and to prevent lodging.

Irrigation. When the seed is sown in a throughly prepared moist seedbed which has been supplied with sufficient moisture by deep initial soaking, the first irrigation would be required 3 to 4 weeks after emergence of seedlings, and the second irrigation 3 to 4 weeks later when the flower buds start appearing. During the period from bud formation to full opening of the flowers the plant grows very rapidly. It must not suffer from moisture stress. The graph attached shows the consumptive water use rate, and the suggested depth and frequency of irrigation keeping in view the critical phase of the plant growth.

Irrigation requirement varies between 16 to 22 inches depending upon the soil type, the season and weather conditions, and the variety grown. Atmospheric temperatures above 32°C promote excessive loss of soil moisture by evaporation and plant transpiration. Care should be taken that the irrigated spring season crop in Upper Sind, in the plains of Baluchistan and in the Southern Punjab (arid and semi-arid zones) does not suffer from moisture stress, as the temperatures in those regions reach high levels in early April when the crop is in the seed development stage.

Seed setting. Most open-pollinated varieties of sunflowers are dependent on honeybees and other long



Graph courtesy of: Goss and Fowell, SCARF-Khairpur tongued insects for pollination. In the absence of honeybees and other insect pollinators the seed setting is low, resulting in poor yields. Honeybees and pollinating insects have cyclical periods when their prevalence fluctuates, and they may be abundant or scarce from season to season and from place to place. There may be large population of wild insect pollinators and honeybees when the sunflower crop is in bloom for one season but in the succeeding season there may not be enough insects to pollinate the acreage planted. Similarly, they may be sufficient and present at a certain farm but absent or insufficient at an other in the same season. Iran, India and several tropical countries are also facing this problem but are going ahead with their programmes of expanding sunflower cultivation. In Iran, starting with 1991 ha in 1967 with a low average yield of 599 kg/ha, sunflowers now occupy nearly 110,000 hectares with only 700 kg/ha yield. The problems faced in that country have been the same as faced in Pakistan, i.e. unfilled seeds and bird dameage. India started commercial cultivation of sunflower in 1970 and this crop now occupies more than 3000,000/ha with an average yield of 727 kg/ha.

Bee keeping is not popular in the plains of Pakistan. In fact here the low natural population is being destroyed unintentonally by indiscriminate use of pesticides in a bid to protect crops from harmful insects.

In order to ensure satisfactory seed setting in open pollinated sunflower, im areas where natural bee population is low or insufficient, it is advisable to :-

a) Either employ hand pollination which is a simple and sure method, or

b) bee keeping should be encouraged. This would not only ensure high yields of sunflower seed and oil but would also provide additional income from the honey produced besides benefitting other crops.

Manual pollination of sunflower under our conditions where farm labour is plentiful and cheap could be successfully and economically employed in order to solve the problem of seed setting. This is a sure, simple and fascinating method and is recommended by top sunflower scientists of the world. Even the UN/FAO Commodity Policy Mission on oilseeds and edible oils after a country-wide survey declared it practicable and recommended it for adoption.

Evidence accumulated to date indicates that the self-compatible hybrid varieties will set a satisfactery crop of seed without the need for either honey bees or - hand pellination.

Maturity, harvesting and storage. A maturity the colour of the back of the head becomes brownish and the kernel in the seed contains 10 to 15% moisture. For harvesting, a common sickle "Datri" is used to remove the head from the plant. The stalk is cut just under the head and the harvested heads placed on the threshing ground and the seed threshed out by beating with sticks. The seed should be spread out in the sun for a few days for drying to avaid deterioration and should be cleaned before storage.

Pests

Birds. Parrots and certain other depredatory birds cause considerable damage to the crop during the period from seed setting to harvest. Bird repellant chemicals and other methods have been evolved for crop protection which are under test. FAO of the U.N. has a special project in hand in this problem in Pakistan. Mr. Tom Roberts, Project Manager UN/FAO pest coutral Project should be contacted in the commiton. In the meantime the crop can be protected by scaring away the birds and planting away from three groves which provide shelter for perching. The fields need to be guarded from first light until dark each day for about a month from seed setting until harvest. One watchman can conveniently walk around and effectively guard a block of ten acres.

Diseases. No significant problem of diseases has so far been faced in most parts of the country. Some damage by root rot and stem rot has been observed. In other countries several diseases cause damage to sunflowers, which are listed below. [illegible] . It is necessary to watch for them though most cultivars now developed are fairly resistant:

Verticillium wilt. Caused by *V. alboatrum* and/or *V. dahliae*. The fungus is endemic and difficult to eradicated from infested soils.

Downy mildew. Caused by *Plasmopara halstedii* or *P. helianthi*. It is destructive disease in wet seasons and saturated soils particularly where crop rotation is not practiced.

Charcoal rot. Caused by *Macrophomina phaseoli*.

Head and stem rot. Caused by *Sclerotinia sclerotiorum*. A soil borne fungus.

Leaf Spot. Caused by *Septoria helianthi*.

Wilt and root rot. Caused by *Fusarium alboratnum*.

Black root rot. Caused by *Scleroti*.

Powdery Mildew. Caused by *Erysiphe cichoracearum*

Insects. [illegible] . A few insects have caused damage in Pakistan including: the black headed cricket in Upper Sind which damages all crops at emergence; and the whitb fly in cotton producing areas. Insects causing damage in the United States are: Homoeosoma ellectellum (sunflower head moth); Heliothis; Lygus; field cricket; grasshoppers; and cutworms.

Orbanche cumana. A parastic plant. Most sunflower varieties of Russion origin are resistant. A five-year rotation is advisable also.

Processing and utilization.

Stability and fatty acid composition are the two most important determentants of the quality of edible oils. In both respects sunflower oil is superior, as it strikes an ideal balance between the amount of polyunsturated fatty acids and stability for edible purposes. It is prized as a cooking oil and can be used as salad oil. It is converted into margarine or hydrogenated to form vanaspati.

For all oilseeds with high oil content such as sunflower combined expelling plus solvent process is used, leaving 0.5 to 1.5% oil in the meal.

