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Oil Crops: Sunflower, Linseed, and Sesame

Proceedings of the Fourth Oil Crops Network Workshop held at Njoro, Kenya, 25-29 January 1988

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OIL CROPS: SUNFLOWER, LINSEED, AND SESAME

Proceedings of the Fourth Oil Crops Network Workshop held at Njoro, Kenya, 25-29 January 1988

Edited by

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Organized by

Kenya Agricultural Research Institute, Nairobi, Kenya
National Plant Breeding Station, Njoro, Kenya
Egerton University, Njoro, Kenya
International Development Research Centre, Canada

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A. International Support

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- EEC (Thailand)
- FAO (Italy, China and Nicaragua)
- IBPGR (Israel)
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- Cargill E.A. Ltd., Kenya
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- UFUTA Ltd., Sesame Company, Nairobi and Mombassa, Kenya
- IDRC, Oilcrops Network, Ethiopia
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FOREWORD

This workshop is the fourth in a series organized by the Oilcrops Network. The first was held in Egypt 1983 giving the leaders of the Oilcrops Projects the first opportunity to interact on all aspects of oilcrops. The second workshop was held in India in 1985 with emphasis on sesame and safflower. The third workshop was held in Ethiopia in 1986 emphasizing niger and rapeseed/mustard. The remaining oilcrops producing edible oils were sunflower and linseed, and this fourth workshop was held to discuss the development of these two crops in addition to sesame, the most neglected oil crop.

The workshop was set up with the following objectives:

1. To continue bringing together oilcrops scientists from Eastern Africa/Southern Asia to exchange information and new ideas on the improvement of research and production of oil crops especially sunflower, sesame and linseed (flax).

2. To present highlights of research work carried out in Kenya as well as to present research developments of sesame, sunflower and linseed in the Network region.

3. To emphasize new areas such as quality, marketing and by-products.

4. To elaborate on better ways and means of germplasm maintenance and exchange.

5. To discuss the results and future collaborative research topics and the experiment of Brassica sub-network.

6. To establish the terms and mechanisms for selecting or electing a steering committee to achieve a better control of the network to serve its participants better and then actually form the steering committee.

The above objectives were fulfilled by the largest number of scientists ever attending our workshops (67 participants), the largest number of presentations (50 papers) and the largest number of countries represented (21 countries). Two more sub-networks were formulated and the steering committee members were elected.

We are grateful to the Kenyan Government represented by Kenya Agricultural Research Institute (KARI), and Egerton University for allowing us to use their excellent facilities.

We are particularly indebted to Dr. W.W. Wapakala, Director of Research KARI, and Prof. Dr. R.S. Musangi, Vice Chancellor of Egerton University for their contribution towards the fine organization of the workshop. Special thanks are due to Dr. Bertolli of UFUTA Ltd. for hosting the reception party and to Mr. Popat of OCD for organizing and hosting the field trip.

The editor is particularly grateful to the staff of the Oilcrops Network: Mrs. Martha Kebede for typing, Mr. Seid Ahmed and Mr. Wossen Taye for proof reading this manuscript over and over again.

Abbas Omran

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SESSION I

OPENING SESSION

Chairman: W.W. Wapakala **Rapporteur: P.Kireru**

OPENING SPEECH

F.M.Nthenge

Deputy Secretary, Ministry of Research,
Science and Technology, Kenya.

(Read by William W.Wapakala)

Mr. Chairman,
The Vice-Chancellor of Egerton University,
Distingushed Guests,
Ladies and Gentlemen,

It gives me great pleasure to be with you this morning on this important occasion of the 4th International Oil Crops Network Workshop. First of all, I would like to express our sincere thanks to the International Development Research Centre of Canada and the various Kenyan firms involved in oil crop production and processing for sponsoring this workshop.

Indeed, it is a great honour for Kenya to host this workshop, and on behalf of the Government and the people of Kenya, I would like to take this opportunity to welcome all the participants especially those who have come from outside Kenya. If it is the first time that you are visiting this country, I hope you will take advantage of your being here to see some of the interesting parts of this country, for instance, our National Parks and of course some of our agricultural research activities. The field day that the organizers have included in the program of the workshop should provide an opportunity for this- but you may wish to venture farther afield.

Mr. Chairman, I understand that this workshop is being attended by research scientists, industrialists, and others involved in the oilseed crop production from all parts of the world; i.e. Asia, Africa, the Americas and Europe. I note with interest that the majority of the participants come from our region, Eastern Africa, and South East Asia which have been linked in the past by ancient trade routes which carried seeds of many species of oilseed crops. As a result of these early activities, oilseed crops like sesame, linseed, castor, to name only a few, which will be discussed in this workshop are important food crops in the region.

The main objective of this workshop is to review the respective national oilseed crop research and development program in the eastern Africa and south south east Asia regions with particular reference to sunflower, sesame and linseed and to consider the establishment of sub-networks which would help to strengthen oil crop research in countries of the two regions. This, Mr. Chairman, is a very ambitious program to be covered in less than five days. However, because of the importance of vegetable oils in the diets of our people, it is imperative that those of you involved in the development and production of these commodities should do all possible to increase the productivity of these crops in our countries. Indeed, most of our countries import vegetable oil. In kenya, for instance, we import more than 50% of our requirements of vegetable oils and fats, and with the rapidly increasing population our requirements will continue to rise imposing high cost to the economy in terms of foreign exchange. This should not be the case particularly when we have the land with ideal climatic conditions for growing different species of oilseed crops. What is lacking is the appropriate technology to grow these crops. This is the issue of prime importance which this workshop should address itself to and come up with practical recommendations as to how you are going to organize for the generation of technology for increasing production of vegetable oils and fats in the participating countries. It is a fact that today we have little information on the response of various oilseed crops to natural complexes of environmental, agricultural and management factors. It is therefore necessary that research workers identify, define and rank the importance of constraints to yield so that they could tacke them effectively.

In the past, in this country, limited and uncoordinated research has been going on in the improvement of different oil crops. With the reorganization and restructuring of our agricultural research system, oilseed crops have been recognized as a major sector of research; and a nationally coordinated research program has been developed and substantial resources have been earmarked for the implementation of the research activities. In the implementation of this program we will bring together research scientists in the ministry, those in the university, the private sector and here we have in mind the Kenyan firms represented at this workshop and our farmers. This approach is not confined to this group of crops, but is something that we are institutionalizing within our agricultural research ststem. The multidisciplinary teams formed will jointly identify and consider constraints to increased agricultural production through annual progress review meetings.

Mr. Chairman, before concluding, I would like to express once again our gratitude to the various organizations: in particular, I wish to mention the Kenya Seed Company Ltd., Messrs UFUTA Ltd., Cargill E.A. Ltd., the International Development Research Centre and the Oil Crop Development for financial contributions; and Egerton University and the Kenya Agricultural Research Institute for organizing the workshop. I understand a number of donor agencies have sponsored participants from outside Kenya. They too should be thanked for facilitating the realization of this workshop. The cooperative efforts that have gone into planning of this workshop are commendable. The collaboration of the private and public sectors is something that we must foster if our countries are to effectively utilize national resources for development. I would also like to thank Prof. R.S. Musangi, the Vice-Chancellor of Egerton University for availing to the workshop these excellent facilities of the agricultural resource centre. Last but not least, the organizing committee should be thanked for the efforts they have made in ensuring that the workshop is a success.

With these remarks, Mr. Chairman, it is my great pleasure to declare the 4th International Oil Crops Network Workshop officially open.

Thank you.

RESPONSE STATEMENT

G.C. Hawtin

Associate Director, Agriculture Food and Nutrition Sciences,
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Mr. Chairman,
Professor Musangi,
Mr. Popat,
Ladies and Gentlemen,

I would like to join the co-sponsors of this meeting in welcoming all the participants, and to offer a special word of thanks to the Government of Kenya and to Egerton University for inviting us and for making available these excellent facilities.

This is the fourth workshop of the Oilcrops Network, and there are participants from more countries and organizations than in any previous workshop. Twenty one countries are represented, and from all continents except Australia. We have participants from as far as Nicaragua in the west to China and the Philippines in the East.

Not only does this workshop have a large diversity of nationalities, but is also receiving support from a large number of different organizations than ever before. I would particularly like to mention the following which are sponsoring participants at the meeting:

EEC	-	2 from Thailand
USAID (USA)	-	1 from Zambia and 1 from Sri Lanka
SIDA (Sweden)	-	1 from Zambia
ODA (UK)	-	1 from Tanzania
CIDA (Canada)	-	1 from Pakistan and 1 from Sudan
FAO	-	1 from China, 1 from Nicaragua and 1 from Italy
IBPGR	-	1 from Israel
Chinese Government	-	1 from China

The rest of the overseas participants are being supported by IDRC. However all the local (Kenyan) participants are being funded by several Kenyan organizations, notably:-

UFUTA
Oilcrops Development Ltd (OCD)
Kenya Seed Company
Cargill Co.

FAO, UFUTA and OCD have also provided funds for the core activities of this workshop and I would like to take this opportunity on behalf of IDRC, of thanking all this large range of different organizations for helping to make this meeting possible.

I would now like to take a few minutes to explain some of the main objectives of this meeting. As I mentioned, this is the fourth meeting of a network which has been expanding considerably over the past few years. The number of scientists actively associated with the network has grown, and increasingly countries outside the network target area of Eastern/Southern Africa and South Asia, have expressed an interest in becoming actively involved in network activities.

This growth has necessitated a rethink of the way the network operates, it's structure and activities. At the 3rd network meeting in Addis Ababa in 1986, it was agreed that the network should be more active in encouraging and supporting collaborative research activities among member countries, and should try to go beyond information exchange and training which up to then had been its main focus. In order to develop specific plans for collaborative research, it was agreed that a small group of scientists, specifically interested in the Brassica oilcrops, would meet in Sweden. This meeting took place in May 1987 and detailed plans were drawn up; these will be described in a paper to be presented later in this meeting. It was agreed that the Brassica scientists would consider themselves a "sub-network", retaining full links with the main network, but would organize specific activities among themselves on Brassica oilcrops. A chairman and co-chairman were elected to help ensure follow-up of the recommendations, with the help of the network advisor.

Given the success of the meeting in Sweden, it is now proposed that here in Kenya, a similar exercise be undertaken on sunflower and sesame. For each crop, priorities need to be established for collaborative research and specific activities agreed upon. IDRC will take serious note of these recommendations and, to the extent possible, will help, provide funding for specific, high priority, collaborative activites. Steps will also be taken to help secure additional support from other interested doner agencies. In the case of sesame, it is proposed that the sub-network activities link very closely with a parallel effort being developed by FAO. We are fortunate to have Drs. Pineda, Ashri and Micke here, who are all involved with the FAO effort, so that we can talk about collaboration in concrete terms and develop some firm action recommendations.

Finally, I would like to say how much I am looking forward to the deliberations of this workshop, and the development of recommendations which will help shape the future direction and activities of your oilcrops network.

VOTE OF THANKS

N.V. Popat

General Manager, Oil Crops Development Ltd, Nakuru, Kenya.

Mr. Chairman,
Invited Guests,
Ladies and Gentlemen,

First let me welcome you all to Kenya and to this important workshop on Oilcrops Network here at Egerton University. The idea of this workshop goes back to November 1986, when Dr. Omran visited Kenya to find out what the country was doing on oilcrops. From then onwards we have already held a National Workshop on Oil Crops, and now we are having the International Workshop, which is a great honour for Kenya.

Let me thank International Development Research Centre, Egerton University, National Plant Breeding Station, Kenya Agricultural Research Institute and the sponsors for organizing the workshop. The program in front of us is very crowded, and I am sure the delegates will address to the challenges faced by developing nations. Such a workshop forms a basis for exchanging ideas. We must address to the population growth, changes in weather pattern and the per capita consumption of oils and fats. As you know the per capita in developed world is over 23 kg, while developing nations have per capita of less than 7 kg; (Kenya is 4.5 kg). We must also address to the economics of oil crop production, i.e. producer prices, and local oil prices increase, international prices which are artificially low due to heavy subsidies.

Research must be directed to crops which do not compete with food crops, the oil crop must complement food production. Issues like intercropping/relay cropping must be addressed. Our type of economy have to be given stress on rural developments, and thus small holders, and rural industrialization should be the future of our countries.

This workshop will form a social basis for exchange of these ideas and experience.

Once again welcome and I would like to wish you all the best, and thank all concerned for organizing the workshop.

SESSION II

COUNTRY PRESENTATIONS - KENYA

Chairman: A.Ashri **Rapporteurs: M.Mahasi**
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OIL CROP PRODUCTION IN KENYA

M.W. Oggema, T.C. Riungu

Because of its wide range in physiography, climate and geography, Kenya possesses a great diversity in natural and cropped fauna and flora. Temperate, tropical and subtropical crops grow side by side throughout the year. This feature accords Kenya the flexibility to grow a wide range of crops. Oilseed crops grown in Kenya are varied and are classified according to their growth habits as annuals and perennials.

Supply and Production

Despite the favorable growing conditions Kenya produces only 30% of its annual requirements. However, for the last four years, the production has been on the upward trend as shown in Table 1. Oil contents and oil yields of the respective crops are shown in Table 2. Over 80% of the area targeted has been achieved on most of the crops.

Table 1. Targeted (T) and achieved (A) areas for production of oilseed crops (in '000 ha).

	1983		1984		1985		1986
Crop	T	A	T	A	T	A	T
Sunflower	34	29.0	35	30.0	40	37.0	45
Rapeseed	5	2.3	5	2.5	5	3.2	5
Coconut	43	25.0	35	29.0	40	30.0	40
Soybean	-	0.5	-	0.7	-	1.0	2
Sesame	-	0.2	-	2.5	5	3.5	5
Castor	10	5.0	10	5.5	10	6.0	10
Groundnuts	40	20.0	40	25.0	40	30.0	40
Cottonseed	-	15.6	-	10.7	-	19.8	-

National Goals

The country aims at achieving self-sufficiency and import substitution through increased productivity. Expansion of total planted hectarage will be the main contributing factor to achieve the national requirements of 160,000 tons of oil by year 2000. The expectation of increase of hectarage is shown in Table 3.

Presently, vegetable oils and fats are some of the largest imports of agricultural products in Kenya. The increase in importation is due to the increase in consumption that has risen from 1 to 4 kg/caput between 1970 and 1986. This is expected to rise to >5 kg/caput by the turn of the century. The current national oil requirement is about 114,000 tons of which only 20-30% is locally produced. Kenya is a net importer of vegetable oils. The increase in consumption is mainly due to the increase in population and change in diet.

Table 2. Oil content and oil yields of different crops.

Crop	Seed multiplication rate	Oil %	Oil yield kg/ha
Sunflower	100	37-40	200
Cotton seed	200	15	50
Groundnut	10-20	40-44	212
Rapeseed	100	40-43	410
Sesame	80	40-43	75
Soybean	100	19-21	172
Safflower	50	25-30	135

Table 3. Targeted areas of oilcrops up to the year 1990.

	Area in ha			
Crop	1987	1988	1989	1990
Sunflower	50,000	55,000	60,000	65,000
Rapeseed	5,500	6,000	6,500	7,000
Coconut	45,000	50,000	50,000	60,000
Soybean	2,500	1,000	3,500	4,000
Sesame	5,000	5,500	6,000	6,500
Castor	15,000	20,000	25,000	30,000
Groundnut	45,000	50,000	55,600	60,000

With such ceaseless demand, the potential to produce oilseed is immense. The potential is greatest in agro-ecological zones with high to medium rainfall and with deep loamy soils in each of the seven provinces. Crops to be grown in each are:

Nyanza: groundnuts, sunflower, soybean, cotton, castor.

Rift Valley: sunflower, rapeseed, soybean, castor, linseed, safflower, jojoba.

Western: cotton, groundnuts, sunflower, soybean, sesame, castor, linseed.

Eastern: castor, cotton, sunflower, safflower, jojoba.

Central: castor, sunflower, soybean.

Coast: Coconut, cotton, sesame, sunflower.

North Eastern: Groundnut, cotton, safflower, castor.

Production is mainly in the hands of private and a few public sector institutions involving small-scale farmers. Such companies or institutions promote production and ultimately assure market for the grain. Prices are arbitrarily fixed, usually at the beginning of the season. The main concern is to align pricing with international and local production factors.

On the other hand, the Kenyan government tries to:

a) provide the climate conducive for participation of all sectors in production, marketing and manufacturing processes,

b) eliminate technological gaps through research and extension services,

c) harmonize producer prices for oilseed crops in relation to other commodities, and

d) facilitate the acquisition and equitable distribution of farm inputs and equipment necessary to enhance production.

Constraints

1. Marketing

Declining world-wide prices for grains make it difficult for the promoter to pay economical prices for locally produced commodities, Table 4. Under these prevailing market prices, farmers find it more profitable to grow other food and cash crops. The market is unreliable for most of the crops.

Table 4. Price in US dollar per metric tonne of oil.

Commodity	1984	1985	1986	1987
Palm Oil	734	501	243	232
Coconut Oil	1163	590	248	236
Groundnut	1024	905	518	498
Soybean Oil	729	572	336	322

2. Labor

The labor requirement for oilseed crops is high compared to that for other high-paying cash and food crops, and the return is lower.

3. Farm inputs

The availability is not adequate and distribution is not efficient concerning the necessary production inputs (fertilizerss, herbicides, insecticides, seed). Varieties grown are of low-yielding potential and most of them are introductions which are not adequately adapted to the areas they are grown in.

4. Gap in production technology

Borrowed technologies do not produce good and economical results and are usually rejected by farmers. Small farming systems are not well understood and recommendations are not usually appropriate to their purposes. Interlinkage between technology developers and promoters (extensionists) is not strong enough to create impact on the farming communities. This results in the farmers applying only part of the recommended factors or using their own traditional techniques such as:

a) poor pest management,
b) low fertilizer rates or wrong fertilizer types,
c) wrong crop species and wrong varieties which have high risks or poor quality,
d) not adhering to the timeliness of operations, and
e) harvesting at wrong stage of growth - either when the crop has shattered or when the moisture content is too high for proper storage.

5. Processing

Due to low oil content of some of the seeds, the processors prefer importing cheaper oils rather than processing locally produced grains. The census to quantify the national milling processing capacity has to be updated for efficient planning. The processing units are not decentralized enough to cater for pockets of farmers remote from the main towns. They are not appropriately situated to take care of disposal of byproducts such as cakes and other products for livestock. No mechanism has been established to encourage domestic extraction and use.

6. Organization and Infrastructure

There are inadequate systems to:

- distribute inputs,
- provide credit,
- organize demonstrations on improved package of practices on farmers' fields,
- store on the farm,
- stanardize grading of the commodities,
- pay promptly for harvested production, and
- transport to buying centres.

Recommendations, Suggestions and Steps Being Taken

1. The oilseed industry has a high potential in Kenya. Vigorous expansion should be undertaken to meet the national goals.

2. The world oilseed crop prices are currently low and local production and marketing should be looked into to revamp the local industry.

3. The major constraints limiting productivity, i.e appropriate materials, varieties, agronomic, pathological, entomological and socio-economic factors are being looked into through research and extension services to eliminate them.

4. Infrstructure and interlinkages among researchers, producers, processors and marketing agencies should be improved to facilitate better communication for exchange of ideas, findings and implementations.

5. There should be co-operation and participation in germplasm collection, evaluation and conservation by local and international bodies.

6. Appropriate production technologies amenable to small farmers should be developed to emphasize farming systems.

7. National milling capacity should be established and on-farm processing encouraged to utilize excess grains for both human and livestock feed.

8. Crop species performance should be established for different agro-ecological zones.

9. Efforts should be made to pay farmers on time.

LINSEED/FLAX SCREENING AND EVALUATION IN KENYA

T.C. Riungu

Introduction

Linseed (Linum usitatisimum L.) is an annual oilseed crop grown mainly for nonedible industrial oil which is used in manufacturing oil paints, varnishes, floor covering, and for provision of fiber. It is a crop that thrives in cool temperatures and is well adapted to altitudes between 1000 and 3000 (3000 to 9000 ft) above sea level. This is mainly the wheatgrowing area. Due to its adaptability, and drought tolerance, it can be grown in areas with 500-800 mm (20-30 in) of rainfall per annum. In Kenya it has been grown as a fiber crop since 1920, but its production disappeared from the agricultural scene between 1955-1956.

The interest in the crop today is for industrial oil which the Kenyan government has continued to import. In 1973, 3751 t at a cost of KSH 1,115,370 were imported. This importation has continued to rise to date.

Variety introduction, evaluation and production 1920 - 1956

Linseed is not an oil crop indigenous to Kenya. All the varieties screened and produced are introductions. The early screening and testing activities established the fact that the higher altitudes that were cold and wet were most suited for flax production. In 1920, 1921 and 1922, there were 9,297, 26,475 and 14,585 acres, respectively under flax production (Ministry of Agriculture annual reports).

The available information on flax experimentation indicates that in 1922 the flax experimental station for screening and evaluation of introduced germplasm was at Kabete. Other areas used for trials were Kiambu, Gilgil, Eldama Ravine, Kericho, Njoro, and Nakuru. The trials were conducted with Dutch, Russian, Japanese and Irish seeds. The results showed that the Dutch, Russian and Irish types were better in quantity and quality of seeds. The varieties matured between 134 and 160 days and yielded between 240 and 350 lb/acre of seed.

Since 1956, when linseed for fiber disappeared, trials were continued on other types for oil provision. These were carried out at Oljoro Orok, Kitale and Nakuru. During the 1959 trials, yields of 4-5 bags/acre (160-200 kg/ha) were realized and linseed production was recommended in Kinangop and Oljoro Orok. However, in 1962 linseed became unpopular in Kinangop because of difficulties in harvesting during wet season and also low yields (possibly as compared to wheat).

Variety introduction, screening, evaluation and production 1959-1987

Introduction, screening and evaluation of varieties was continued by the National Plant Breeding Station, Njoro, and other government stations. The germplasm used was mainly for oil extraction and most of it was introduced from Canada and Ethiopia. By 1976, when the last successful experiments were conducted, 25 varieties were already under trial.

The results over the years showed that the varieties performed well. Flowering was found to be between 60 and 80 days while maturity ranged between 115 and 150 days. The seed yield ranged between 580 and 2330 kg/ha and the oil content was between 38% and 41%. The only diseases observed were pasmo, rust and seedling rot.

The field performance data gathered over the years led to the recommendation and release of 10 varieties for commercial production, 5 of which are shown in Table 1.

Table 1. Mean values of some characters of released varieties

Variety	Flowering days	Maturity days	Seed yield (kg/ha)	Oil content (%)
Linda	72	132	2330	40.0
Linot	71	132	2190	40.0
Norlata	72	131	2120	40.0
Cree	67	134	2020	39.4
Nored	67	134	1820	39.8

Research work has shown that varieties like the ones mentioned above are adaptable to Kenyan conditions. However, the crop has yet to be fully commercialized as far as its cultivation is concerned. There is no production presently, possibly due to lack of markets, promotion, and reasonable prices.

Conclusion

The past research work has concentrated on germplasm acquisition, screening and evaluation. Presently due to lack of promotion and production, the on-going work at the National Plant Breeding Station is still mainly on bulking and maintenance of available germplasm and released varieties.

To substitute the importation of linseed oil, production, processing and marketing of the crop should be undertaken.

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SOME AGRONOMIC ASPECTS OF SUNFLOWER PRODUCTION IN KENYA

Jane W. Wamuongo

The aspects of sunflower production require that an agronomist might address her/himself to include:

a. fertilizer/nutrient application
b. plant population (spacing or seed rates)
c. intercropping
d. effect of different soil moisture status on the crop etc.

Fertilizer

Many elements are essential for sunflower growth and seed production. Carbon, hydrogen and oxygen which are provided by air and water. These elements comprise 95.5% of the dry weight of the mature sunflower plants and seeds. The remaining elements come from the soil matrix or fertilizer and are grouped into three categories:

1. Primary:- N,P,K - which are the most deficient on crop land.

2. Secondary - Ca, Mg, S - whose deficiency are usually regional.

3. Micronutrients - whose scaricity is sometimes regional but most often occurs only in parts of the fields.

The NPK trial (Thika, 1977) showed no significant differences among the treatments but noteable trends were observed, Table 1. The presence of high levels of NPK tended to incease kernel weight e.g check had 58g and 40:80:40 had a kernel weight of 68g. Despite the high yield loss due to bird damage, it appears that NPk is needed to increase yields e.g check yielded 392 kg/ha as compared to 40:80:40 which yielded 504 kg/ha. Similar trends were observed at Thika during the short rains and Embu during both the short and long rains. There were no significant differences among the treatments with respect to yield but there were noteable differences in the plant characters studied.

At Njoro, no effect of NPK or Cu on sunflower seed yields could be determined due to the insensitivity of the experiment (CV = 29%) and the level of soil fertility at NPBS, hence the need to conduct fertilizer trials at off-station sites, Table 2.

Spacing

The space between rows is largely determined by the machinery available to the farmer. Under non-arid conditions and at optimum plant populations, sunflower should produce highest yields when inter-and intra-row plant spacings are equal. This equidistant spacing produces an earlier and more complete soil cover than other spacing, which in turn intercepts more rainfall and may reduce runoff and soil erosion.

Table 1. Effect of NPK on grain yield of sunflower - 1977 (Long Rains - Thika)

Treatments (kg/ha)				Plant characters			
N	P_2O_5	K_2O	1000 Kernel wt. (g)	Height (cm)	Stem deam. (cm)	Head diam. (kg/ha)	Grain yield* (kg/ha)
0	0	0	58.0	179	1.3	12.4	392
20	0	0	45.0	152	1.3	11.3	351
40	0	0	55.0	152	1.2	11.6	360
0	40	0	55.0	158	1.2	11.8	386
0	80	0	53.0	161	1.3	11.5	408
0	0	40	57.0	162	1.4	11.9	412
20	40	0	64.0	164	1.4	12.7	466
40	40	0	50.0	163	1.4	11.3	368
20	80	0	58.0	147	1.2	11.3	359
40	80	0	58.0	169	1.5	12.0	350
20	0	40	53.0	151	1.3	11.8	284
40	0	40	65.0	161	1.3	12.3	473
0	40	40	57.0	152	1.3	12.0	335
0	80	40	60.0	171	1.4	12.2	435
20	40	40	60.0	155	1.4	11.4	319
40	40	40	56.0	164	1.4	13.3	496
20	80	40	62.0	152	1.3	12.3	354
40	80	40	68.0	163	1.5	13.5	504
	LSD (5%)		NS	NS	NS	NS	9
	(1%)		NS	NS	NS	NS	-

* Yields reduced by as much as 5x because of bird damage.

Table 2. NPK and Cu trial on sunflower (NPBS 1982)

Treatments (kg/ha)				Yield
N	P_2O_5	K_2O	CU	kg/ha
40	0	0	-	1823
40	20	0	-	1462
40	40	0	-	1525
40	60	0	-	1816
40	80	0	-	1423
40	120	0	-	1745
0	80	0	-	1690
20	80	0	-	1540
60	80	0	-	1706
80	80	0	-	1352
120	80	0	-	1352
40	80	60	-	1462
40	80	60	+	1659

CV = 29.6%

In North Dakota, it has been found that a population of 25,000 plants/ha and row spacings of 30 cm gave the highest yield (Read et al. 1982). In Canada (Read et al. 1982), 25,000 plants/ha gave the highest yields, but no yield differences were found between row spacings of 36, 53 and 89 cm.

In Kenya (D'Souza and Tuikong 1987), it has been reported that plant populations exceeding 100,600 plants/ha lead to a decrease in percentage of oil content. Optimum percentage of oil content has been achieved in plant populations of between 62,200 and 100,600 plants/ha.

In Kenya, the cultural practices in sunflower production have been to plant 3 seeds/hill by hand which are later thinned to 1 plant at about the 4-leaf stage, or using the commercial maize planter.

Large populations were associated with thin plant stems and small head diameters, e.g. mean head diameters and stem thickness for the highest population (148,074 plants/ha) were 13.4 cm and 0.8 cm respectively as compared to 17.5 cm and 1.8 cm in the smallest population of 24,624 plants/ha, Table 3.

Table 3. Effect of seedrate - spacing on grain yield and plant characters of sunflower-1977 (Long rains - Thika)

Spacings (cm)		Yield and Plant Characters					
Between rows	Within rows	Plant popu. plants/ha	Head diam.(cm)	Height (cm)	1000 Kernel wt.(g)	Stem diam. (cm)	Yield kg/ha
45	15	148,074	13.4	149.9	38.5	0.8	775
45	30	72,926	12.3	164.9	42.3	1.2	889
45	45	49,248	13.0	168.6	42.3	1.1	768
60	15	111,389	12.6	171.3	48.0	1.2	621
60	30	55,611	13.8	170.3	46.8	1.3	1105
60	45	37,074	13.2	155.1	44.8	1.2	678
75	15	88,711	17.8	174.7	49.0	1.3	772
75	30	42,289	15.1	183.0	54.5	1.5	623
75	45	29,526	13.0	165.2	56.0	1.4	896
90	15	74,037	17.4	189.3	59.5	1.7	972
90	30	36,963	15.6	172.4	57.5	1.6	791
90	45	24,624	17.5	178.4	58.3	1.8	692
LSD (5%)			1.8	18.6	7.6	0.2	NS
(1%)			2.4	-	10.4	0.3	NS

Seed yields at the three plant populations were significantly different, Table 4. The lowest plant population (40,000 plants/ha) resulted in the highest seed yield. The differences were, however, too large especially between 40 and 60,000 plants/ha.

Table 4. Sunflower population trial (NPBS 1982)

Plant population plants/ha	Seed yield kg/ha
40,000	1808
60,000	1100
80,000	1493

CV = 7.2% F = 26.6**

Spacing and Fertilizer

In the Canadian situation (Read et al. 1982), it has been found that the effect of nutrients should be most apparent in narrow spacings because of greater interplant competition. In drier years, wider row spacings would be advantageous to yields because of reduced competition for limited soil moisture. Conversely, narrow spacings might be advantageous in wetter years.

Intercropping

Intercropping sunflower with the already existing and accepted crops in small scale farming areas is practised especially where land pressure is high. Unfortunately, there hasn't been enough work done in this area of research.

Soil moisture status

Different crops tolerate moisture stress differently, and trials conducted at Njoro have shown that time of seedbed preparation has an effect on residual soil moisture status at planting time.

Conclusion

Although population density and NP fertilizers do influence several growth characters of sunflower, the crop seems to have the capacity to adapt to its immediate surroundings and compensates to a large extent for several external stresses (Vijayalakshmi et al. 1975).

Mixing fertilizer with seed at planting should be avoided as it can cause a reduction in the stand. Band placement of fertilizer is therefore recommended. Fertilizer type i.e. the form in which a nutrient may be taken up by a plant can also influence the yield and profitability of the crop. In sunflower, for example, it has been observed that the uptake of N in the NO_3 (nitrate) form is active as opposed to the $NH^{4}{}_{+}$ (ammonium) form (D'Souza and Tuikong 1987).

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GROWING SUNFLOWER FOR OIL CROP DEVELOPMENT LTD (KENYA)

C. Ng'ang'a (for OCD Team)

What is oil crop development?

Oil Crop Development (OCD) is a subsidiary company of East Africa Industries with its head office in Nakuru. The company is the leading promoter of vegetable oil production in Kenya. Presently, the company is promoting sunflower and oilseed rape, and at the same time looking into the possibility of including other vegetable oil crops in its promotional activities. Small-scale farmers play a dominant role in the growing of the crops and contribute about 95% of the total output of oilseeds.

The promotional activities of the company have three main aspects:

1. Agricultural extension.
2. Coordination and organization of marketing structures.
3. Applied research on intercropping, suitable varieties for various ecozones, fertilizer rate and type.

Oil Crop Development currently serves about 70,000 farmers, and the agricultural extension offered by the company relies on group training as it is practically impossible for the company's extension personnel to reach all farmers individually.

In the field, there are various developmental gatherings organised by the Local Administration, Ministry of Agriculture, Harambee groups, women's groups etc. OCD extension personnel join in and offer relevant training on the growing and marketing of a specific oil crop.

The main aspects of the agricultural extension service are:

1. Teaching farmers the appropriate crop husbandry practices including the rotational benefits of oil crops promoted by OCD; and also the provision of high quality planting seeds to farmers through seed distribution agents.

2. Coordination and organization of marketing structures which involve:-

   i) Recruitment of capable buying agents who buy the sunflower crop at the company-announced prices and pay the farmers promptly.

   ii) Coordination of transport of the produce from the agents' field stores to the OCD godown in Nakuru where the seed is milled to produce oil and cake.

   iii) Prompt payments to the buying agents and transporters.

OCD recognizes the importance of orderly crop collection, processing and marketing. It is the efficiency of this cycle which ensures that farmers receive cash for their produce promptly. Without a well-organized marketing structure no amount of agricultural extension will bear fruit, for the farmers will not adopt the growing of a crop that is not either directly edible or readily saleable for cash.