For efficient recovery of oil and production of low fibre meal the seed is decorticated before expelling. The hulls are about 25 to 27% of the seed weight. By efficient decortication 17 to 18% hulls are removed and the rest goes in the cake or meal. Protein in the decorticated meal is 45 to 46% with 17 to 18% crude fibre.

In USSR the hulls are sometimes used for manufacture of alcohol, furfurol yeast and as basic material for chipboards. Mostly they are used as fuel in factories for steam generation. In the United States the hulls are ground and pelleted with various rations of alfalfa meal, thus producing a high quality roughage for ruminants.

Dry flower-heads or dics after threshing contain about 9% protein and 4 to 6% fat, and can be used as a cattle feed. These are easily pulverized into a flour and added to animal feeds. They may also be used locally as a fuel for cooking.

Preliminary investigations of sunflower meal carried out by the scientists in US as a source of high-protein human food have provided encouraging results. It does not cause gases in the digestive tract as do soybean meal products. So far the commercial use of sunflower meal is as a protein-rich livestock and poultry feed.

Research needs.

1. Variety evaluation
2. Development of production practices for irrigated as well barani areas.
3. Development of harvesting and threshing techniques
4. Development of a breeding programme. Priority to be given to self-compatible varieties.
5. Development of resistance to, or control of, insect pests and diseases.
6. Fertilizer requirements.

Production targets.

Irrigated areas. For the two crop seasons of the first year sunflower production should be confined to the irrigated areas of upper and lower Sind (Divisions of Hyderabad and Khairpur), in the Punjab to the Divisions of Bahawalpur, Multan and Sargodha, and in Baluchistan to areas irrigated by Bolan and Nari rivulets near Dadu, Sibi and in Patt Feeder area and Nasirabad Sub-Division.

Sunflower has already been extensively tested on a semi-commercial scale in these areas. Lack of technical know how with the farmers, unattractive prices and absence of necessary marketing facilities were responsible for the crop not having caught on commercially.

Barani Areas. In barani areas for the first two years it should be extensively tested on a semi-commercial scale in Swat, Hazara and Kohat Districts of NWFP, in AJK, and in Rawalpindi Division in the Punjab, and in 10 -15 inch rainfall zone of Toba Achakzai, Toba Kakri, Submountane areas Nuski, Wad and Kohlu in Baluchistan.

Suggested Contracted crop targets.

1000 acres.

	Punjab	Sind	NWFP	AJK	Baluchistan	Total
1977-78	1	1	0.5	.05	0.5	3.05
78-79	5	4	0.5	0.5	0.5	10.5
79-80	10	8	2	1	2.2	23.2
80-81	22	18	4	1	3	48
81-82	32	30	14	4	6	86
82-83	50	45	25	5	10	135
83-84	75	66	30	6	18	195
84-85	90	75	36	9	18	228

Target for Sind The above crop targets for the province of Sind have been fixed in consultation with Oilseeds Botanist, ARI, Tando Jam with whom discussions were held in the office of ARC Oilseeds Research Advisor at Islamabad on 14.10.1976.

Targets for Punjab. The above targets for sunflowers in Punjab have been obtained from a proposal submitted by the Oilseeds Botainists, ARI, Lyallpur to Punjab Government and the PIDB in 1974-75.

The above are conservative estimates based on a guaranteed price of Rs.110 per maund for clean dry seed. Depending on the success of the first two years the target may be increased.

APPENDIX-G

SOYBEAN (CLYCINE MAX. L) MERRILL

Historical Perspective

Soybean has a fasinating history, its origin is a matter of some contraversy but most writers describe it as one of the oldest food plants originating from China. The first written record of soybean is found in the ancient Materica Medica by Emperor Shenung who ruled China much earlier than 2000 B.C.

Oriental people recognize it as a plant which provides food to serve all needs of the family and is considered as a universal protective factor in food. It is high protein-meal corp; its oil is a by-product. Its proteins contain nearly optimum proportions of amino acids essential for the nutrition of man and animals. *Its oil is considered superior to milk fat. Its carbohydrates are extremely low equal to only about one third of the amount present in Wheat and Rice. The lecithin contents in its oil help building nerves and mental power and rejuvenation of endocrine glands. The same lecithin content in one pound of soybean flour is considered equal to four eggs. Soybean flour can be blended with wheat flour for high protein chappatis and tanduri roti. Methods have been developed for the preparation of milk and Curd from soybean which have similar nutritional properties as cow's milk.

Soybean is the largest source of edible oil in the world U.S.A. Brazil, China, Japan and Indonesia are the important producing countries. Its cultivation is now spreading all over the world.

The history of soybean in Indo-Pakistan subcontinent is difficult to trace but it can be safely said that soybean is known in this part of the world since a long time but its cultivation untill recently remained confined to small research plots though conditions were suitable for its cultivation in most parts of Pakistan.

* "Soybean" Information Bulletin 2/1976 BCSIR Drs. G. Rehman, A. Khalique, Dr(Miss) F.Z. Majid and Dr. M. Shabidullah.

In Hazara district of NWFP an ind.genous variety called Mothi is grown for feed and forege since time immemorial.

Soybean has been under investigation with researchers in all the Provinces. In NWFP yields ranging from 29 to 42 maunds/ acre have been reported from experiments conducted by the Economic Botanist under the International Soybean variety performance Trials. Oilseeds Botainst, ARI Tando Jam has reported yields ranging from 25 to 33 maunds per acre from the Research Plots. Economic Botanist Baluchistan at the Agriculture Research Institute, Sariab, Quetta, obtained yields ranging from 15 to 18 maunds/acre. Experiments are also underway in the irrigated plains of Baluchistan. Current experiments at the ARC Research Station at Islamabad, conducted by the Oilseeds Advisor, amply demonstrate the suitability of soybean for the high rainfall areas of Rawalpindi Division in the Punjab.

Several attempt have been made during the past two decades to introduce the soybean in the crop husbandry of NWFP and Sind but lack of marketing facilities reportedly frustrated the efforts.