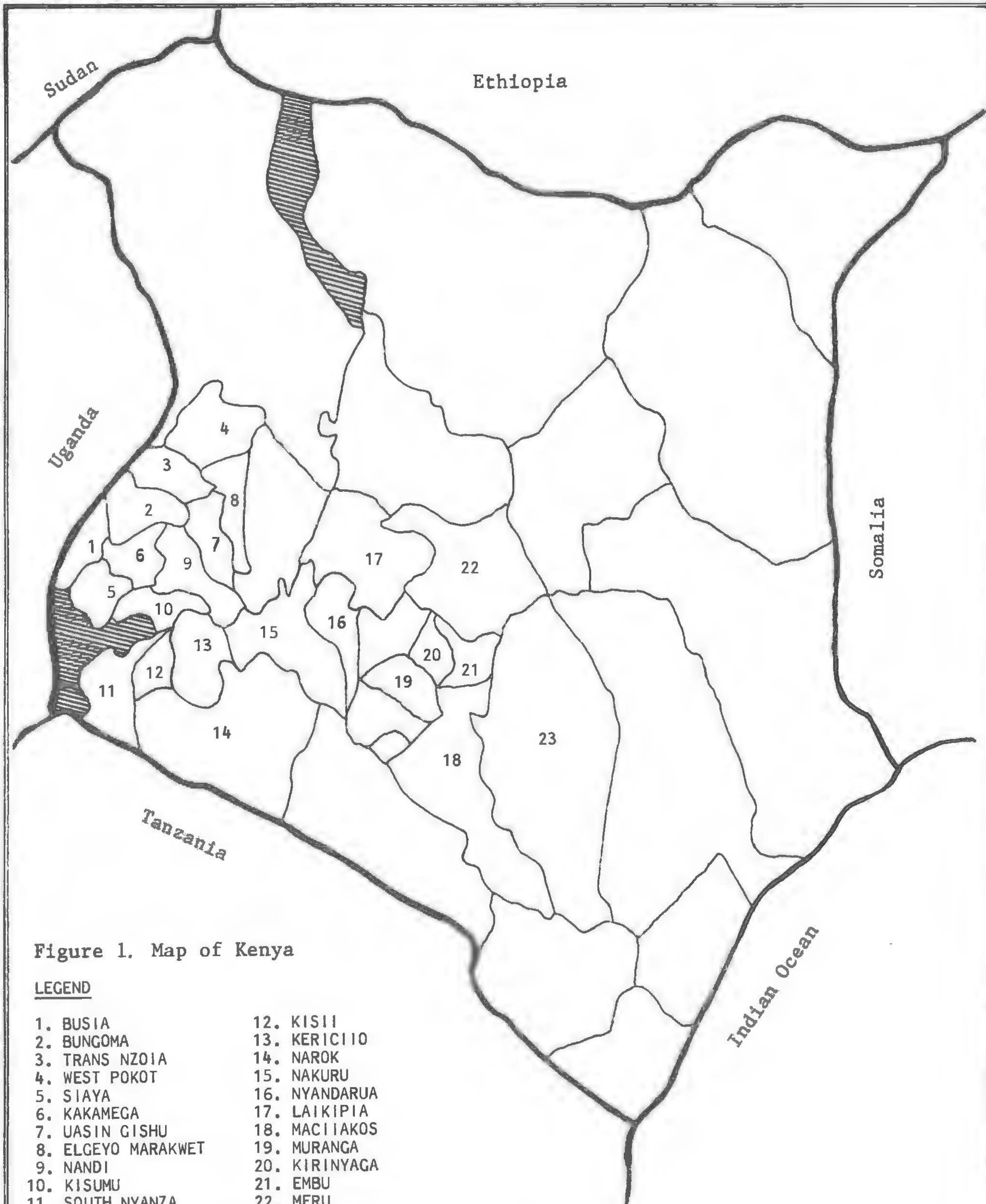

Figure 1. Map of Kenya

LEGEND

1. BUSIA
2. BUNGOMA
3. TRANS NZOIA
4. WEST POKOT
5. SIAYA
6. KAKAMEGA
7. UASIN GISHU
8. ELGEYO MARAKWET
9. NANDI
10. KISUMU
11. SOUTH NYANZA
12. KISII
13. KERICIIO
14. NAROK
15. NAKURU
16. NYANDARUA
17. LAIKIPIA
18. MACIIAKOS
19. MURANGA
20. KIRINYAGA
21. EMBU
22. MERU

How can one become an OCD grower? (Fig.1)

The map shows the districts which are currently being covered by OCD and therefore any farmer in these districts can grow the crop with OCD provided that he is registered. Registration can be done at any of the company's offices or by the extension officers operating in the various districts.

How to grow sunflower? (Fig.2)

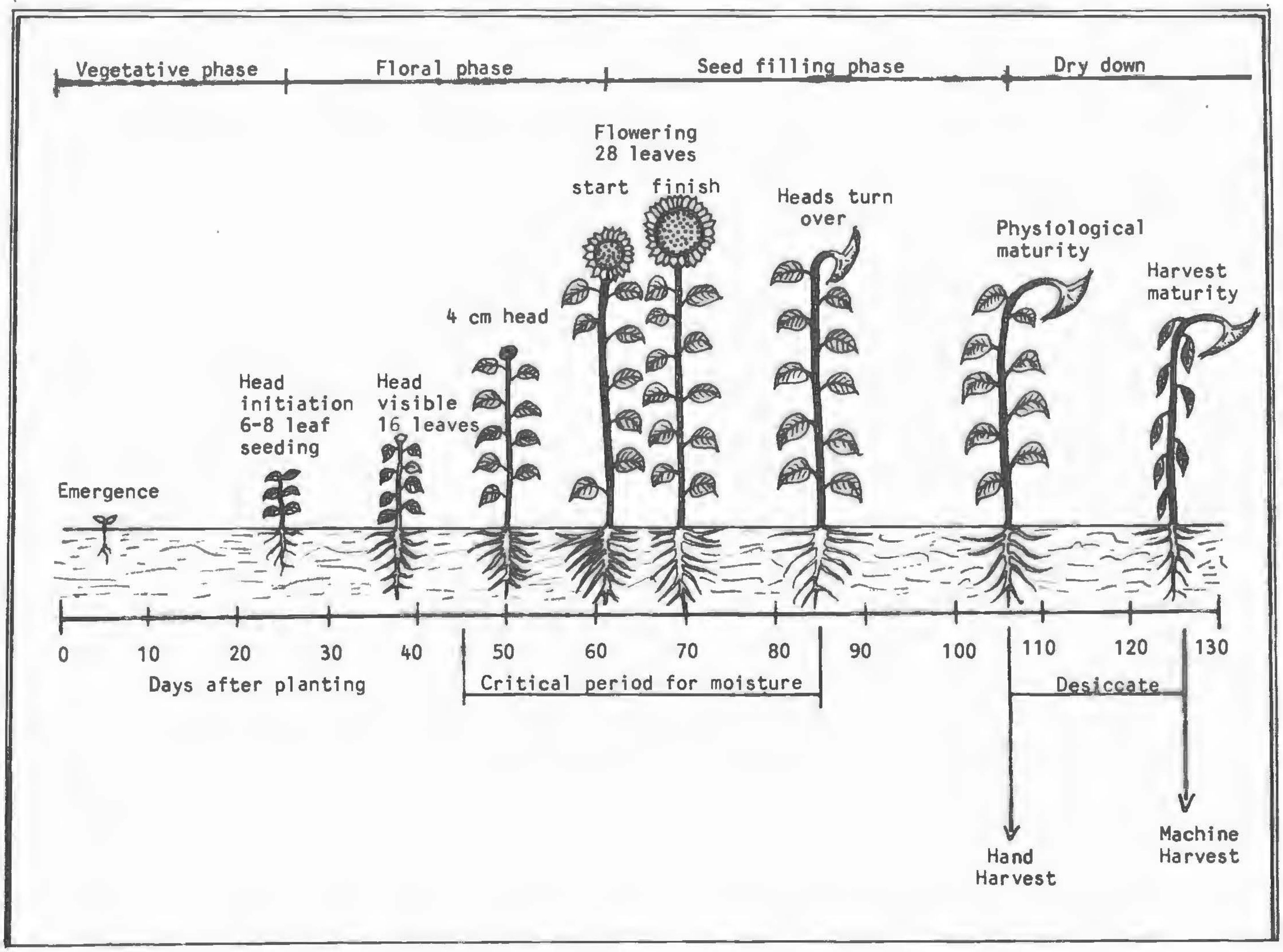

Figure 2. Sunflower growth stages.

a) Seedbed preparation: The seedbed should be firm to ensure that seeds planted obtain adequate moisture for rapid and even emergence. Excessive cultivations should be avoided to prevent soil structure breakdown and/or compaction which results in reduced aeration and water infiltration. Breakdown of soil structure also causes reduced nutrient uptake and yield.

b) Time of planting: Sunflower may be planted over a long period as is normally done in western Kenya. Higher yields are, however, obtained from earlier planting. Early maturing varieties should be considered when late planting is unavoidable. Actual planting dates will depend on rainfall pattern.

c) Planting: The ideal planting depth is 3-4 cm. Planting deeper than 7 cm will reduce emergence, especially if small seeds are used. Deep planting can also delay emergence and produce weaker seedlings. Two to three seeds should be planted per hole. These are later thinned to one seedling per hole after establishment.

d) Spacing: The recommended spacing is 75 cm between the rows and 30 cm within the rows which gives a plant population of about 44,000 plants per hectare. This plant population may be increased for short and early maturing varieties grown where moisture is not limiting.

e) Weeding: Sunflower does not compete well with weeds, so weed control is very important particularly in the first few weeks. Effective weed control to the 8-10 leaf stage is therefore vital to ensure good yields. After this stage weeds are suppressed by shading due to the crop's large ovate leaves. The frequency of weeding will depend on factors such as rainfall pattern, soil type, variety and degree of weed infestation, all of which are known to influence the critical weed competition period in crops.

f) Crop rotation: Sunflower has an extensive root system and therefore performs well compared with other crops where rainfall is less than the desired amount or when planted in rotation following shallow-rooted cereals. Such crops also do well when planted after sunflower.

g) Fertilizers: Research on fertilizer type, rate of application and the economics of using fertilizers is still continuing. The current recommendation is 50 kg DAP per acre or 3g per hole applied at planting. When hand planting is carried out, the fertilizer has to be mixed thoroughly with the soil before planting the seeds so as to prevent the seeds from being scorched by the fertilizer.

h) Harvesting: Sunflower is physiologically mature when the back of the head turns yellow and the bracts become brown. Harvesting normally presents three main problems: i) the open-pollinated varieties ripen unevenly so more than one operation is usually needed, ii) the crop can be prone to shattering although the hybrids distributed by OCD are not seriously affected, and iii) bird damage can be severe, especially in isolated fields.

To prevent shattering and bird damage, and to encourage rapid drying, the heads should be cut and spiked when the crop reaches physiological maturity. Threshing is usually done by beating individual heads with sticks or by using a sheller.

i) Yields: Yields vary from 400 to 1000 kg per acre depending on crop husbandry, area, variety etc.

Gross margin of sunflower

As with most small-scale agricultural enterprises, the costs of production are normally less well-documented than the returns. Discussions with various existing growers have, however, produced the following average views on costs incurred by then:

Operation		Cost per acre (KSHS)
Ploughing (Oxen)		180.00
Making furrows (Oxen)		70.00
Planting (5 man-days at 20 per day)		100.00
Planting seeds		Free
Fertilizer (one 50 kg-bag of DAP)		240.00
Weeding/thinning		120.00
Spiking the heads		40.00
Threshing/winnowing		50.00
Total	KSHS	800.00

Assuming a yield of 12 bags (50 kg each) of sunflower seed per acre, then the total income per acre will be 12 bags x 50 kg x Kshs 2.80 = Kshs 1680.00 per acre.

Gross margin (output minus variable costs) will therefore be Kshs 1680-Kshs 800 = Kshs 880/acre (Kshs 2173.60/ha). Consider the costs and returns of your present cash crops, substitute your own costings for those stated above and evaluate for yourself just how profitable a crop of sunflower can be on your own land. Bear in mind also the convenience of free planting seed and expert advice, the ready market and prompt payment, and the relatively short life cycle of the crop, not to mention the benefits which the sunflower residues may leave in the soil for the next crop.

How OCD growers are paid

Due to the large number of farmers involved, OCD extension officers could not buy harvested produce and pay the farmers promptly. Seed buying is therefore done by OCD appointed agents who are currently being paid a commission of 20 cents for every kg of seed bought. OCD extension officers, however, ensure that the farmers are paid promptly and according to the company's announced price, which is currently Kshs 2.80 per kg.

Where can one grow sunflower?

Sunflower is a drought-resistant crop possibly because of its deep tap roots which can extract water down from 2m in well-structured soils. Sunflower can therefore extract more soil water than other crops such as maize, sorghum and wheat. The crop grows well in areas which receive an annual rainfall of 750 mm or more although good yields have been obtained in areas receiving less than 750 mm of rainfall. In Kenya, sunflower can be grown from sea level upto about 2500m above sea level provided soil moisture is not limiting. Soils that will produce a good crop of maize will also be suitable for sunflower.

Where does OCD operate?

Area	Districts covered	Office P.O.Box
Western Kenya	Uasin Gishu, Trans Nzoia, Nandi Elgeyo Marakwet, West Pokot, Bungoma, Busia, Kakamega.	4548, Eldoret
Mount Kenya	Meru, Embu, Kirinyaga, Muranga.	365, Meru
Nakuru/Nyahururu	Nakuru, Nyahururu, Laikipia.	2657, Nakuru
Kericho/Nyanza	Kericho, Narok, South Nyanza Siaya, Kisumu, Kisii	751, Kisumu
Machakos/Kitui	Machokos, Kitui	1223, Machakos

What does OCD consider before moving into a new area?

Before OCD starts its oil crop promotional activities in an area it must clearly identify the following:

1. Suitability of the area for the crop.
2. Farmers who can grow the crop well.
3. Availability of sufficient acreage for the crop to justify the posting of an extension officer to the area.
4. Existence of an efficient marketing structure (or one that can be developed) to buy the produce from the farmers and pay them promptly.

The company realizes that the promotion of oil crop growing has to be parallel to the development of a marketing structure where one does not exist. Marketing structures have been more limiting in the promotion of oil crops than agricultural extension, and the company aims at streamlining these marketing structures so that they can exploit the oil crop production potential in all suitable areas.

Because of the vastness of OCD's involvement in oil crops promotion, the use of agents has been found to be an essential element in the success of this small-holder project. Without agents, OCD could handle only a relatively small number of farmers and only those close to their branch offices.

Which type of sunflower does OCD promote?

Two types of sunflowers are grown in the country: a) oilseed varieties and b) birdseed varieties. The oilseed varieties currently recommended are hybrids 893, 894, 898 and 903. More hybrids are being tested in the National Performance Trials and are likely to reach the sunflower farmers as from the 1988/89 crop year. These are the varieties which OCD is promoting because of their high oil content (35-45%).

We also offer some open-pollinated varieties such as Kenya Fedha.

The bridseed varieties which are grown for markets in Europe and the United States include Comet, Kensun White, Hungarian White and Grey Striped. OCD does not promote the growing of these varieties because of their low oil contet (about 28%).

<u>What are the advantages of growing sunflower?</u>

In addition to the cash benefits, sunflower growing has the following advantages:

1. Sunflower does relatively well under adverse weather conditions. It is considered to be more drought-tolerant than most crops, and can therefore be grown in drought-prone areas and perform better than such crops as maize. In fact, in some marginal rainfall areas of Eastern Province, farmers have been able to harvest sunflower where maize has totally failed.

2. Sunflower responds to fertilizer, but is not as demanding of nutrients as most cereal crops.

3. In high potential areas such as Western Kenya, farmers still grow sunflower, despite its relatively low financial returns compared with maize and wheat because these crops give better yields when planted on fields which had sunflower the previous year. This is known as the "rotational benefit".

4. In areas like Trans Nzoia and Bungoma, farmers use the money from sunflower to harvest their maize crop as the former matures earlier. Sunflower also gives ample time for the following crop because it matures early.

<u>Where does OCD get planting seeds?</u>

Currently OCD is getting the bulk of the sunflower planting seeds from Kenya Seed Company (KSC) which is not only involved in the production of sunflower seeds but also in other crops such as maize, wheat, barley, sorghum etc.

It is estimated that out of a total of over 400t of sunflower planting seeds expected to be issued to OCD-registered farmers during the current 1987/88 crop year, only 70t will be imported seeds. As from 1988/89 crop year, it is expected that KSC will supply OCD with all the sunflower planting seeds.

Oilseed Rape planting seeds are bulked by OCD from imported breeders' seed. The cleaning, dressing and packaging are however, done by KSC at their factory in Nakuru.

<u>What is the quality of the sunflower planting seeds issued by OCD to registered farmers?</u>

The breeding of sunflower varieties is done at the National Plant Breeding Station (NPBS), Njoro - a government body charged with the responsibility of carrying out research on oil crops - and, to some extent, by KSC. Promising lines are entered by the breeders into the National Performance Trials (NPT) which are laid out in all agro-ecozones where sunflower is grown.

The coordination of these trials is done by NPBS. Promising lines are tested for three years after which a line showing consistently high seed/oil yields and resistance to major sunflower diseases is recommended and released by the Specialist Variety Release Committee (SVRC) and the National Variety Release Committee (NVRC) respectively. SVRC consists of researchers from NPBS, Director of Research, Directors/Officers in Charge of the stations where the trials were laid out, KSC, National Seed Quality Control Sercice (NSQCS), University of Nairobi, promoters and millers; whereas the NVRC consists of the Director of Agriculture, Director of Research and the director of NPBS.

Once a variety has been released, the breeders' seed is passed over to Kenya Seed Co. for bulking to "super elite" and "elite" before the production of hybrid seed is carried out.

During seed production, NSQCS carries out field inspection of the seed fields to ensure that the varieties being produced are true to type, pure and free from seed-borne diseases and that the right isolation distance is maintained. All seed crops which do not meet the above conditions are rejected. The approved fields are harvested and the seeds delivered to KSC factory in Kitale for cleaning, sizing, dressing and packaging. At the factory, samples of the various seed lots are drawn by NSQCS for purity, germination and moisture content tests at the seed laboratory in lanet. Only seed lots with purity of at least 99%, germination of at least 85% and moisture content of 7% or less are packaged in one kg-packs and delivered to OCD for distribution to OCD registered farmers.

<u>How does OCD distribute planting seeds?</u>

OCD is currently serving about 70,000 Kenyan farmers. To facilitate the smooth distribution of planting seed the company engages the services of local people to help in seed distribution. These people are paid a small commission for each 1 kg distributed.

<u>Major sunflower diseases, how to identify them and their control</u>

Sunflower is susceptible to a number of diseases, some of which can cause substantial yield loss if not controlled. The crop can be attacked from germination through maturity to harvest. The following are the major diseases of sunflower. As yet, none of them have proved to be a significant problem in Kenya.

1. <u>Downy mildew</u>: This disease is caused by a seed-borne, soil-borne and wind-borne fungus known as <u>Plasmopara halstedii</u>. Plants may be infected from the time of seed germination until flowering, but they are more prone to total infection during or immediately after emergence. The fungus can persist in the soil for 5 to 10 years after introduction and therefore control of the disease by short-term rotations is not possible.

   Sunflower planted on land with no previous sunflower history can still show downy mildew because the spores of the fungus occurring on volunteer sunflower plants in neighbouring fields can be blown to newly planted fields and cause heavy infestation under certain weather conditions.

   Typical symptoms include dwarfing and discolouration of the leaves, appearance of white cottony masses on the lower leaf surfaces and little, if any, seed set in erect platform heads. Plants infected early in their development normally do not produce seed.

   Ways of minimizing losses from this disease include planting resistant varieties, crop rotation, early season destruction of volunteer sunflower and field selection. Severe downy mildew may necessitate complete abandonment of an area.

2. Rust: This is caused by the fungus *Puccinia helianthi*. The disease is not usually observed until flowering. It spreads by wind-borne spores from sunflower trash and volunteer sunflower plants. It is characterized by small reddish-brown spots which occur primarily on the leaves but which in severe infestations, also occur on the stems, petioles, bracts and the back of the head.

   The disease can be controlled by planting rust-resistant varieties and destroying volunteer sunflower before planting.

3. Sclerotinia stem and head rots: This is caused by the fungus *Sclerotinia sclerotiorum* which has an extremely wide host range and attacks many broad-leaved vegetable and field crops including dry beans, oilseed rape, potatoes and soybeans, but does not attack cereals.

   The first symptoms are a sudden wilting of the leaves. Wilted plants when uprooted show a prominent canker which has a grey-to-brown colour and a water-soaked appearance. Dense white mould forms in which hard black resting bodies of the fungus (sclerotia) develop within the stem, making the stems become shredded and then collapse.

   When frequent rains and extended periods of high humidity occur after flowering, the disease may appear in the heads and partially or entirely rot them, leaving only the vascular bundles and fibres and causing the head to appear shredded and brush-like. Numerous large sclerotia often form in rotted heads.

   The disease can be controlled by:

   a) using a four-year or even longer crop rotation including fallow periods and cereal crops. Crops mentioned above should not be grown in rotation with sunflower where these rots occur,

   b) planting sclerotia-free seeds to prevent the infection of clean fields,

   c) removing infected plants from the field to reduce the carry-over of sclerotia in the soil, and

   d) planting early, as this tends to reduce infection.

4. Verticillium wilt: This is caused by the fungus, *Verticillium dahliae* which has a wide host range and causes wilt of several other cultivated plants and weeds. The disease shows as a mottling of the leaves, beginning on the lower leaves and progressing slowly upwards. Leaves showing such mottling soon dry completely. Symptoms are not usually observed until flowering. It is a persistent soil-borne and seed-borne disease that will remain in the soil for several years. Susceptible varieties of sunflower and potato should not be grown in the same rotation, especially if wilt has been previously observed in either crop in the rotation.

   To minimize the introduction and build-up of verticillium in the soil, farmers should: a) plant only high quality, disease-free certified seeds, b) avoid growing sunflower on a land known to have a history of verticillium wilt, and c) use a 3-to 4- year crop rotation which includes non-host crops.

5. Phoma black stem: This is caused by *Phoma oleracea*. It is characterised by large brown to black lesions, generally on the stem but occasionally on the leaf petioles, leaves and the back of the head. The spots are usually first

seen on the stem at the base of the leaf petiole and spread under favourable conditions to form large black patches.

Although it may occur at any time during the season, it is more pronounced after flowering. Infested plants are often weakened, producing small heads with poorly filled seed. The stem is severely weakened at the point of attack, and is subject to lodging.

Splashing water is the primary means of spreading spores of this disease. Field sanitation and crop rotation help to control the disease.

6. Alternaria leaf and stem spot: This is characterized by a roughly circular and uniformly dark-coloured spots on leaves and elliptical lesions on the stem, petioles and the back of the head. The stem lesions are not normally associated with the attachment point of the petiole but are scattered. Under conditions of high humidity and warm temperatures, the lesions enlarge rapidly, merge and frequently blacken the complete stem.

   Little is known about the causal fungus and no means of control can be suggested.

7. Charcoal rot: This is caused by the fungus *Macrophomina phaseolina*. It is the most destructive stalk-rot of sunflower under high temperatures and drought conditions.

   Usually symptoms are not apparent until after flowering, when poorly filled heads are evident and premature ripening and drying of the stalks occur. The diseased stalks are normally discoloured at the base, the pith is disintegrated, and the vascular fibres have a shredded appearance. After a period of hot and dry weather, the fibres become covered with small black growths giving a charcoal appearance. Charcoal rot can be distinguished from Sclerotinia stem rot in that the sclerotia are very small, seldom exceeding the size of pepper grains, and that a white cottony growth on the surface of the root and the stem base is lacking.

   Losses caused by this disease can be minimized by crop rotation and field sanitation.

8. Powdery mildew: This is caused by the fungus *Erysiphe cichoracearum*. The disease appears in the form of white mildew areas which may enlarge and merge until most of the plant surface is involved. As the season progresses, the mildewed areas take on a dusty, powdery appearance. The powder may be removed by shaking.

   Losses can be minimized by planting disease-resistant varieties and field sanitation.

Major sunflower pests

Sunflower crops are attractive to pests at all stages of plant growth. The major pests are:

1. Cutworms: Cutworm larvae are the most threatening pests in establishing sunflower crops. Other than sunflower, they also attack maize, cotton, beans, cabbage and coffee seedlings. They are 2.6-4.5 cm long when fully grown and are grey-brown or grey-green in colour, often with a reddish tinge.

Young caterpillars feed on the leaves of the seedlings whereas older ones damage the stems causing the plant to fall over. In some cases the caterpillars may prevent the emergence of germinating sunflower by cutting off the plant just below the soil surface. They feed at night and may often be found the next morning just below the surface of the soil and close to the damaged plant.

Seedlings can be protected from caterpillar damage by dusting round the base of the stems with Aldrin 40% or mixing the Aldrin with the planting seed and fertilizer at the rate of 1 kg of Aldrin/100 kg of planting seeds, immediately before planting.

2. American bollwarms: This is one of the major pests of sunflower, which will also attack cotton, tomatoes, beans, citrus, sorghum, tobacco and pigeon peas. The fully grown larvae are slightly hairy and grow to about 4 cm in length. They are usually green when they hatch, but as they grow, they may turn brown with black spots or stripes along the sides.

   The larvae feed on leaves, developing seeds, bracts, petals and the backs of the heads. The damage caused by these larvae boring into and feeding on the back of the maturing heads may promote infection by head rot fungi.

   The pest could be controlled by spraying Malathion 50% EC, Kilpest or Ambush CY at recommended dose rates.

3. Birds: These are the main pests in maturing sunflower, especially, in isolated fields. The control measures include:

   a) Planting sunflower away from woodlands and marshy areas, b) planting sunflower when other farmers in the area are also planting sunflower or other alternative crops, c) scaring birds as soon as they are seen in the vicinity of the crop, d) harvesting sunflower as early as possible to avoid prolonged exposure to bird damage, e) cutting and spiking physiologicaly mature heads, and f) planting hybrids to ensure a shorter harvesting period.

How can one become an OCD agent?

1. Collect an "Application to become an OCD oilseed Agent" form from the OCD head office in Nakuru or from the branch offices in Eldoret, Meru, Machakos and Kisumu.

2. Complete the form and take it to the nearest government administrative officer which will give his recommendation on the suitability of the applicant as an OCD agent.

3. The forms are then taken to the agricultural managers (based at the various branch offices) who are required to furnish the head office in Nakuru with the information on a) number of agents in the area, b) total expected production of sunflower in the area, c) number of farmers in the area, d) whether the applicant is capable of carrying out the business, and e) whether the terms and conditions have been explained to the applicant.

4. The forms are then sent by the agricultural managers to Nakuru head office for approval.

How OCD buying agents are paid?

Once recruited, OCD agents are required to furnish OCD Naikuru with details of their bank account, i.e., branch, address and account number.

The crop bought by the agents from farmers is received at the OCD godown in Nakuru where it is weighed and sampled for moisture, oil and admixture determination. The Crop Purchase Voucher (CPV) with information on weight, the agent's name, oil, moisture and admix is raised and despatched to the Nakuru office. Agents are penalized if excessively wet or dirty seed is delivered.

Once the CPV is received in the office, payment is prepared and OCD's bank (Barclays Bank - Nakuru West) is advised to transfer the money due to the agent to the agent's bank by inter-bank or internal telegraphic transfer. Currently a commission of 20 cents is paid for every 1 kg of milling seed bought by the agent and in addition OCD bears the cost of transporting the seed to Nakuru.

The advantages of the bank transfer system are that it is fast (it only takes 1-2 days from the time the crop is delivered to Nakuru for money to reach the agent's bank), and that the agent does not have to come to Nakuru in person. This means that the agent can remain behind buying more crop and send only his driver to deliver the crop to Nakuru.

Uses of sunflower

After cleaning and drying, the seeds are crushed at the premises of one of our contracted oil millers. This operation removes most of the oil, which, after further processing, can be bottled for use as cooking oil (e.g., Frytol) or blended with other edible vegetable oils and fats and sold as shortening (Kimbo), ghee (Cowboy) or margarine (Blue Band).

The residue left after the oil has been extracted (sunflower meal) can be used in that form or compressed into sunflower cake for animal feed purposes. High in protein, and still containing oil not removed in the crushing process, this cake is a first class constituent of high-grade, balanced rations used particularly for intensive dairy herds and poultry flocks.

Most of the edible oil used in Kenya has traditionally been imported from Malaysia in the form of crude or refined palm oil. This is expensive in terms of scarce foreign exchange, deprives Kenyan livestock farmers of the benefit of the cake, and means we are vulnerable in the event of external factors preventing shipments from reaching our shores. Equally important, the import strategy gives much less opportunity for the employment of Kenyans in growing, transporting and processing or handling the crop as agents.

All in all, the Oil Crop Development Scheme is run by Kenyans for Kenya. The domestic benefits are shown from the oil crop cycle, Fig.3.

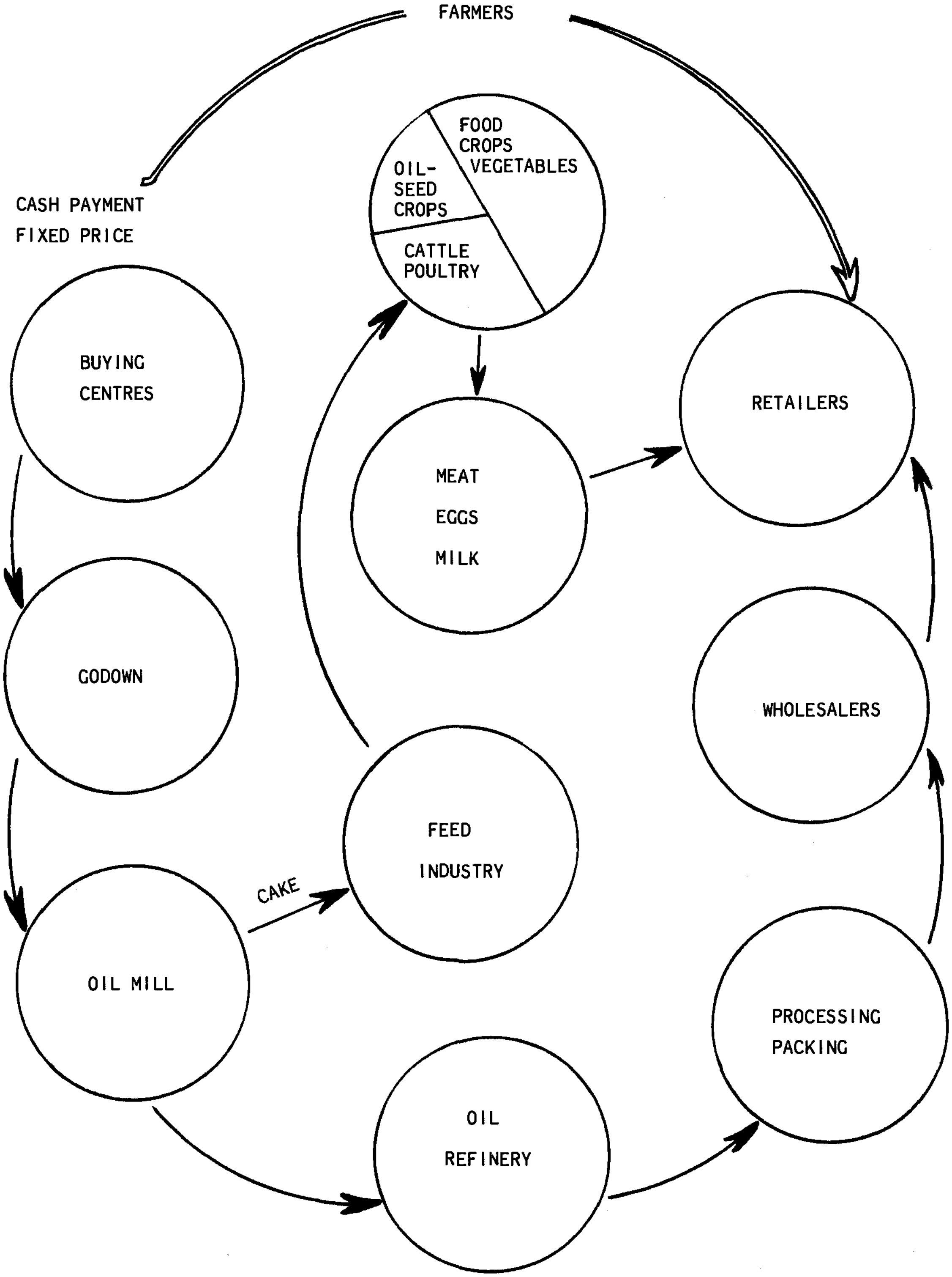

Figure 3. OIL CROP CYCLE

SESAME RESEARCH AT THE REGIONAL RESEARCH CENTER MTWAPA, KENYA - A REVIEW OF PAST WORK, POTENTIAL AND FUTURE PROSPECTS

S.T. Gichuki and J.G. Gethi

Introduction

The coast province of Kenya borders the Indian Ocean in the east. The altitude rises gradually from sea level to 900 m except a few hilly areas rising up to 2000 m. Soils are varied but are mainly sand limestone or shale deposits with low organic matter and deficient in the major nutrients. Rainfall is bimodal with an annual level of 1200 mm along the coastal strip and decreasing northwards and westwards to the hinterland up to 760 mm. Temperatures are high throughout the year with little seasonal variation. Monthly mean maxima vary between 20°C and 30°C and minimum 15°C and 20°C. Relative humidity is high ranging between 65 and 95% (Farm Management handbook).

Sesame has been grown in the Kenyan coast for a long time and is recorded being exported from Mombasa as early as 1850 (Kingi 1987 unpublished) and Malindi (1983) when 350 tonnes were exported (Malindi subdistrict annual reports). In the last two decades production has been more or less constant with a reported increase between 1979 and 1981, Table 1. Decline in production has been observed due to weather changes, lack of planting seeds and competition with other crops.

The sesame seed is used as food, pound into a cake and then eaten as a confectionary or with other foods. The processed oil is odorless and has a long shelf life (Kingi, 1987). Sesame oil also contains sesamolin and sesamin which are used as synergists for pyrethrin based insecticides (Weiss, 1970).

Low yields of the crop that range between 80 and 400 kg (Ministry of Agriculture, 1976) and its relative importance as a cash crop prompted research work on it as early as 1913. Research work on varietal introduction, evaluation, screening and studies on some agronomic aspects are reported in this paper. The potential and prospects for future research work on the crop are also discussed later.

Variety Evaluation

From 1962 to 1987 variety trials were conducted to evaluate the performance of both local black-seeded and imported varieties. Most of these trials were conducted at Mtwapa and its other testing sites. Results from these experiments have shown that the local black-seeded variety outyields all other imported varieties.

In 1962, four South American varieties were tested against the local black-seeded variety, Table 2. The local variety outyielded all the others.

In the following year, 216 varieties developed in Tanzania, 9 from America and 7 from Kenya were tested. Only 32 varieties yielded more than 330 kg/ha as compared to Kilifi local and Mtwapa local which yielded 768 kg/ha and 724 kg/ha respectively (MOA 1963). Again in 1965, 50 Venezuelan varieties were tested against Mtwapa local and Moranda, Table 3. The Venezuelan varieties yielded lower than the local and they were also attacked by aphids and red mites while the local one was resistant.

Table 1. Simsim production in the coast province of Kenya 1970 - 1986 MOA Annual Reports)

Year	Average (ha)	Yield (t)
1970	5,000	1,200
1971	-	473
1972	3,275	-
1973	-	276
1974	-	155
1975	4,319	387
1976	5,308	814
1977	-	-
1978	5,308	719
1979	5,877	1,272
1980	6,631	1,118
1981	8,448	3,008
1982	5,958	1,163
1983	-	-
1984	-	-
1985	5,534	3,551
1986	4,763	2,393

Table 2. Yields of five simsim varieties (MOA Annual Report, 1962)

Variety	Yields (kg/ha)
Local	656
Moranda	216
Inamar	156
Acaragua	156
Venezuela 52	138

Table 3. Yields of the best ten simsim varieties (MOA Annual Report, 1965)

Variety	Days to 1st flower	Days to mature	Yields (kg/ha)
Local	44	125	1376
304/1	44	112	660
468/2	44	101	562
Moranda	51	120	548
318/1	51	12-	481
381/1	44	121	457
428/2	51	120	457
413/2	44	120	457
360/2	44	112	432
421/2	44	120	277

Under irrigation in 1974 the local black-seeded variety outyielded Moranda by 262 kg/ha (C.D.C. report 1974). In the 1987 variety trials the black-seeded variety outyielded eleven other varieties, Table 4. However, in observation plots some promising varieties were identified which will be tested further (CARS Annual Report, 1978).