In 1955 the former BOM (Sind) imported 30 tons seed or variety Hampter 266-A, for seed multiplication and planted same with 44 farmers on a total area of 1300 acres in Lower Sind. A total production of 11002 maunds was obtained with an average of 8.46 maunds/acres.

In 1976 the crop was again planted on tetoceo acres but due to poor germination and subsequent damage caused by inprecented rain only 1882 acres reached maturnity. A total yield of 16521 maunds (average 8.77 mds/acres) was obtained. Arrangements have been maded by PEOC for planting 5000 acres in the Province of Sind in Kharif 1977.

In the NWFP the Provincial Department of Agriculture i imported 100 tons seeds of the following four varieties of soybean from USA in early 1976:

Table

S.No.	Variety	Quantity	
1.	Bragg	70 Tons	
2.	Lee	20 Tons	
3.	Picket-71	5 Tons	
4.	Forrest	5 tons	100 tons

Contd...P/4.

The seed was distributed to the farmers for planting in different Divisions of the Province through the Deputy Directors of Agriculture as shown below:-

Table

	Bragg	Lee	Picket-71	Forrest	Total
DDA, Peshawar	30	8	2	2	42
DDA, Malakand	30	8	2	2	42
DAA/TA Peshawar	10	4	1	1	16
	70	20	5	5	100

The seed was initially given on seed to seed basis i.e. an equal quantity of seed would be recovered from the produce of the relevant farmers and will be given to those farmers who do not have seed of the new varities. A floor price of Rs. 100/- per maund and a guarantee for the procurement of the entire surplus produce was also given.

Area sown was reported to be about 2500 acres.

Result obtained

The Chairman, strategy Work Group and two members visited the growing areas in NWFP in April 1977. The concerned staff of the Department of Agriculture whom they met reported that the average yields obtained were 6 to 15 mds/acres but due to delay in arrangements for procurement the farmers were compelled to dispose off bulk of the produce as livestock feed and only about 4500 maunds seed (i.e. average about 2 mds/acre) could be procured by the Department and the Sarhad Development Authority, partly reserved as seed for redistribution to the farmers for planting 4000 - acres in Kharif 1977 and the rest transferred to PEOC for oil proceeding.

Botanical features affecting the success of the crop:

Growing season:

It is a Kharif crop.

*Researches indicate that soybean plant being photoperiod senstive and making the transition from vegetative to flowering stages in direct response to daylength, its flowering is delayed and excessive vegetative growth is produced, even its flowering is prevented if days are too long. On the other hand the plant flowers within 30 days, much before there is adequate vegetative growth to produce maximum yields if the days are too short. The scientists have, therefore, placed soybean varities in 10 maturity groups from 00 to VIII according to their day length and temperature requirements, which are given below:-

Table

Day length	Days to maturity
About 16 hours	105 - 102 days
About 14 hours	165 - 180 days

Roots

Soybean root system consists of a weak taproot with a large number of secondary roots arranged on it in four rows and several orders of branch roots and extensively branched adventitious roots. The root system would vary with cultural conditions. Being a leguminous plant soybean is capable of obtaining nitrogen from the atmosphere through the action of becterium 'Rizobium Japonicum'. Under favourable conditious nodules start developing on roots within a week or ten days after emergance but nitrogen fixation starts about two weeks later. At maturity the system is extensively nodulated.

* Wilcox, J.R, Soybean Investigation USDA/USAID FEDS - Field Report No.11 September, 1971.

Stem.

Closer planting causes slendar stem, longer internodes, and taller plants resulting in decreased ability of theplant to stand. If the population is optimum the reduction in row width by a few inches would have little effect on the ability of the plant to stand. Low population encourages excessive branching and stronger stem.

Flowering.

The plant will enter the reporductive stage following the period of vegetative growth varying with variety and environmental conditions including day length and temperature. The axillary buds develop into flower clusters of 2 to 35 flowers each.

Pod and seed formation.

*Soybean plant draws about 30% of its potassium and 40% phosphorus and nitrogen from the soil during the seed filling stage.

Compensation

Wider plant distancing encourages excessive branching contributing towards yields. Soybeans therefore have the ability to compensate for the population veriation.

Maturity.

When all the leaves become yellow with half of them having fallen from the plant.

Harvesting

The crop should be harvested soon after maturity to avoid seed shattering. In US and other countries, soybeans are harvested with about 17% moisture; shattering and seed cracking occurs, resulting in yield losses when the crop is harvested with moisture below 13%. When the dry matter accumulation in seed is concluded the moisture content drops rapidly which may cause the crop to become too dry for optimum harvest and result in heavy shattering.

*Soybean Studies on the Production and Utilization. BCSIR. Bulletin 2/1976.

Environmental requirements

*Soybean would grow in a wide range of soils. Deep and well drained soils are ideally suited. Good yields are also reported from heavy clay and somewhat poorly drained soils but in such soils root rots cause severe losses and reduce the yields. Worldwide investigations reveal that the optimum PH range of soils for soybean cultivation is 6.0-6.5. It does however grow on alkaline soils but in such soils the micronutrient deficiencies hamper its growth. Salinity tolerant varieties are available which should be tested. Its cultivation in saline soils or soils with higher PH value results in increased mortality, leaf necrosis, decreased percentage and rate of germination, dry stem production and low seed yield and quality. The UN/FAO commodity Policy Study Team in 1975 cautioned that much of the soil in Sind has high salt content and Soybean is very susceptible to salt toxicity.

*Study on the total uptake of the major elements 'NPK' conducted by scientists in the US revealed that a crop of soybean which produced 3,400 k.g. of seed/ha contained approximately 177 k.g. of nitrogen, 21.k.g. of Phosphorous, and 59/k.g. of potassium. This goes to show that for obtaining above yields these are the minimum amounts of major nutrients which must be available to the plant.

Soils of Pakistan have sufficient postassium but are deficient in nitrogen and Phosphorous. It would be necessary to apply one bag of Diamonium phosphate per acre at the time of land preparation to provide the required amount of phosphorous and also some nitrogen as a starter. The bacterium introduced by inocluating the seed would take care of the future nitrogen requirements.