The black-seed variety is tall, late maturing (110 - 125 days) with an average of 48.84% oil content, 1.48% free fatty acids, and 4.19% moisture content. The residue cake after oil expression has 44-50% protein (Kingi 1987).

Plant Populations and Arrangements

Field trials indicate that higher yields are obtained in higher plant populations exceeding 100,000 plants per hectare (MOA Annual Report, 1963; W'Opindi, 1979).

In 1963 the experiment on two different spacings showed a yield of 655.4 kg/ha at a spacing of 45 x 10 cm compared to 448.9 kg/ha at 45 x 15 cm.

Table 4. Yields and characteristics of 12 sesame varieties (CARS Annual Report, 1978)

Variety	Days to 1st flower	Days to 50% flower	Days to mature	Plant height (cm)	Mean yields (kg/ha)
Dodekaniso	31	38	84	58.2	156.3
Balmi	31	39	83	60.9	161.5
B.A.Sindos	29	35	83	70.0	228.1
Sindos 64	30	35	83	61.5	186.5
Makro Kapso	29	37	83	60.4	152.4
Promo	30	37	83	65.1	197.8
Ciano 16	32	39	83	67.4	214.6
Pachequeno	34	40	83	73.0	284.4
Tecras 77	35	41	83	82.6	292.7
Yori 77	41	56	92	104.7	322.9
Local Black	51	63	109	174.5	516.7
Local White	42	53	109	92.6	97.9

Multilocational experiments at 3 sites in the region (Mtwapa, Msabaha and Matuga) showed a yield increase with increased plant population (CARS Annual Report, 1979). The optimum yield was achieved at plant populations between 100,000 and 400,000 plants per hectare. In the higher plant populations a rectangular arrangement gave higher yields, Table 5.

Table 5. Seed yields (kg/ha) of simsim grown at various populations and plant arrangements.

Treatment		Yield
Population	Plant arrangements	(kg/ha)
50,000	45 x 45 cm	490
	60 x 34 cm	941
100,000	30 x 30 cm	1026
	60 x 15 cm	1072
200,000	22 x 22 cm	1190
	60 x 8 cm	1005
400,000	16 x 16 cm	879
	60 x 4 cm	1381
800,000	11 x 11 cm	682
	60 x 2 cm	2238

Time of Planting

Investigations on time of planting show that the best time to plant simsim in the coast region is during the mid-season rains of July and August (CARS 1979, 1980, 1981). Planting at the onset of the mid-season rains and two weeks later showed no significant differences in yields while late planting showed a decline in yields, Table 6.

It was also observed that late planting resulted in increased incidence of pests and diseases especially in the absence of rains after germination. Excessive rain was also noted to lower simsim yields.

Fertilizer Trials

Some work seems to have been done in 1968 and 1975 at Ngao to determine the optimum N and P requirements, but results of these experiments were not reported.

A fertilizer rate experiment in 1968 investigated the response of different rates of N and P fertilizers under irrigation. Nitrogen was applied as sulphate of ammonia (21% N) at two levels and with a control. Phosphate was also applied as double super phosphate (42% P_2O_5) at two levels and with a control, Table 7.

According to the results, the application of 187.5 kg/ha of sulphate of ammonia (21% N) and 250 kg/ha double super phosphate (42% P_2O_5) gave the highest yields. It was also apparent that high levels of both N and P and low levels of P gave low yields.

Table 6. Yields of simsim in kg/ha from crops planted at different dates.

Year	Time of planting	Yields (kg/ha)
1980	May	557.0
	June	473.0
	July	582.0
	August	480.0
1981	Mid-July	1288.1
	Late-July	1217.3
	Mid-August	1108.3
	Late-August	852.3
	Mid-September	228.2

Table 7. Yield of simsim in bags per hectare at different fertilizer rates (CARS Record books, 1968)

		Sulphate of amonia		
		0 kg/ha	187.5 kg/ha	375 kg/ha
Double	0 kg/ha	6.04	4.84	7.26
Super	125 kg/ha	6.46	8.08	6.84
Phosphate (DSP)	250 kg/ha	8.46	9.44	5.64

Other trials in Lamu where N and P fertilizers were compared showed a depressing effect on yields due to fertilizer application (MOA 1972).

Treatment	Yield kg/ha
A - Control	799
B - 200 kg N	746
C - 200 kg P	639
D - 200 kg N and 200 kg P	746

Intercropping

In earliest recorded experiment on intercropping was in 1956 at Msabaha where maize was intercropped with Simsim on a pure stand yielded 583.6 kg/ha while a mixed stand yielded 244 kg/ha. In another experiment in 1984 simsim was relay-cropped with maize as practiced in farmers fields. Different simsim spacings were tested. Simsim yields from pure stand plots were significantly different from relay-cropped plots, Table 8. No economic analysis was done and it is, therefore, difficult to compare the results.

Table 8. Yields of maize and simsim in a relay-crop experiment (1984).

Spacing	Mean maize yields (kg/ha)	Mean simsim yields (kg/ha)
S1 A SS pure 60 x 15	-	1,004.8
S1 B SS pure 60 x 15	-	956.8
S2 A (M + SS) 45 x 15	3.80	610.4
S2 B (M + SS) 45 x 15	3.51	425.2
S3 A (M + SS) 45 x 35	3.02	541.8
S3 B (M + SS) 45 x 35	3.58	627.6
S4 A (M + SS) 30 x 15	3.67	384.1
S4 B (M + SS) 30 x 15	3.81	524.7

Simsim webworm control

In simsim webworm (Antigastra catalaunalis) is the most serious pest of this crop in the region. The recommended control is thiodan 35% E.C. The experiment to determine the number of sprays necessary to control the webworm showed no significant difference between 0 and 3 sprays, Table 9. Increased number of sprays actually showed a depressing effect on yields. However, it was observed that there was a low incidence of webworm during the trial period (CARS, 1980).

Table 9. Yields of simsim at different numbers of sprays with thiodan 35% E.C.

Number of sprays	Seed yield in kg/ha
0	522
1	522
2	496
3	405

Potential and Future Prospects

As shown by the production trends, Table 1, and results of past experiments, it is apparent that Sesamum indicum (L) has a high potential for development at the coast of Kenya. This has been enhanced further by favourable developments in its market for the last two years.

Reported research station yields of 2238 kg/ha (W'Opindi 1980) compared to farmers yields of 80 - 400 kg (MOA 1976) show a great variation. There are several reasons for the low yields in farmers fields. These include rainfall amounts and distribution, poor agronomic practices, unevenness of ripening, pest attack, the dehiscent nature of the black variety and nutrient deficient soils.

Previous varietal evaluation work has shown that although black-seeded variety is superior to imported varieties there is a lot of variation in yields and rate of maturity within different lines of the variety. This indicates a potential for development of high yielding lines from the black-seeded variety that are both pest resistant and ripening evenly. To achieve this it will be necessary to collect several strains of the black-seeded variety within the region followed by an intensive selection program. Also, some of the imported varieties which are early maturing may do well in the hinterland which has less rainfall over a shorter period. Crossing of the black-seeded variety with the promising and early maturing varieties is necessary to reduce the maturity period of the black-seeded variety. The nonshattering characteristics in some of the imported varieties should be incorporated in the local black-seeded variety to reduce harvesting losses.

Since the sesame crop is planted in midseason as a relay crop there is great potential in investigating its role in various crop combinations. This will include the place of simsim in rotation sequence, its associations with other food crops like cassava and maize as an intercrop and the role of cake residue as an animal feed. The objective of this will be to improve the net output per unit area of land as well as enhancing the performance of the entire farming system. Similarly agronomic aspects like time of planting and methods of planting and harvesting should be studied.

Although preliminary experiments on fertilizer use show poor response, the exhaustive nature of the crop suggests that it might need additional nutrients. Therefore, more detailed work will be essential on its nutritional requirements.

Finally, one of the major constraints to simsim production is the simsim webworm (Antigastra catalaunalis). Research work should be done on this pest with an aim of coming up with an effective control program. The biology of the pest should be studied. Special emphasis should be laid on identifying the natural enemies of the webworm and cultural practices likely to control the pest. These together with screening of suitable insecticides will assist in developing an integrated pest management program for simsim.

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KENYA SEED COMPANY - OIL CROPS PRODUCTION - WITH EMPHASIS ON SUNFLOWER SEED PRODUCTION

William Kundu

The role of Kenya Seed Company in seed production is perhaps unique due to the presence of a private enterprise in cooperation with government research and extension services so as to present a package of inputs to the farmer. As seedmen, we are pleased to be of assistance in providing the vital link between the researcher and the farmer.

Research

The National Plant Breeding Station at Njoro (NPBS) carries out research on oil crops, mainly rapeseed, linseed, safflower and sunflower. The relative priority given to breeding oil crops, especially sunflowers, includes studies on:

- testing yield
- introduction of new materials
- disease resistance
- uniformity
- flowering pattern
- maintenance of varietal characteristics
- importing varieties and seed for multiplication and equally important, making decisions on the exchange of germplasm and cooperative activities developed by the Government, Kenya Seed Company and International centres.

Oil crop research is the foundation on which a good seed program is built. The plant breeder is responsible for the initial and basic seed multiplication. In Kenya basic seed is a term of broad meaning. It involves three classes or levels of seed:

1. Breeders' seed
2. Super elite seed
3. Elite seed

The definition of each of these classes is given in the regulations of the NSQCS (National Seed Quality Control Service) which are used for certification purposes of all crops in the country. In Kenya, the system of basic seed production varies slightly from one crop to another. In crops such as sunflower, Kenya Seed Company and the Government of Kenya (NPBS) provide the breeders seed each year to be multiplied. The seed is then turned over to contract growers of Kenya Seed Company for the production of super elite and elite classes of seed. The Kenyan Government has allowed Kenya Seed Company to multiply all the classes of basic seed under strict government supervision and inspection.

Now we have to ask whether it is necessary to produce all these classes of seed and are we trying to achieve by having defined them. Once a variety is released by a breeder and is registered on a varieties list, then the breeder is usually left with a small quantity of source seed available. This has to be multiplied as quickly as possible so that it reaches commercially attractive proportions and can be made available to farmers. The government authorities, commercial interests and/or breeders are interested in ensuring that during the process of multiplication the new variety does not change its character in any way. When grown in farmers fields the new variety must be the same as it was grown by the breeder in his trial. So we are interested in the production of genetically identifiable and pure material for further multiplication. There are differences in the production of basic seed depending on whether the crops are self-pollinating or cross-pollinating. Cross-pollinating crops have to be multiplied under closely controlled conditions so as to ensure genetic stability and purity whereas self-pollinating crops do not require the same strict supervision other than the attention paid to the segregation and maintenance of varietal characteristics. The production of basic seed has to be closely monitored with the expected production of commercially certified seed. This is not always easy to do and the estimation of future sales in four or five years time is usually difficult. In the case of hybrid sunflower seed production, under conditions in Trans Nzoia where the use of irrigation is nonexistent during part of the year which cannot be commercially justified, we have the following time and sequence of production:

1988 Sales of hybrid sunflower seed to farmers for commercial sunflower growing.
1987 Production of final hybrid cross seed (certified seed).
1986 Production of parental crosses and varieties (elite seed).
1985 Increase of inbred lines (super elite).
1984 Inbred maintenance and multiplication (breeders seed).

A period of four years is needed to multiply a new line and produce a new hybrid sunflower. This requires some effort of planning and an estimate of what acreage is likely to be planted to a new hybrid in four years' time. In the case of self-pollinated crops this time span can be reduced to three years.

These stages of seed production are, of course, a continuous process. One of the advantages of a commercial company such as Kenya Seed Company is that it has the flexibility of planning to produce sufficient basic seed which, in turn can produce more certified seed as and when the need arises. Kenya Seed Company retains over 100% of basic seed so that should disaster occurs the company will not be out of business. The seed is kept in a cold store to ensure its viability over a long period of time.

In the production of basic seed, the National Seed Quality Control Services (NSQCS) plays the most important role. They are responsible for the genetic purity of the basic seed and ensuring that various conditions and regulations are followed. They ensure that a farmer receives what the breeder has developed. The inspection service does not control the final stage of production only, as it must know what material produces certified seed and how it is produced. Similarly, if the inspection service controls the basic seed production only, it would not ensure that the farmer receives what the breeder has developed. The inspection service therefore needs to control all the stages of seed multiplication from super elite to certified.

Varietal lines

Most of the lines that are being used in commercial sunflower seed production originate from NPBS Njoro. Currently, some of the most important are: 1. Fedha, 2. Shaba, 3. Local White, and 4. Large White.

Maintenance of these lines involves the planting of a basic seed plot with seeds from NPBS. The seed is isolated from other sunflowers by 3 km in distance or by 30 days with regard to flowering time. Roguing the off-types is carried out before flowering.

Hybrid seed parents

These consist of the cytoplasmic male sterile (CMS) and restorer (R) lines. The maintenance of CMS lines involves the use of corresponding B line back-crosser since the CMS cannot be self-maintained. The restorer lines are maintained just like the varietal lines since they are crude varietal lines, i.e. they have not been selected for single heading characteristics. At present Kenya Seed Company maintains nine inbred lines and six open-pollinated varieties.

The maintenance of these hybrid lines is similar to that of the varietal lines with regard to time and distance isolation and also roguing. The extra task on these lines is the check ploting carried out inorder to confirm that the B line has maintained the CMS line in a sterile form. Any CMS that has pollen entails the discarding of some, together with the B line that is used.

Certified seed

The isolation for certified seed is similar to that for the above but the distance is reduced to 1.5 km. The reason for this is mainly land scarcity. For varieties, further seed bulking is done with the necessary roguing so as to acquire large enough quantity for sale. For hybrids, this is a stage in which the CMS line is crossed with the R line to form the final hybrid (F1). For a three-way cross, the single-cross female is crossed with the R line. This stage is also registered with NSQCS for field and processing inspection.

OILSEEDS FROM A POST HARVEST PERSPECTIVE

O.G. Schmidt

In this brief presentation I would like to offer analysis, share some information, pose some questions, and leave you with a challenge.

Oilseeds can and do contribute to the food security of the oilseeds producer, the target of this network, in at least three ways: as raw material for food (often processed and consumed on the farm), as feed for farm animals, or as a source of cash with which to purchase food.

Some of the factors which affect how a particular harvested oilseed is viewed by the producer include:

a) the family's need for cash or food at harvest times
b) availability of labor to convert the oilseed into an edible form;
c) access to nearby processing machinery and cash to pay for the mechanical conversion of the oilseed to food and or feed;
d) availability and cost of buying the processed product in a ready-to-eat form;
e) how much money can be obtained from the sale of surplus production (price);
f) ease or difficulty of home storage of part or all of the crop, either for sale at a later time when prices are higher or for processing into food as the family needs it and;
g) cost and difficulty of transporting the surplus to someone willing to buy it.

The oilseeds food systems in many eastern and southern African countries exhibit some common characteristics:

1. The urban demand for oilseed products, especially for cooking oil, exceeds the often-declining national production levels,

2. There is a rural demand for cooking oil, in the right size of container, and at the right price,

3. The level of rural demand for cooking oil is in large part undetermined, and certainly under-supplied by a costly (and rarely available) output from the urban located and relatively large-scale processing plants,

4. The rural consumer as she purchases the oil, is paying for the cost of transporting the farm product to the distant city, its processing, and the transport back to the rural area.

It is a tenable hypothesis that the development and deployment of small-scale oil-expelling enterprises in rural areas would improve the availability of cooking oil, reduce its cost to the rural family and provide available and less expensive press cake for the family's animals which are part of the rural food production ststem.

One of the Regional Food Security projects in the nine-country SADCC (Southern African Development Co-ordination Conference) held a workshop in Zanzibar in mid-November 1987 to address this issue. The workshop's objective was to examine the existing projects and programs and to develop interventions to enhance oilseed utilization in a cost-effective manner. The meeting learned about progress with a number of small-scale processing technologies (hardware), and their suitability in responding to the problems of the rural producer : are they technically sound, do they suit the economic and agricultural environments, can their operation be sustained in the rural environment, can they be profitable for the owner/operator?

The workshop's outcome is an embryonic network to link the existing applied researchers. The intent is to develop a collaborative program of machinery testing in rural locations, leading to the systematic introduction of suitable hardware. This nascent network will initially focus on sunflower. Issues which will have to be addressed by that network are local manufacture, operator training, business training, gauging what effects the intervention with the technology has on the community and on planting patterns, and identifying what new problems were caused.

It is obvious that any effort to increase the utilization of, and demand for, oilseeds have clear linkages to breeding programs. For instance, can the breeder deliver a variety with adequate storage characteristics? Each household requires small amounts of oil steadily throughout the year; the raw material will be stored until it is needed for processing at the same steady demand rate. Or, does the breeder's new variety have good processing characteristics, is it well matched to the capabilities of the small expeller? Post harvest considerations (feedback from the eater, the storer, the processor) as much as the realities and constraints in the production system, should influence the objectives of breeding programs. Thus linkages between post harvest researchers and breeders should be formalized and strengthened in national programs.

There will also be situations where the improvement program needs direct dialogue with policy makers. The breeder may strive for a high oil content hybrid, but the producer's price may not correspond to the oil content. In such cases it may be in the interest of the producer to adopt the hybrid for home retention and on-farm processing. But in order to maximize cash income from the sale of surplus production, the producer might select instead a variety that has a high yield of seed weight per hectare regardless of its oil content. Thus pricing policies can inhibit farmers' adoption of breeder's varieties.

I hope that this brief presentation whets your interest in reading the paper presented to the Zanzibar workshop by Mr. T.Rukuni of the SADCC Food Security Projects, and in establishing contacts with colleagues in your own countries who are concerned with oil expelling. I hope as well that a future meeting of this oilseeds network will address the topics of processing and utilization: how they can and should benefit the producer and the urban consumer, and how results of work in the postharvest sector might contribute to the formulation of beneficiary oriented breeding priorities.

HOW CAN OILSEED PRODUCTION AND PROCESSING ENHANCE FOOD SECURITY?

Tungamirai Rukuni
(Read by Ozzie Schmidt)

Food security can be difined as the availability of, and access to, nutritionally sufficient diets for active life regardless of the vagaries of the climate and the economy.

The majority of diets in southern Africa comprise high-bulk, low-energy density cereals or root crops. Adding vegetable oil can enhance palatability and energy density, the latter being especially important for weaning children, pregnant mothers, and the elderly and infirm who are otherwise hard put to digest adequate amounts of food to fulfill their energy requirements.

Vegetable oils are expressed from a wide variety of oilseeds including groundnuts, sunflowers, cotton seed, soybeans, sesame seed, oil palm and coconuts. This paper focuses principally on sunflower as a crop which can have a significant impact on food security.

Sunflower Production

Virtually all countries in the area being discussed here grow sunflowers although the area planted and the yields are declining. Zimbabwe is perhaps the exception. The trend is approximately 0.5t per hectare against potential yields of 1.5t demonstrated by research.

Similarly, yields of groundnuts per hectare are low. However, production has remained reasonably stable. The reasons for the difference between the production of the two crops appear to be that groundnuts fetch a better price and the product finds more markets than does that of sunflowers. For instance, best grade groundnuts can go for confectionery use at a high price. Lower grade groundnuts can go for oil expelling, the oil and the cake can both be sold. Alternatively, the curshed nuts make peanut butter. If groundnuts are not marketed formally they can be processed and consumed at home.

On the contrary, sunflowers are consumable only if they are crushed for cattle feed or preferably if the oil is expelled and the cake used for cattle feed. The rate of consumption or the number of marketing pathways open for sunflower seeds are relatively limited.

A similar analogy can be made in the case of soybeans; not only can the seeds be profitably processed but also the stover is useable as hay. The leguminous nature of the crop enhances rotation of crops and the cake left from oil expression can be used for cattle or human feed depending upon the degree of its refinement. Again, the pathways open for consumption or marketing are greater than those for sunflowers.

This strengthens the argument that before encouraging further production, the processing and market side of the equation must be addressed.

The production patterns of crops are mainly influenced by the prices offered for their products and the relationship between those prices, including yields and the resources invested to produce them. (See Tables 1 and 2).

Table 1. Sunflower Production in Selected SADCC States 1981/86

Country		81/82	82/83	83/84	84/85	85/86	86/87
Mozambique	Area ha	5 880	3 376	3 897	1 566	1 174	
	Av. t/ha	0,31	0,34	0,30	0,46	0,37	
	Gross Prod.t	1 850	1 164	1 169	717	437	
Malawi	Area/ha				4 078	2 551	
	Av t/ha				0,41	0,46	
	Gross Prod.t					1 705	1 185
Zambia	Area ha	Estimated 57 000 ha					
	Gross Prod.t		34 930	43 008	42 424	26 651	14 750
Tanzania	Gross Prod.t		9 423	9 494	4 449	7 728	10 513

Table 2. Influence of producer price on production of oilseeds in Zambia. Sunflowers vs Soybean.

		1983	1984	1985	1986	1987
Soybeans	Total Prod.t	6 999	9 556	10 603	25 053	22 095
	Price Kwatcha/t	503,33	583,33	676,69	1 250	1 444
Sunflowers	Total Prod.t	34 930	43 008	42 424	26 651	14 750
	Price Kwatcha/t	430	430	557,6	839	1 400

Demand for Cooking Oil

An accurate assessment of the effective demand for cooking oil is difficult to make. However, some conjectures can be made from the available information.

The majority of countries in the SADCC region import significant amounts of cooking oil while domestic production accounts for approximately 50% of consumption. The demand reflected here is principally of the urban area where physical and financial access to supplies exists. It takes no account of the majority of the population residing in rural areas where there is little demand for oil. This is largely due to the fact that oil is expressed in urban centers and hence the value added in the process of expression and transport makes the product out of the economic reach of farmers.

The observations tend to strengthen the hypothesis that developing small-scale oil expression enterprises in rural areas would increase the oil supply and improve its distribution so as to meet the demands of the rural population.

Pilot projects have shown that there is no difficulty in selling oil in the villages. The local expressors sell oil in small quantities which suit the people's needs and pockets even though the cost per litre may be considerably greater. Reports indicate that people prefer unrefined oil for its taste, although this has yet to be verified.

However, a number of important aspects must be considered to establish the effective demand in the rural areas. How many people have how much money or other resources available to exchange for oil? What percentage of the available oil can be recovered? Based on the question of the efficiency of extraction, how much does it cost to expell oil and what throughput is needed to make the enterprise profitable? Is there a market for the by-product cake? Can other benefits be ascribed such as nitrogen fixation or the use of the stover for some purpose? I will address some of these questions in the following section (See Table 3).

Table 3. Oil Imports (Metric Tonnes) Selected SADCC States

Year	Tanzania	Malawi	Zambia
1982	6 053		Annual Zambia requirement estimated at 27-44,000 t/annum
1983	959		
1984	4 177	1 801	Average domestic prod. is about 14,000 tonnes.
1985	7 009	1 801	Zambia is therefore less than 50% self sufficient.
1986	13 995	775	

The high import figure for Tanzania in 1986 results from the trade liberalization programme.

Small-Scale Oil Expression and Extraction

Traditional household processing

Traditional household processing involves crushing the seeds, heating the resulting pulp in water and then skimming off the oil as it rises to the top. The efficiency of this process and the quality of the product are both low.

The improvement in this traditional method of processing is that the pestle and mortar were mechanized in India in the form of a ghani. Large pestle and mortars are used in Malawi although objective studies have to be done on their efficiency.

Ram presses

Various designs of ram presses exist in the extraction of vegetable oil. These include designs from the Institute of Product Innovations of the University of Dar es Salaam and the Bielenberg design from the Appropriate Technology International in the USA, Figure 1. There have also been adaptations of this design (for details, see Figures 2,3,4,5 and 6). The process involves decorticating the seeds, winnowing, roller crushing, roasting, pressing and finally filtering the oil. These expellers work on the principle of applying high pressures to the pretreated seeds in a confined cylinder and then capturing the released oil.

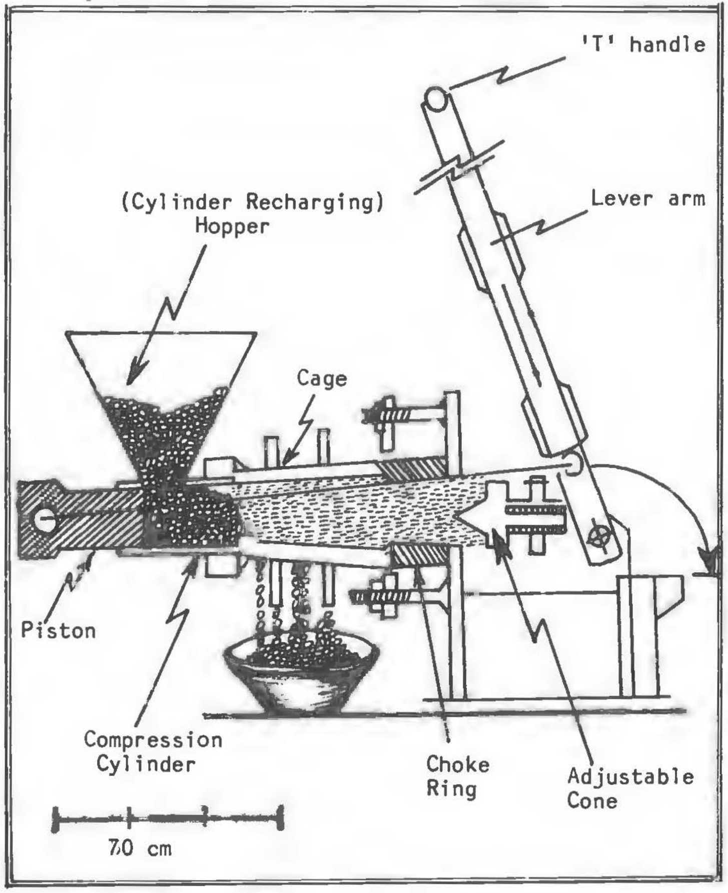

Figure 1. Bielenbeg Ram Press

Source: A.T.I. Washington DC.

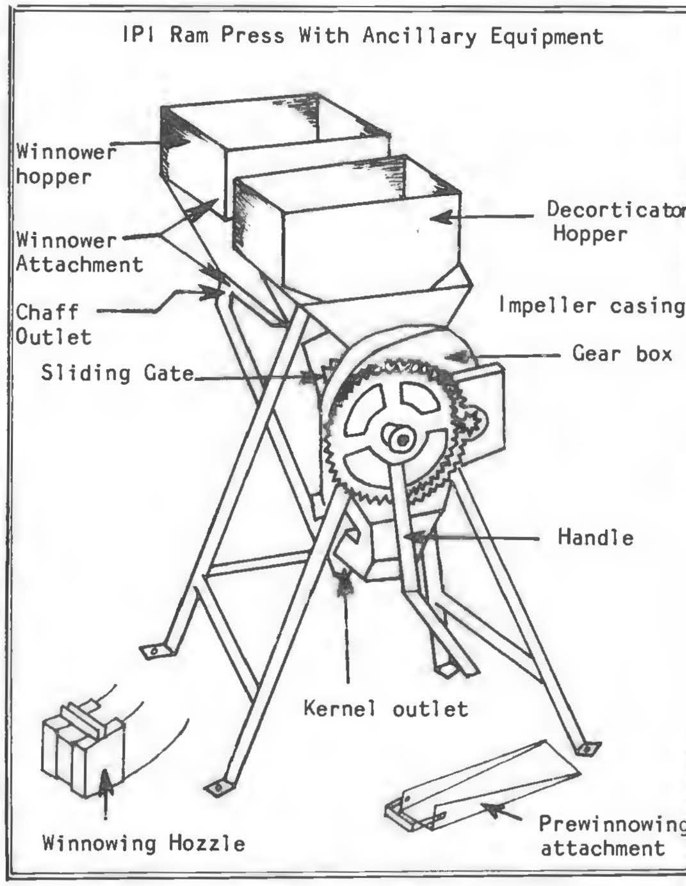

Figure 2. Description of the decorticator winnower and its parts

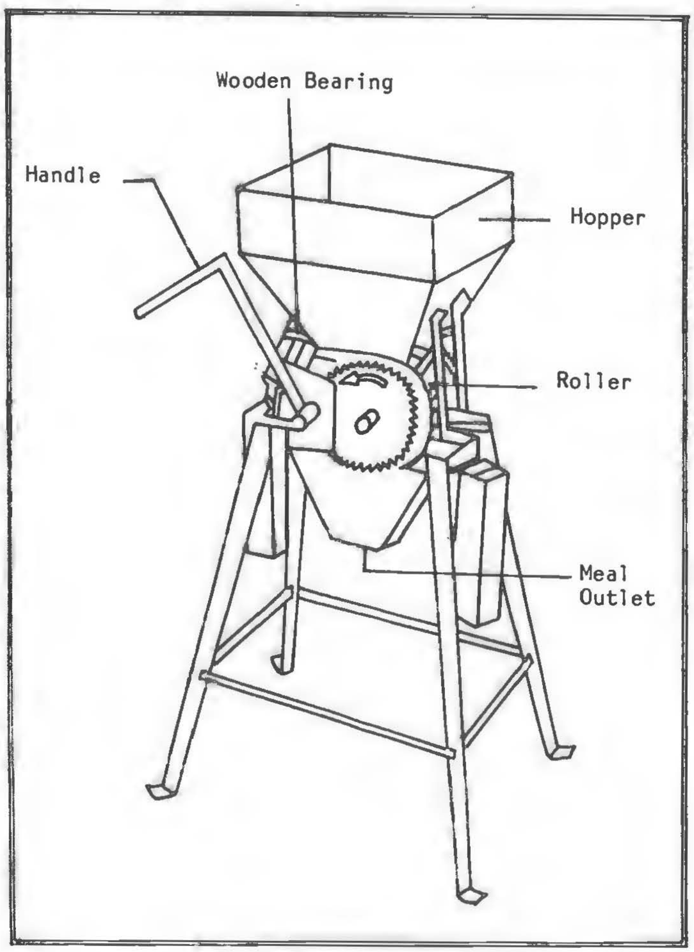

Figure 3. Description of the seed crusher and its parts

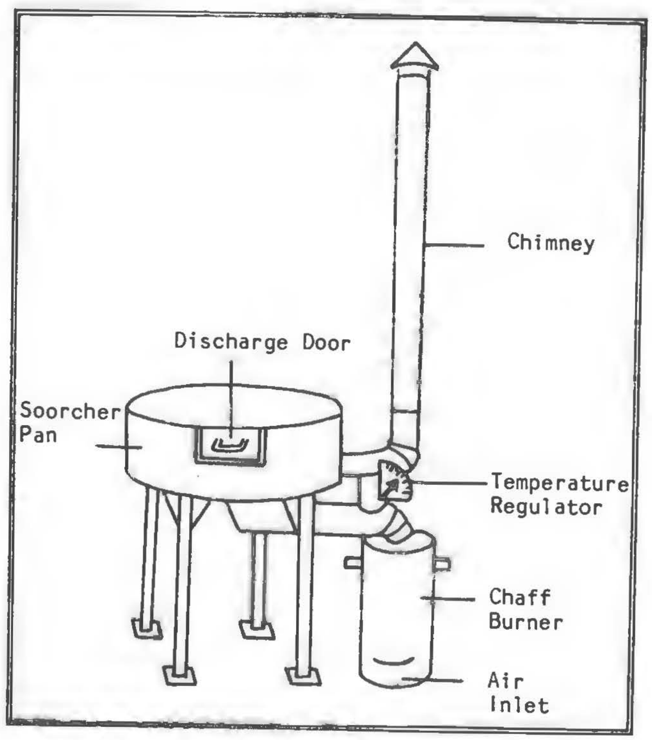

Figure 4. Description of the seed scorcher and its parts

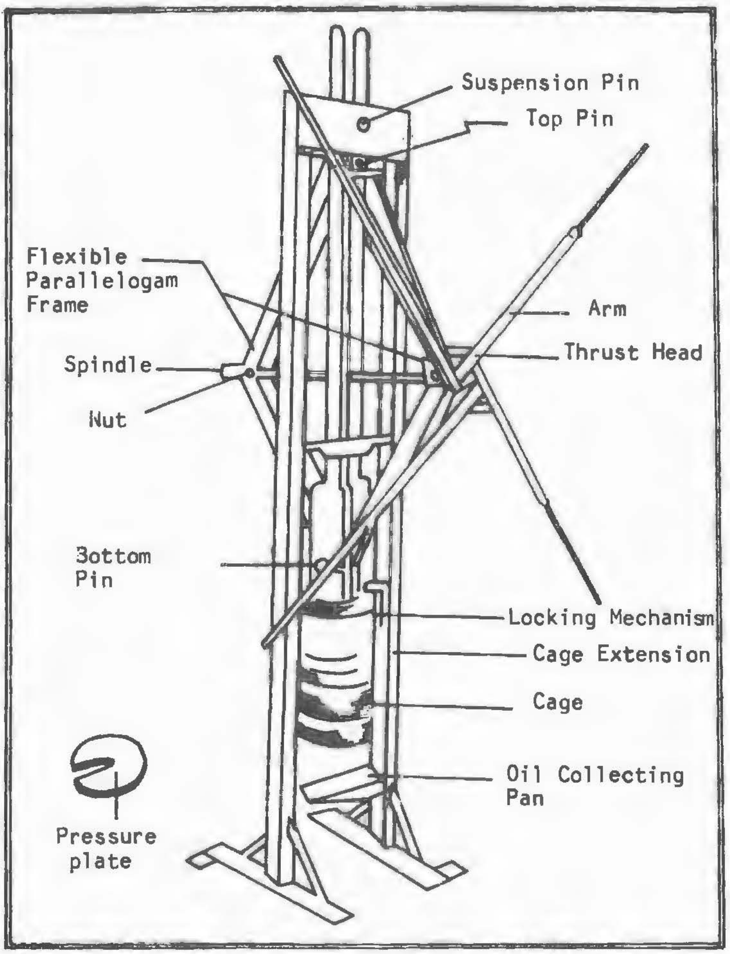

Figure 5. Description of the IPI oil press and its parts.