*Soybean, a leguminous plant is capable of obtaining nitrogen from the atmosphere through the action of becterium 'Rhizobium Japonicums' present in the nodules developing on its roots. For its successfull growth the nitrogen fixing bacteria can be easily introduced by coating the seed with commercially available effective brands of inoculum.

* Soybean on worldwide basis. Wilcox, J.R, Pak. Oilseeds study USDA/ USAID Ist Phase Report - January, 1971.

The farmers in soybean growing countries regularly inoculate the seed each season before planting, irrespective of the fact that there has been a nodulated soybean crop in the same field previously. The most reliable and effective brand of commercial inoculum is the 'NITRAGIN' from USA. Facilities are also said to be available for the production of inoculum at A.R.I. Tarnab, NWFP.

Care should be taken to meet the nitrogen requirement of the plant by applying commercial nitroge-nous fertilizers if nodulation is poor.

Climate & temperature

Soybean varieties so for tested have withoutstood the high summer day temperatures of 118 °F in Hyderabad Sind under irrigated condition.

Water

Soybean crop requires about 50 - 80 cm. of water. Excess moisture or drought can be injurous to germinating seed. Flowring and pod filling stage is the most critical when the crop must not suffer from moisture stress. In southern Sind, the soybeans mature successfully with about 30 acre/inces of water. Depending upon the weather conditions and the soil type, irrigation is applied after every 10-20 days.

Production practices.

Seeded and seeding method.

Deep ploughing and a well pulverized and moist seedbed, is important for satisfactory germination and for efficient moisture and nutrient uptake by roots. Seed is best planted at 1½ to 2 inces deep, with a kharif drill in rows 18" to 20" apart and 2 inches to 4 inches from seed to seed. 18" or a 20" wide row should have 4 to 6 plants per foot of row.

Seeding rates: and satisfactory stands.

A good seed lot has nearly 85% germination. The seed rates would vary with the variety because of great difference in seed size among varieties. Normally 40 to 60 Lbs. seed/acre is used for obtaining optimum population of 1,20,000 to 1,40,000 plants depending on the variety, the environment and the field fertility level. Soybean has the ability to compensate for variation in population. Varieties suseptable to lodging or those having tendency to branch do better at lower populations as compared to the lodging resistant and non branching varieties.

Irrigation.

Moisture stress at the time of flowering and pod development world result in low yields. For a successful harvest, irrigation would be required after every 10-20 days. **Soybean crop requires about 30 acre/inches of water in Sind. *In Hazara, Parachinar and (Kurram Agency) and Malakand it is grown as "BARANI". The rainfall in those areas is reported to be sufficient for a successful harvest.

Weed Control.

It would be necessary to effectively control the perennial and Kharif weeds which grow luxuriently in soybean fields during monsoon and cause severe loss of yields. It is important to control weeds as early as possible in the season.

Place in cropping system.

Soybean is a Kharif crop maturing in about 120-150 days. In south Sind it is grown with irrigation and is planted in June while the cotton is planted in April-May. It therefore does not much affect the cotton acreage but according to preliminary irrigation by the oilseed Batonist would partly replace rice and sorghum. Soybean/Wheat rotation seems ideal for that area as under this pattern it would not make demand for additional land.

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*Report on cropping Pakistan, Department of Agriculture West Pakistan, Peshawar Region 1969.

In Punjab it can be introduced in the high rainfall areas of Rawalpindi division and in Sialkot District. It could also find a place in irrigated areas of Sargodha Division where cotton fails to grow satisfactorily and the farmers are looking for an alternative Kharif cash crop.

In NWFP high rainfall areas of Mansehra, Swabi, Malakand Agency and Kurrum Valley where there is adequate summer rainfall and other conditions are suitable, it would however cause some displacement of barani Maize which is an exhaustive crop and its repeated cultivation without following a proper rotation with a legumenous crop has caused soil depletion particularly in areas where Wheat-Maize rotation is followed. Soybean in such areas, besides producing higher economic returns for the growers would help improving soil fertility. Soybean can also be interplanted with Maize in alternate rows or alternate blocks of three to four rows.

Varieties

Study by a team of experts from US under the auspices of US-AID Mission in Pakistan in 1971 and reports of various agricultural Research Institutes indicate that varieties adapted to Pakistan are Hill, Dare, and York in maturity group V; Hood, Lee 68, and Davis in maturity group VII, Bragg, Semmes, and Jackson in matiruty Group VII; and Hampton, Hardee, and Improved Pellican in maturity group VIII. Varieties Picket-71 and Forrest have also been recently successfully tested on semi-commercial scale in NWFP. In Sind varieties Cokor 240 and I.F. 60 and Hampton 266-A have been tested with success. It is important that the varieties selected are determinate should be in character and be resistant to lodging and shattering.

Short duration varieties Loopa and Subesine which mature in 80-90 days and are recommended by oilseed Batanist Sind if it is desired to vacate the land earlier.

Pests and diseases.

No serious insect pest and disease problem has so far been reported in Pakistan except some damage by field cricket, white ants and white fly, besides minor trouble with post emergance damping off and root rot, nevertheless Dr. J.R. Wilcox, US Soybean Investigation Expert who visited Pakistan in 1971 reported that Hairy caterpillers and sucking insects have caused damage to variety trials of soybeans and cautioned that virus yellows of soybean severly troubling the crop in Northern India could be expected to infest soybeans in Pakistan, besides over 30 different insects observed on soybeans in India could also be expected to attack this plant. Soybeans, therefore, need to be carefully watched for the occurance of insect/pests and diseases in areas where we are introducing this corp.

Harvesting threshing and storage.

*It is important to harvest soybeans at the proper time to minimize yield losses and quality deterioration in the field. The quality of the seed is affected by environmental and climatic conditions from the time its moisture content first drops below 25% during the post maturiation drying phase until the seed is harvested. The problem of maintaining viability during the period from ripening and harvest is greater in soybean than other crop seeds since the soybean seed is physiologically mature, it is in effect 'stored' in the field during this period. Frequent or prolonged precipitation during this period, results in alternate wetting and drying of the seed in the pods causing severe deterioration.