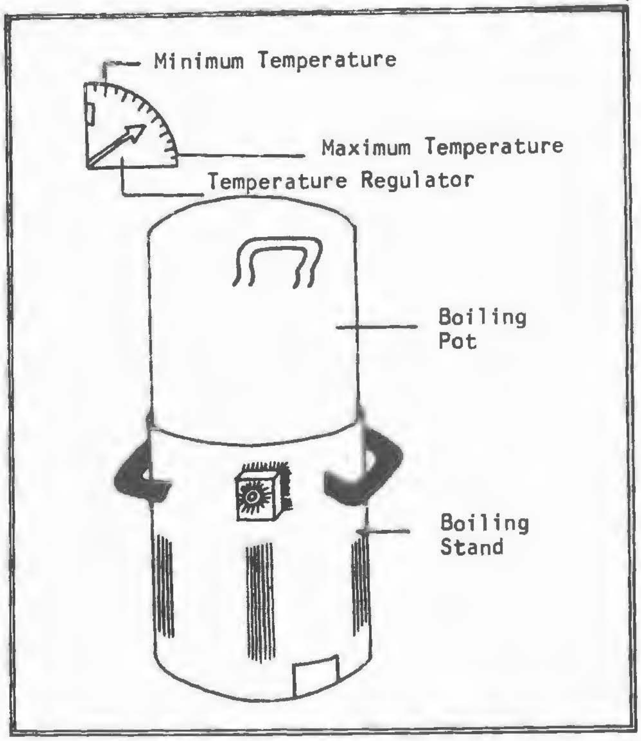

Figure 6. Boiling stand and its pot

Results of this system, under efficient management, have claimed recovery rates of 65% of available oil. However, if non-treated seeds were used, the extraction rates would be greatly different.

The principal advantage of the press system is that it can be manually operated and therefore has a relatively low capital cost and can accommodate relatively small throughputs with reasonable returns.

Screw expellers

Screw expellers operate in such a way that the seeds are squeezed between a tapered screw shaft and a conical cage, the screw being set so that the pulp is driven successively towards the point of the screw. As a result of this process, pressure is increased and oil is released, Figures 7,8 and 9.

While the extraction efficiency of such machines is high, the screw shaft is exposed to a considerable amount of wear. The refurbishment of such shafts requires precision grinding and rebuilding, which are usually beyond the capability of rural workshops. The fact that the majority of such machines are imported makes the provision of continuous services difficult as the scarce foreign exchange is needed to import spare parts.

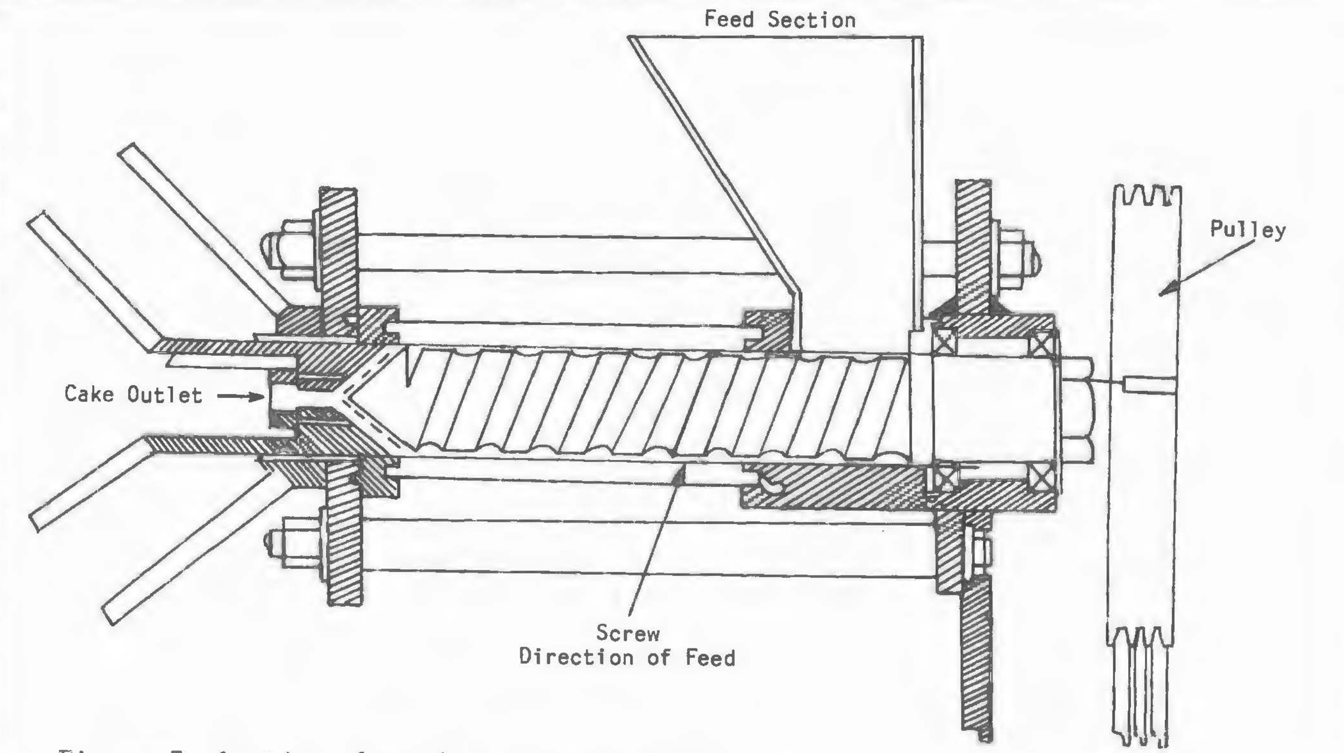

Figure 7. Section through a screw expeller.

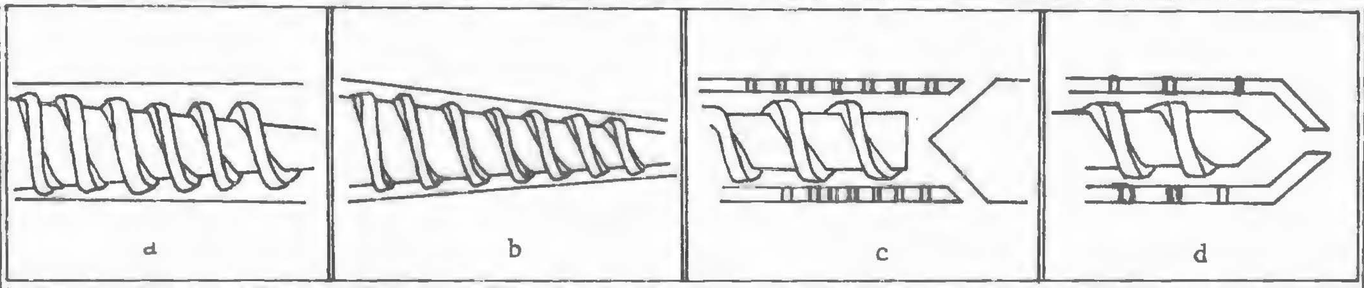

Figure 8. Types of screws for screw expeller.

NOTE

A useful feature in screw operation is a steadily increasing pressure which extracts the oil continuously down the barrel length. This is often achieved by a variable depth screw shaft (a) or a tapered screw (b). A similar effect may also be achieved by variable width gap relief slots down the length of the extraction chamber. In addition a control plug at the discharge end determines the overall internal pressure profile. The plug, usually conical, may point inside the chamber to give an annular flake discharge (c), or it may be a convergent hollow cone to give an extruded 'stick' discharge (d).

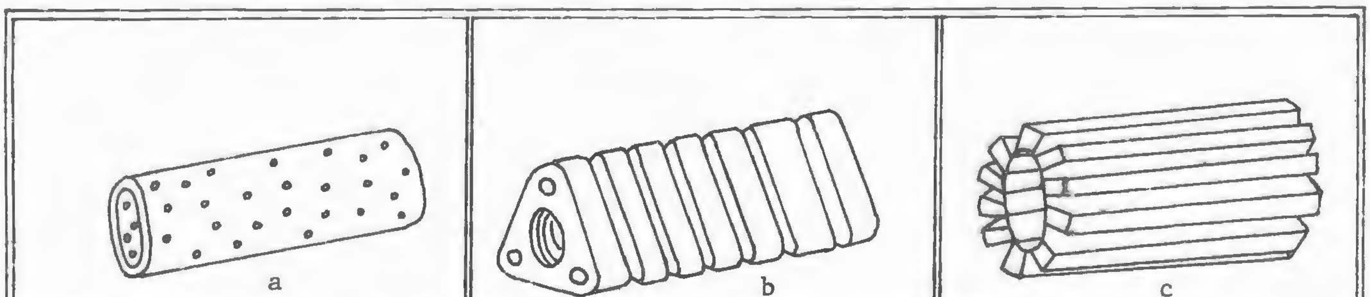

Figure 9. Types of cage for screw expellers.

- pertorated tube (Fig. a)
- orifice plate (Fib. b)
- parallel bars (Fib. c)

NOTE

The perforated tube suffers from the need to drill hundreds of tiny holes in a fairly thick walled tube (about 3mm). A 2mm drill would break very easily; such tubes block easily with some crops and there is no hole adjustment apart from replacement tubes.

Furthermore, the capital costs are high as the machines are imported and the market for the oil and by-products must be large to cope with the large amounts produced by these machines. Finally, all these machines need some form of mechanical force to operate like electricity, a diesel engine, or some suitable substitute. The wear problems which are noticeable in such machines are particularly associated with sunflowers as these seeds have a hard and abrasive testa.

Technically, the traditional pestle from Malawi, also found in India from which the motorized ghani was developed, falls into this category, Figure 10. Although the throughput and efficiency of oil extraction of the pestle and mortar are very low, the pressure used is much lower and the residence time in the chamber is longer than for the other designs.

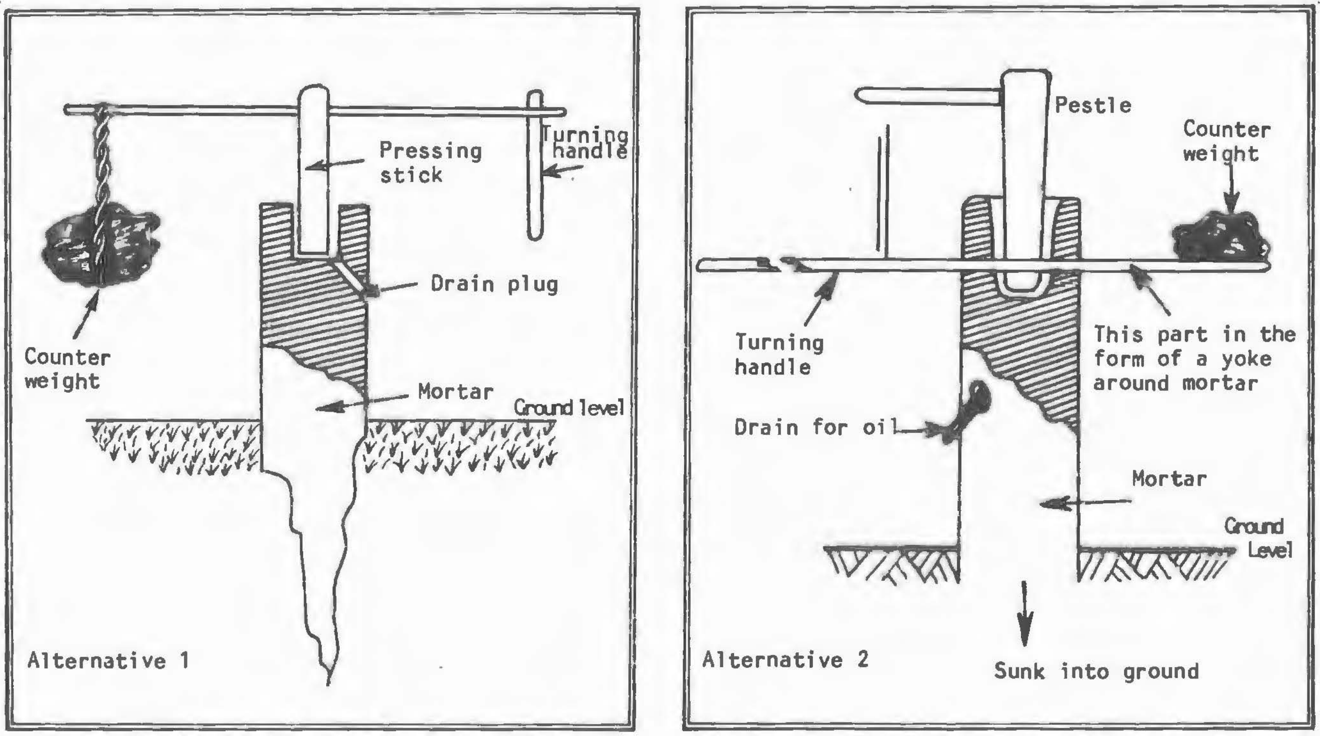

Figure 10 Cold process method basic design

Although these various types of machines with their different designs are in use in the region, there has been little systematic work to evaluate them or to assess suitable business conditions for the enterprise. The cross price competition between oilseeds and other crops and even between oilseed crops, the capital investment, the efficiency of the machinery, the price at which demand is effective for the product and the entrepreneurial skills of the businessmen involved (to name but a few of the factors) will affect the viability of the enterprise.

A critical decision may well be taken on the form of business to be undertaken. Possible alternatives might be service milling where the farmer pays a fee and collects his oil and cake; service milling where the cake or some proportion of the oil is retained by the miller as payment for the service; or commercial milling where the miller buys oilseeds for cash, stocks them and then sells oil and cake. This latter approach may well suffer from cash flow problems as crops tend to mature within a short period of time. On the other hand, the sale of oil and cake is determined by the speed with which they are processed and is dependent upon the needs of consumers.

Our work in the SADCC region has led us to the conclusion that there is a need to evaluate all the available machinery which might possible be suitable for small-scale rural oil expression enterprises.

The aspects of evaluation include the life of the machinery, its throughput, both fixed and variable costs, the quality of the product, and importantly the spare part requirement and ways of minimizing it by using the potential for its local production.

Having considered the technical aspects of the various machines, there is then the need to systematically assess each proposed installation to see whether the equipment installed matches, as closely as possible, the market and the agricultural and entrepreneurial environment. Here, must emphasize the point that each installation will require a through assessment of the effective demand for oil and products, the entrepreneurial skills of the person or people intending to undertake the oil expressing entreprise, and the agricultural environment (both technical and economic) as it affects the availability of oilseeds. I do not anticipate that any one type of machine can be declared the most suitable for the region. What we can achieve is knowledge on the capabilities of those available so that they can be meshed into suitable situations.

The major outcome of the workshop which the SADCC Post Production Food Industry Advisory Unit recently sponsored in Zanzibar was the establishment of a working group comprised of representatives from institutions in the SADCC region working on oilseed processing. The task of this group is to examine existing projects and programs and to develop additional programs if they can effectively lower the cost of oilseed utilization. The group comprises A.S. Chungu of the Institute of Product Innovation of the University of Dar es Salaam, Harzi Ncube of the Zimbabwe Institute of Agricultural Engineering, Joe Mwale of the Zambia National Council for Scientific Research, Wells Kumwenda of Chitedze Research Station Farm Machinery Unit in Malawi, and Solly Dinat from the Rural Industries Innovation Centre in Botswana. In addition, Keith Machell from ITDG (the Intermediate Technology Development Group), A.Swetman from ODNRI (Overseas Development Natural Resources Institute) and Mr. Ramanthan from CFTRI (Central Food Technological Research Institute) in India will contribute.

The key research and development issues are the development and adaptation of oil extraction technologies to suit the economic and agricultural environments to which they are being delivered, and the development of support systems for those technologies. Here, the experience that spares are often not available through import because of foreign exchange constraints has been stressed. Thus it is important to see that the highest possible proportion of spares can be made in the recipient country. Of course training in the business, the technical operations and the maintenance skills required for profitable operation is also significant.

In addition, there is need to develop and disseminate techniques of matching the scale of enterprises to the market and to ensure that the technology and the entrepreneur involved are able to deliver the goods at a price which people can afford while still making a profit on their investment. These tools need to be developed and subsequently disseminated to users, appraising projects or enterprises inorder to ensure that no additional white elephants join the existing herd.

Only if the food processing projects are viable and operating in areas where their products, both food and income, are absorbed will they have a positive impact on food security. If these conditions are met, I foresee a better supply of oil and oilseed by-products. There will also be a better stimulus to production and the productivity of oilseed crops. There is the potential to create employment and to increase income through value added to primary products through processing.

When seen from the breeder's point of view, there is the need to ensure that suitable high yielding varieties are available. There is also the need to ensure that the varieties offered are amenable to storage on the farm or in the small factory without loss in quantity and quality. As harvests are synchronous the oil-processing capacity must handle the sudden supply over time.

Agronomic and Breeding Considerations

Sunflower production is presently low and productivity is approximately one third of the potential reported from research. The majority of the arable land in the SADCC region is agroecologically marginal which makes sunflowers perform better than the other crops. There is, therefore, the opportunity to improve food security by promoting sunflowers in conjunction with their processing and marketing.

If the potential is demonstrated, adding to the value of farmers' products through processing, and if farmers benefit from it, then it is likely to be a motivation for increasing both production and productivity. The one could act as a spur to the other.

Presently, the vast majority of the peasantry rely on open-pollinated varieties, some with oil contents as low as 28%. Hybrid varieties are already available but there is little incentive to grow them as their price is not equated with their potential oil content when they are formally marketed. However, in a situation where farmers have an interest in the amount of oil extracted from their oilseeds, this position could be changed. Consider sercice milliing alluded to above! where farmers have the oil in hand to sell and pay a fee per bag of seeds processed, they will be motivated to grow hybrid varieties that yield more oil.