The crop should be harvested threshed, dried and stored soon after maturity to prevent damage from weather adversities and also to avoid seed shattering. In US and other countries, soybeans are harvested with about 17% moisture. Shattering and seed cracking occures resulting in yield losses when the crop is harvested with moisture below 13%. Seed cracking and shattering problem is also reported by growers in Sind.

* Post harvest technology of soybean, by Dr. F.Z. Majid and Lutifun Nihar, B.C.S.I.R, Dacca.

*The storability of seed is very much influenced by the degree to which the seed has deteriorated prior to storage. Soybean seed subjected to weathering before harvest, or damaged during threshing and or inadequately aerated during bulk storage does not store well.

U.S. Farmers recognized early that soybean seed was somewhat different from most other seeds. Very often the soybean seed ferminated poorly even just after harvest and its germination gurther decreased during storage to the extent that by the next sowing season it was worthless for planting despite the fact that common seed saving methods had been practiced. The farmers therefore truned increasingly to the specialized seed producers for their entire seed requirement.

Storage of soybean seed is an acute problem in sub-tropical and tropical regions causing rapid deterioration in viability and the seed quality and also favoured growth and activities of undesireable pests and moulds etc.

Dr. N.G. Mamicpic conducted a study on seed longevity of soybeans in relation to seed production in Philipines. This study indicated that viability in soybean can be maintained for atleast 10 months if the seed is stored with 8% moisture throughout but very drastic loss of viability occurs when seed is stored with 12% or higher moisture content. When stored in porous bags, the moisture content in seed increases from 8-12% in less than a month if the RH is high. For 5 months storage, drying seed to 8-12% initial moisture content and packed in jute or other porus bags in ordinary room should keep it in good condition. But for 10 months storage, seed must be dried to 8% moisture content and kept in vapour proof or air-tight containers to maintain viability. Yet an extensive (on the farm) storage study in U.S. indicated that if moisture in seed was held in safe limits, most other storage problems were minimized. At 10% moisture content or less, soybeans remained in good condition upto 4 years and with about 12% moisture, germination declined considerably in the first year and was down to nearly Zero after 3 years.

* Drs. F.Z. Majid Lutifun Nihar, BCSIR Laboratories, Dacca "Post Harvest Technology of Soybean."

In Bangladesh at the B.C.S.R. Laboratories and in India at the Central Food Technological Research Institute (CFTRI) considerable work has been done on the problem of rural storage and suitable methods have been developed keeping in view the general level of literacy of the farmers and resources available to them.

Processing and utilization

Modern solvant extraction equipment is used for processing soybeans for obtaining maximum recoveries of both the oil and the protein. Experimental processing by lever Brothers with 100 tons seed purchased free PEOC in 1977 has given 21.8.% oil and 78% meal. The seed contained 23.6% oil with 6.8% moisture.

With increased production the problems connected with the disposal of soybean meal after oil extraction, would arise. There will be a strong competition from major producing countries in the world market. The example of 1974-75 is before us when Pakistani Oil Millers were compelled to shut down their solvent extraction plants because of Brazil dumping the soybean meal in the Europern market at a throw away price, which rendered solvant extraction economically unfeasible in Pakistan.

In order to avert recurrance of such a situation it would be necessary to consider the possibility of setting-up cattle feed plants in the country and to convert the meal into livestock feed for domestic sales as well as for export. The other basic material for the manufacture of live-stock feed is the molasses which is already available in the country in substantial quantities. There are 25 sugar mills already in production in Pakistan, besides a large number are under construction; manufacture and export of of cattle feed would not only solve the problem of disposal of the meals and the molasses but would also help in improving the operational economics of the solvant extraction plants.

Research

In barani areas of NWFP the Provincial Department of Agriculture has recently undertaken a systematic programme of adaptive research and demonstration. Under this scheme which commended in Kharif 1976 and is known as Barani Agriculture Development Project, a five years phased programme has been launched to demonstrate successful production technology of different crops including soybeans under dry farm conditions.

For the first year it had been decided to conduct adaptive research inorder to obtain needed information on fertilizer requirements for soybeans under barani conditions and to determine the suitable varieties. This work would prove extremely useful in the promotion of soybean cultivation in barani areas of NWFP which constitute the major portion of the arable land.

In the barani areas of Punjab also a similar project has been launched. It would be useful if in this province as well soybean adaptive research is undertaken by the barani project authorities.

Crop production targets.

Guided and contracted crop targets are suggested as below:-

Soybean	Punjab	Sind	NWFP	A.J.K	Baluchistan	Total
1977-78	0.5	5	5	0.5	-	11
1978-79	1	10	10	1	-	22
1979-80	2	20	16	1	-	39
1980-81	5	25	20	2	-	52
1981-82	18	50	40	2	-	110
1982-83	35	75	50	5	-	165
1983-84	45	100	78	8	-	231
1984-85	60	100	90	14	-	254

APPENDIX--H

SAFFLOWER

World Importance

Until recent years safflower (Carthamus tinctorius) was confined to regions of Asia, Africa and Europe where it had been grown for centuries. In Inda, western Turkey and Upper Egypt it was and is grown for its oil, and oil extraction was accomplished with rather primitive equipments. Over a much larger area, including most of the Middle East, safflower is grown for its flowers which are used to color foods. During the last 50 years, and particularly during the last 35 years, safflower has been established as an oilseed crop in the United States, Australia, Mexico, Spain and Portugal. Its success in the latter countries has stimulated renewed interest in its potential as an oilseed crop in Asia.

Hostory and Importance in Pakistan

Seed of safflower can be purchased in bazaars of most towns of Pakistan, where it is found in shops that specialize in the sale of plant materials for medicinal purposes -- such shops are called "pansaries". Such seed is probably locally grown, but may be imported from India.

Safflower is grown on a very small scale in the vicinity of Gujrat, where it is used as a fodder crop. There it is grown as follows:

1) it is sown in late September and early October with wheat; 2) it is harvested as green plants before wheat harvest and fed to livestock; 3) it is harvested for seed in early April, about the same time as, or not long after, wheat harvest; 4) both spiny and spineless, and red- and yellow-flowered, types are present; and 5) rust is present in small amounts. Over the years production has decreased.

Safflower is grown on the tributaries of the Indus River (at Gilgit on the Gilgit River, and Karimabad on the Hunza River). The flowers are used to color foods, and are crushed to from "pills" which are reported to have medicinal properties. The seed, apparently with the hulls removed, is used as an ingredient of cakes, or "chappaties", and eaten on special occasions.

A serious weed in dryland areas of Pakistan is a close wild relative of safflower (C. oxyacantha), locally called "pohli". It often remains as a rosette in wheat fields until after harvest, when it sends up strong stems with abundant branching. Pohli apparently draws on soil moisture below the level of wheat roots. In this respect it is similar to cultivated safflower.

Safflower has been grown on a small commercial scale inSind Province during the last two years. Planted in November, it performed well, and matured in April or May. In 1976-77 it was severely attacked during and after flowering by a leaf blight caused by a Ramularia or Alternaria species which grew rapidly during the warm bumid weather that prevailed over much of Pakistan in that year. Some heads and some plants were attacked by insects. Farmers complained about the spiny nature of the imported variety.

Botanical Features Affecting the Success of the Crop

Growing Season. The minimum growing season for safflower is about 120 days. This assumes that there is a very short rosette period, and good growing conditions prevail. However, if sown in southern Sind Province in November, it will flower in February and will mature in April, or about 150 days after sowing. At Islamabad, if sown in December, it will flower in late April and will mature in June, 180 days after sowing. Where winters are cooler and more prolonged the growing period will be 200 days. It matures about one month after wheat in Pakistan.

Rosette stage. After emergence from the soil the young plant spends some time in a rosette stage, the time varying from a week or so to two or three months depending on the variety, the temperature and day length. When planted in the fall and winter, and the temperatures are cold, the rosette stage is prolonged, but when sown in the late spring when temperatures are high and long days prevail, the rosette stage is short. Some "winter types" must have a period of quite cold temperatures before they will advance beyond the rosette stage. The rosette stage is a critical stage in development because rapidly elongating winter weeds may grow over the safflower and seriously reduce yields.

__Stems.__ The stems of safflower vary from 60 cm to 2 m in height, depending on the variety, the environment and the planting date. The stems may have few branches, usually concentrated at the top of the plant, or they may have abundant branches from the top of the plant to the bottom. The number of heads varies with each variety. Yield appears to be associated with head number.

__Spines.__ Most varieties of safflower grown for oil are spiny, the degree of spininess being variable with different varieties. In the United States spiny varieties have been higher yielding and have had higher oil contents compared to spineless varieties. In India spiny varieties have been damaged less by birds. Farmers in Pakistan have expressed reluctance to accept safflower as a commercial crops because of the spines. Fortunately spines do not develop on the lower laves, but reach their full development on the margins of the upper leaves and the bracts (modified leaves) around the heads. Also, if plants are grown close together, branches will be confined to the upper part of the plant. This means that the plants can be harvested by hand as long as they are handled at the base of the stem.

__Compensation.__ By compensation is meant the ability of the plant to compensate for differences in plant population, or for loss of part of the plant to insects. When safflower is sown in the fall and has a long time to develop, differences in seeding rate have very little effect on yield. On the other hand, when sown in the spring, and the development of individual plants is restricted because of the short growing season, thin stands will result in low yields. In a somewhat similar way the plant will compensate for insect damage if it occurs early in the season in a fall planting, but the compensation will be much less if it occurs late in the season or in late-sown safflower.

__Roots.__ Safflower has strong and long roots which penetrate in deep fertile soils to depths of more than 3 m. In India and in California safflower in such soil that is well supplied with water prior to planting can complete development with no additional water.

Lack of seed dormancy. Present commercial varieties of safflower have no seed dormancy at maturity. This means that prolonged rains at harvest will cause the seed to germinate in the head, thus lowering the quality of the crop, and ruining the seed for planting purposes. For this reason it is important to plan the cropping season for safflower to permit harvest to be completed before summer rains begin. For the same reason harvested plants should be threshed promptly, and should not be exposed to continuous rain.

Environmental Requirements

Soil

Deep, fertile, and well drained soils are preferred. Heavy soils with good water holding capacity have been most productive. Sown in shallow soils safflower has not performed well, presumably because there is insufficient space for good root development.

Safflower is similar to barley in its salinity tolerance under dryland conditions, but slightly more sensitive than barley, cotton and sugar beets when irrigated.

The plant does not have any ill effects on the soil. In fact, there is some beneficial effect (as measured by improved infiltration rates) from the agressive root system that penetrates deeply into the soil. Under dryland conditions it will exhaust the soil of moisture down to depths of 2 to 4 meters.

Climate

Atmospheric moisture. Above-ground parts of safflower plants are sensitive to atmospheric moisture, primarily because it makes them more sensitive to diseases. Sensitivity increases with later stages of developments. Most serious in Pakistan are the diseases caused by Ramularia and Alternaria, both usually severe after winter rains when plants are well developed. Botrytis blight and rust can be severe if humidities are high.

Temperature. Frost resistance of safflower depends upon the variety and stage of development. In the seedling stage most varieties will tolerate temperatures down to -7°C if they are hardened to cold, but will be damaged if growing rapdily. Once out of the rosette stage, temperatures down to -4°C will cause damage, and in the bud or flowering stage any temperatures below freezing will damage at least the developing flowers. Winter type varieties are being developed in Iran that will tolerate temperatures down to -15°C, if the plants are in the rosette stage.

Safflower is quite tolerant of high temperatures, if roots are well supplied with water but not waterlogged. High temperatures combined with high humidities have an adverse effect on pollination.

Wind

Safflower is resistant to lodging caused by wind, if good stands prevail, because the plants interlace their heads and support one another.

Water

Water consumption is maximum during the period of greatest vegetative development, just before and after flowering commences. Consumptive use studies in Arizona, USA, indicate that on a hot day in May safflower will use 12 mm (0.5 in) of water, compared with 10 mm (0.4 in) for cotton. During the growing season it used 113 mm (44 in). Somewhat less than this is required in northern California, where it is estimated that about 650 mm (25 in) of available (not applied) water will give a yield of 3,000 kg/ha (32.7 md/A) or more. Under dryland conditions at least 450 mm (18 in) of available water will be required to produce 2,000 kg/ha (21.8 md/A).

Roots of safflower are sensitive to excess amounts of water. Flood irrigation, where water stands even for short periods of time, will often bring on a severe attack of Phytophthora root rot. The disease is magnified if temperatures are high. Young plants will stand temporary waterlogging if temperatures are below 20°C. Because of root sensitivity to excess moisture, water management is extremely important.

Place in the cropping system

As in other parts of the world, safflower will compete in most cases with a cereal crop for a place in the cropping system. In Pakistan wheat will be the strongest competitor. In most situations where October or November plantings are made, wheat will be a better choice because it will quickly cover the ground and compete better with weeds. It will also mature earlier, and permit timely land preparation for a summer crop. However, where plantings must be made too late for optimum wheat production, safflower should be a good alternative crop. Late planting may be necessary in the following situations:

1) After cotton, or other late harvested crops.

2) After rice -- i.e. dubari lands.

3) On land flooded by summer rains -- Kucha lands or riverine tracts.

4) In barani situations where a moist seedbed cannot be prepared until late winter rains occur.

Safflower has done well on land with a high water table, perhaps 4 to 6 feet below the surface of the soil.

In making a decision to grow safflower, it should be remembered that it will mature 4 to 6 weeks after wheat.

Meriting trial in Pakistan is the culture of safflower with wheat or gram (Cicer arietinum). In south central India safflower is some-times sown in single rows alternating with 4 to 5 rows of wheat or gram. In barani situations in Pakistan, where the soil is deep and well supplied with water, safflower may prove to be a successful substitute for pohli. Like pohli, it should make much of its growth after the wheat or gram, and should draw on moisture supplies beyond the reach of the roots of other crops.

Safflower should not follow safflower because of the danger of building up diseases in the soil.

Varieties

For the immediate future the best source of varieties will be the United States. In the Unites States most of the commercially grown varieties are being developed by private companies including the following:

Cargill Incorporated, Route 2, Box 5240, Dixon, CA 95620

Pacific Oilseeds Incorporated, P.O.Box 1008, Woodland, CA 95695

Cal West Seeds, P.O.Box 817, Woodland, CA 95695

Anderson, Clayton & Company, P.O.Box 2988, Phoenix, Arizona 85036

USDA and State researchers in the USA are developing some varieties also. Inquiries about varieties should be directed to:

Department of Agronomy & Range Science, University of California, Davis, CA 95616

Department of Agronomy, University of Arizona, Tucson, Arizona, 85721

Of the many varieties developed by public agencies in the United States, Gila has been the most successful both in the US and abroad. It has performed well in Sind Province and in tests near Islamabad. Seed stocks are available in Pakistan from the Pakistan Edible Oil Corporation.

Two types of safflower are available, one with high levels of linoleic fatty acid in the oil which is the principal safflower oil of commerce, and the other with high levels of oleic acid which is increasing in popularity. Details of these two oils are given below under Processing and Utilization.

All commercial varieties available from the United States will be spiny. They will vary in oil content, but those developed most recently will have oil contents above 40%.

Safflower varieties are available in limited amounts in Iran from the Oilseed Research and Development Company, 146 Shah-Abbas Kabir Avenue, Tehran, Iran. Both spiny and spineless varieties are under development.

Propagation of varieties in Pakistan. It is important that Pakistan develop its own safflower seed stocks of both introduced and locally developed varieties. Safflower presents no difficult problems in seed propagation because it is highly self-pollinated. Nevertheless some outcrossing does occur, so it is necessary to isolate seed multiplication fields by at least 1000 feet from both domesticated and wild safflower. Seed should be handled carefully to maintain high levels of germination. The tough flesible hull of the seed will often show no injury, but the seed inside may be severely damaged -- this is called invisible seed injury.

Planting seed should be treated with a fungicide to destroy disease spores on the surface of the seed and to give the young seedling some protection during the first few days after germination.

Breeding programs. Introduced varieties are being evaluated at the provincial research institutes and at the Pakistan Agricultural Research Centre. Breeding programs are being, or will be, initiated at the Tandojam and Punjab Research Institutes.

Production Practices

Seedbed preparation. Seedbed preparation will be similar to that for mustard and rape. Seedbeds prepared for wheat should be satisfactory also, if care is taken to have moist soil close to the surface.

Where irrigation water is available, it will be advisable to supply water before planting, sufficient to moisten soil to depths of 2 meters. This, of course, will not be necessary after a crop well supplied with irrigation water.

Fertilizer applications. Nitrogen requirements will be slightly higher than for wheat. Where N is known to be scaree, 75 to 125 kg/ha should be applied under irrigation or where the soil is well supplied with moisture, and 20 to 50 kg/ha under barani conditions. Where phosphorus is needed, 60 kg/ha of P_2O_5 should be applied. In California banding of phosphorus one inch below the seed has been more effective than broadcast applications.

Seeding methods. Worldwide many methods of seeding have been used. Best results have been obtained where seeds have been drilled about 2 to 3 cm into moist soil -- this will be 5-6 cm if there are 3 cm of dry soil on the surface. Because it is inadvisable to sow more than 6 cm deep, it may be necessary to plant the seed in furrows 5 to 6 cm deep. Broadcast plantings have been successful if the seed can be placed in moist soil. Safflower should not be planted in dry soil.

Seeding rates. Recommended seeding rates are as follows:

Situation	15-30 cm row spacing kg/ha	45-60 cm row spacing kg/ha
Dryland	22/33	17-22
Irrigated.	28-44	22-28

In rows spaced 45 cm apart, 22 kg/ha amounts to about 8 seeds per 30 cm of row. To seed 33 kg/ha in a multiple row seed drill adjust the drill to sow 22 kg of barley or 50 kg of wheat per hectate.

Seeding rates should be adjusted as follows:

Decrease seeding rates in very early plantings, and increase them in later plantings when plant development and head number will be reduced.

Increase seeding rates with large sized seed.

Increase seeding rate about 20% for broadcast plantings because many seeds will be too deep to emerge or too shallow to germinate.

Satisfactory stands. For close drill rows or broadcast stands on dryland, there should be 3 to 5 plants per 30 cm square, and under irrigation 5 to 10 plants per 30 cm square.

Weed control. Safflower is vulnerable to weeds just before and after emergence. In large part this has been a consequence of the slow early development of the seedlings, which remain in a rosette stage for an indefinite period. For this reason it is important to avoid fields where weeds are known to be a problem. Furthermore, seedbed preparations and timing of seeding should be planned to permit the safflower seedlings to be free of weed competition in early stages. Once stems are initiated, safflower becomes a good weed competitor.

Irrigation. Two features of the crop affect the nature and success of irrigation: a) its susceptibility to Phytophthora root rot; and b) its deep root system.

Complete crop failure has often followed surface irrigation, with the damage usually associated with Phytophothora root rot. For minimizing damage from this disease the following rules are recommended:

a) Use the most resistant variety available.

b) Preirrigate to raise soil moisture levels to field capacity to the depths of root penetration between 2 and 4 meters.

c) Plant on beds, which permits better water management and lets the base of the plants dry out more quickly after an irrigation.

d) Irrigate in every other furrow, alternating the furrows with each irrigation.

e) Irrigate before the plants are stressed from lack of water (evidenced by lower leaves drying up).

f) Avoid prolonged irrigations, especially during warm weather -- the surface soil should be drained within 48 hours of commencing an irrigation, and ponding should be avoided.

g) Continue irrigations until after full bloom, for maximum yields.

h) Where salinity is a problem plant the seeds on the sides of sloping beds, since the salt accumulation is greatest on the ridge.

<u>Harvesting and storage.</u> If safflower is combined directly, harvest should be delayed until the moisture content of the seed is 8% or less. This will be when the seed of the latest heads has turned white in color. Combine equipment is the same as that used for barley or wheat, but with the following adjustments:

a) Reel speed is about 25% faster than the forward speed of the combine.

b) Peripheral speed of the cylinder is 750 to 900 m (2,500 to 3,000 ft)/minute if harvest is for shipment to an oilseed processor, and 600 to 750 m (2,000 to 2,500 ft)/ minute if harvest is for seed for planting.

c) Clearance between cylinder bars and concave bars is 1.0 to 1.5 cm (3/8-5/8 in).

d) Other adjustments are set to remove only empty seed.

The crop may be windrowed when the seed contains 25% moisture, usually about 10 days before it would dry down to 8%. Four to 7 days later it may be combined with a pickup attachment.

For safe storage, the seed should contain less than 9% moisture, and preferably no more than 5%.

Pests

Pests will be a problem in safflower production. In part this is simply because Pakistan is part of the area where safflower diseases and insects have been present for a long period. In part it is due to the presence of the wild species, C. oxyacantha (pohli), o... much of Pakistan, which serves as an excellent host for all pests of safflower.

Reference has already been made to foliage diseases and Phytophthora root rot. Verticillium wilt will be a problem if safflower follows other crops such as cotton that also are attached by this disease.

Serious damage can be caused by larvae of the safflower fly (Acanthiophilus helianthi), which is usually more severe in late plantings.

No safflower varieties have been identified with resistance to orobanche and/or dodder, so safflower should not be sown in fields where those pests are present.

Processing and Utilization.

Modern extraction equipment, with minor modifications and appropriate adjustments, is used for processing safflower in the United States, and ghanis (kohlus in Pakistan) are used in India. It is not anticipated that the extraction of the oil will present a problem. Disposal of the meal may be a problem, as it is with other oil seeds.

The safflower oil of commerce has high levels of linoleic acid. Because of this it is reported to have beneficial effects in terms of lowering levels of cholesterol in the blood, thus reducing the incidence of athersler-osis. The oil is used in salad oils, in soft margarines, and in cooking. As a cooking oil it tends to form a film at high temperatures. It is the tendency to form a film that makes the oil useful in the manufacture of paints, varnishes and enamels. An added advantage is that the oil will produce a varnish and paint that will not yellow with age.

Some recently developed varieties have an oil that is high in oleic acid, and low in linoleic acid — it is sometimes called high oleic safflower oil. That oil is similar chemically to olive oil. It has proven to be an excellent cooking oil, and commands a price equal to, or higher than, regular safflower oil. Because Pakistan will probably use most of the safflower oil that it produces for cooking purposes, it should seriously consider the production of high oleic oil.

The value of safflower meal is related to its protein content. There is a good market for the meal in the USA, and a good market for the oilseed cake from ghanis in India.

Research needs

Research needs in order of decreasing priority are:

a) Variety evaluations.

b) Development of production practices after rice.

c) Development of production practices for follded areas — kucha lands and riverine tracts.

d) Development of production practices for barani areas

e) Development of production practices for irrigated areas.

f) Development of improved harvesting and threshing techniques.

g) Evaluation of the World Collection.

h) Development of a breeding programme.

i) Evaluation of products from crosses of domenticated safflower and pohli.

Production targets

Necessarily for the first year or two safflower production will be scattered over areas where it has some promise. These will be on dubari lands of Sind and Baluchistan Provinces, on riverine or kucha tracts and in barani areas of northern Pakistan. Acreage will increase as the best areas are identified and as production practices improve. Centres of production should then develop.

Acreage targets are as follows:

	Punjab	Sind	NWFP	A.J.K.	Baluchistan	Total
1977-78	0.5	2	-	-	0.5	3
1978-79	2	7	-	-	1	10
1979-80	5	10	-	-	2	17
1980-81	15	25	-	-	5	45
1981-82	30	40	-	-	10	80
1982-83	35	75	-	-	15	125
1983-84	60	100	-	-	20	180
1984-85	80	100	-	-	30	210

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