There is a restraint that hybrid seed is not always readily available and has to be purchased for cash every year, but the case of hybrid maize seed in Zimbabwe demonstrates that once farmers appreciate the value accruing to them by using hybrid seed, then they will willingly buy it.

It is essential that the trend of yields from oilseeds be brought onto a rising plane. If this can be achieved, and the farmers can reap the benefits of these gains directly, as I have suggested earlier, then the oilseed crop could be expanded. The varieties need to be available to do this. Oil contents from the seeds have to be good and yields of seed should be improved to attract farmers to the crop. Furthermore, productivity gains must be obtainable with the minimum of purchased inputs if peasant farmers are to be able to participate.

Sunflower are especially susceptible to bird damage, a problem that needs to be addressed by breeders.

In summary, the breeding programs need to continue to pursue their present objectives with the greatest despatch. Meanwhile, the mechanisms for making the crop and its processing attractive to farmers have to be addressed so that the breeders' improvements can be understood by farmers and consumers.

I perceive that small-scale oil expressing, by which farmers can directly benefit from the higher oil content of hybrid seeds, might be a useful motivation to the extension of better sunflower varieties and this will in turn stimulate the expression industry. The possibility of installing NMR (Nuclear magnetic Resonance) equipment to assess oilseed content throughout formal marketing systems will be prohibitively expensive.

Conclusion

There would appear to be demands for oil and possibly oilseed cake in the rural areas of the region. We need to know at what price these demands will become effective. There is a range of machinery for expressing oil from oilseeds which needs to be critically and objectively evaluated, technically and economically.

There is need to closely assess each potential site for an oil expressing enterprise inorder to ensure that the capacity of the enterprise matches the damand for oil and cake and is related to the availability of oilseeds. The methods of making these complex assessments need to be refined and made available in easily replicable forms.

There is the possibility that small-scale oil expression might allow farmers to reap the benefits of improved varieties and agronomic practices directly, thereby providing the incentive to adopt such innovations. It seems unlikely that hybrids will appear attractive to farmers if the oil content is not related to the price received and that the installation of evaluators will be prohibitively expensive.

The PFIAU (Post Production Food Industry Advisory Unit) is also willing to assist in the siting issues to try to match enterprises to suitable environments and will willingly collaborate with other workers to develop standardized methods.

I hope that through these interventions we may be able to contribute to food security by making the oil and its by-products available in the rural areas and, equally important, providing a stimulus mechanism through which farmers will be motivated to adopt better varieties and practices of producing sunflowers to their own advantage.

THE ECONOMICS OF OILSEED PRODUCTION AND PROCESSING FOR EDIBLE OIL AND PROTEIN CAKE IN KENYA

Carlos Zulberti

Introduction

Edible oils and fats are substances of vegetable or animal origin which, together with carbohydrates and proteins, constitute the main types of food for human consumption. They are nonvolatile, insoluble in water and slick or greasy to the touch. They have a caloric content more than twice as high as the other dominant foodstuffs.

Animal fats are obtained from milk, fish, marine mamals and as by-products of the slaughter of livestock. Edible vegetable oils are obtained from some fleshy fruits (olive, palm, etc.), annual and perennial oilseeds, maize germ and cottonseed.

The oils and fats of vegetable origin were traditionally obtained from their bearing materials by rendering. In the present day, mechanical pressure and solvent extraction are the main techniques used. In most cases - oil palm is a notable exception- the residue from the extraction of fats and oils is the cake with a relatively high protein content which could be used as human food, animal feed or fertilizer.

Most vegetable oils and protein cakes are obtained from plants specifically cultivated for that purpose. But, there are important oils and cakes which are obtained as by-products of other industries. Cottonseed oil is a by-product of the seed cotton processed for fiber in the ginneries and maize oil is obtained from the germ collected at the maize milling industry.

Oilseeds are defined, for the purpose of this paper, as those annual crops which have a relatively high oil content and are, or could be, cultivated for the extraction of edible oils and the production of protein cakes. The following crops satisfy the definition, within the Kenyan context.

Common name	Scientific name
Groundnut	*Arachis hypogae*
Rapeseed (Turnip rape)	*Brassica campestris*
Rapeseed (Argentine rape)	*Brassica napus*
Safflower	*Carthamus tinctorius*
Simsim (Sesame)	*Sesamum indicum*
Soybean	*Glycine max*
Sunflower	*Helianthus annuus*

The definition specifically eliminates the perennial oil producing crops such as olive (*Olea europea*) and oil palm (*Elaeis guineensis*) because they are practically unknown in Kenya due to either their lack of ecological adaptation or proper introduction.

Coconut palm (*Cocos nucifera*) has also been excluded even though it is well known in the coast, grows naturally there, and its oil is important, especially in the manufacturing of soaps. The reason for its elimination is that the decisions regarding its cultivation have to be based on a different set of parameters than is the case for annual crops.

Any feasibility study of cultivating perennial crops has to include the analysis of the market conditions for inputs and outputs for several years in the future due to the extended gestation period of the investment and the long duration of its productive life. This is not the case with annual crops which can react to market changes on a yearly basis and are the main concern of this report. Nevertheless, the possibilities of coconut production in the coast should not be underestimated and a specific study on its potential could be a usefl complement to the work described below.

Most of the annual oilseed crops produce seeds with an oil content of 40% or more, on a per weight basis. Only one of them, soybeans, has a much lower oil content of only 18%. However, soybeans have the highest protein content of all the other seeds, reaching a value of 36%, twice as high as its oil content, Table 1.

Table 1. Oil and protein contents of selected oilseeds

Seeds	Percentage content on a per weight basis			
	Oil	Cake	Protein	
			In cake	In seed
Groundnut	40	52	50	26
Rapeseed	40	56	52	29
Simsim	44	52	40	21
Soybean	18	79	46	36
Sunflower	44	37	43	16

It can also be seen that protein constitutes 40-50% of the weight of the press cake, which shows its importance as animal feed.

The extraction of oils from the seeds can be achieved at increasing levels of sophistication: exudation, pounding, boiling and skimming, and hand-operated batch presses at the farm level; animal-operated Indian ghani and small-engine-continuous-operation expellers at the village level; mechanical presses and solvent extraction plants at the industrial areas of many cities.

The selection of which crop to grow?, how raw material and intermediate inputs be processed?, which outputs should be obtained?, where the plants should be located?, how to promote the consumption of the final products, etc. are the parameters which require a careful analysis before making decisions in any production endeavor, and especially in the vegetable oil-protein industry.

The complexity of the industry arises from at least five main sources:

- its backward linkages to agricultural producers of variable size who produce annual and perennial crops of a relatively easy interchangeability and, to other industries which produce raw materials for oil production as by-products of their own operations;

- the production of co-products in almost fixed proportions for direct use by consumers and as inputs to other industries;

- the intervention by Government through the licencing of imports, regulation of prices, financing of research and extension services, etc;

- the highly active international trade where subsidies and protectionism are much more the rule than the exception; and,

- its dealings with a variety of enterpreneurs, from the very small farmer who cultivates oil-protein seeds in association with one or more other crops on less than one hectare of land, to the government which is in partnership with the leading food processing multinational in the world.

To facilitate the decision making process in government and in the various public and private institutions participating within the system, a description of the different components of the oil-protein system and a clear understanding of their internal and external linkages and interactions is required. Without that understanding, policy measures, promotional activities, investment decisions etc., may fail to achieve the desired goals due to the lack of comprehension of what the main constraints are and how to deal with them.

The World Situation

The prices of oilseeds have continuously decreased in the international markets after the relatively high values were reached during 1983/84. Taking rapeseed, soybeans and sunflower seed as examples, the reductions in the prices paid in Rotterdam have been from 351 to 188, from 301 to 209 and from 360 to 205 US$/mt respectively, Figure 1.

Even larger significant reductions are observed in the price of vegetable oils. The variations in US$/mt have been from 696 to 297 for rapeseed, from 722 to 324 for soybean, and from 765 to 354 for sunflower. The most dramatic reduction was in the price of palm oil which went from 767 down to 274 US$/mt between 1983/84 and 1985/86. However, it recovered in 1986/87 reaching a price of US$310/mt which is still only 40% of the 1983/84 price, Figure 2.

The price of the corresponding protein meals did not follow the same pattern. Firstly, they did not peak in 1983/84. Secondly, they had a lowering tendency in 1984/85 but they most recovered in 1985/86. Thirdly, they followed different patterns in 1986/87 with the price of rapeseed cake decreasing and the price of soybean and sunflower cake slightly increasing, Figure 3.

The effect of these different price variations in vegetable oils in relation to their co-products -the cakes- has been a reduction in the spread between their respective prices as it is shown in Figure 4, 5 and 6 for rapeseed, soybeans and sunflower respectively. In other words, the value of the ratio between the prices of oils and the price of their respective cakes has diminished during the last two years, reaching a value of only 1.7 for soybeans, Figure 7. If we look to these ratios in a broader perspective over a period of nine years, it can be observed that for rapeseed and sunflower the tendency is to return to the previous values but, in the case of soybeans, the ratio reached in 1986/87 is the historically lowest. This poses a question about the role of protein cakes, especially soybean cake, in the international vegetable oil market as it is analyzed below.

The total production of the major protein meals reached 108.0 million metric tons in 1986/87. Out of this total, 65.1 million metric tons, or 60.2%, were soybean cake followed by rapeseed, cottonseed and sunflower cakes, fish meals and others, Figure 8.

Total exports amounted to 36.2 million metric tons with soybeans reaching 25.3 million metric tons, or 69.9% of that total. The second highest volume of exports of protein meals came from fish meals with 9.0% of the total. From the

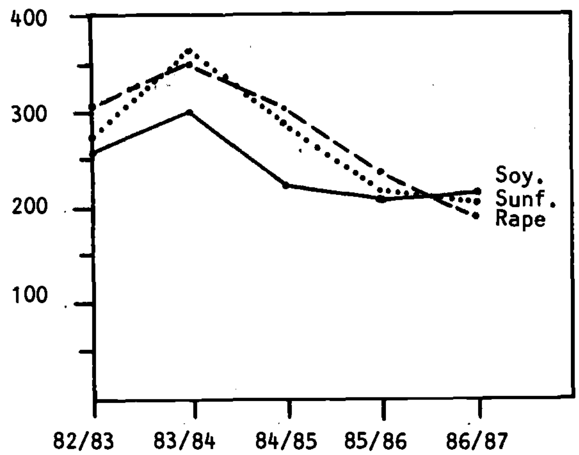

Fig.1 Oilseed price

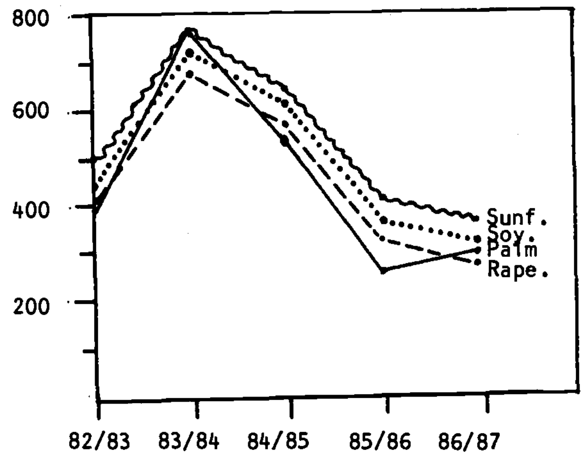

Fig.2 Vegetable Oil Prices

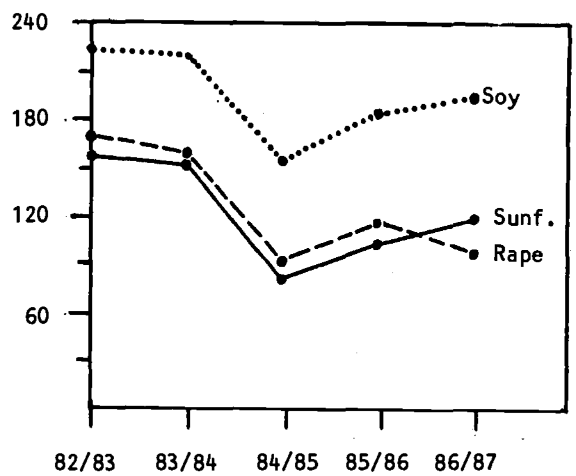

Fig.3 Protein Meal

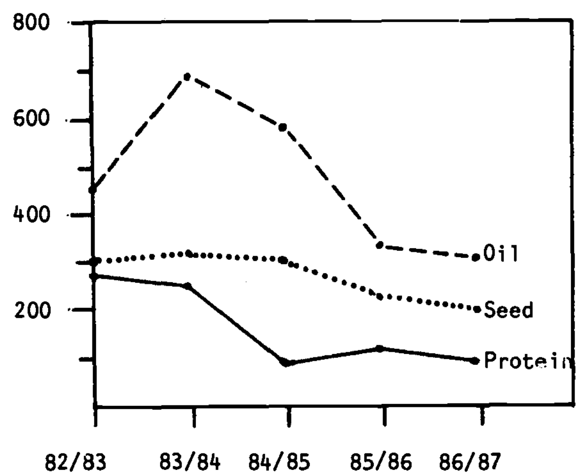

Fig.4 Rapeseed price

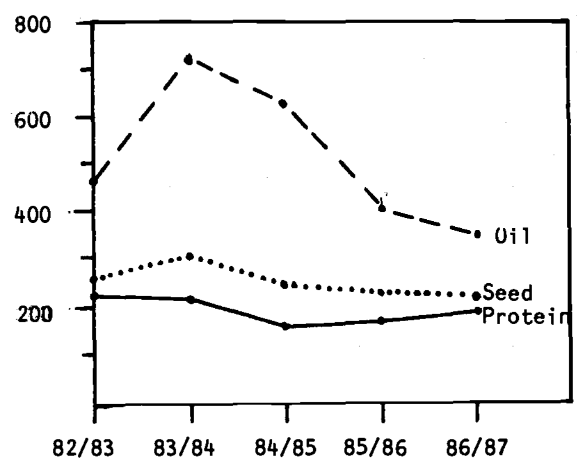

Fig.5 Soybean Price

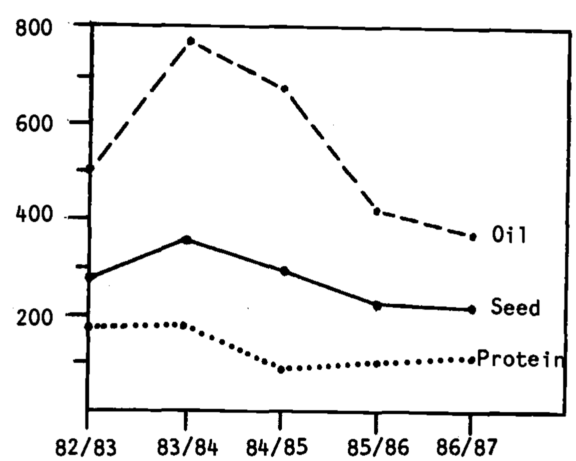

Fig.6 Sunflower Price

rest, only rapeseed reached more than 5%, Figure 9. This figure shows the importance of soybean cake as a source of protein for animal consumption, and its dominance in the international market of such products.

But, soybean cake cannot be produced alone. Soybean oil is produced concurrently in almost fixed proportions. Since the amount of cake produced is more than four times as much as the quantity of oil obtained and the price of the oil has not been four times as high as the price of the cake, then the income derived from the cake has historically been greater than the income derived from the oil. Using the 1986/87 international prices and the proportion of cake and oil presented in Table 1 as references, the income derived from the cake was more than two and a half times as much as the income derived from the oil in that year.

The point being made is that, given the dominance of the soybean cake in the international market of protein meals and, due to the fact that the income derived from the cake is much higher than the income derived from the oil, the decisions regarding soybean production are based more on what happens with the demand for protein meals than on the demand for oils. In other words, the protein market leads the way in the production of soybeans and the oil market receives whatever is produced soybean oil as a by-product. Let's see what effect this situation has in the oil market.

The total production of vegetable and marine oils reached 49.5 million metric tons in 1986/87. Soybean oil is, as it is the case in protein meals, the most important with 29.7% of the total, followed by palm oil with 16.2%, rapeseed oil with 13.6% and sunflower oil with 13.2%. The other important oils are those from cottonseed, groundnut and coconut, but none of them reach the 10% mark, Figure 10.

The volume of vegetable and marine oils exported during 1986/87 was 16.5 million metric tons. Out of this, palm oil accounted for 5.1 million metric tons (31.1%) and soybean oil for 3.9 million metric tons (23.5%). Other important ones were sunflower oil (10.9%), rapeseed oil (9.7%) and coconut (8.0%, Figure 11.

Two of those oils come from perennial crops -palm and coconut- which means that they do not have the possibility to rapidly adjust to market changes due to the long gestation period of the investments required for their production. Moreover, after the plantation is in production, the initial high investments are considered sunk cost and it will only need to cover its operational costs for the system to continue in operations.

If the 24.9% of the market supplied with by-product oils -soybeans and cottonseed- is added to the percentage of the market covered by the slow supply reacting perennial crops (39.1%), a total coverage of 64.0 is reached. In other words, almost two thirds of the supply to the market is insensitive to short-term variations in prices.

The rigidity in the supply response and the inelasticity of the demand- proven in 1983/84 when a relatively small reduction in supply caused substantial increments in prices- suggest that ample and unpredictable price variations in the vegetable oil market can be expected for several years in the future.

In addition to this undesirable fact, the market is seriously distorted due to protectionism in several developed as well as developing countries. Protectionism isolates the producers and consumers in the protected countries from the price variations of open markets, a fact which limits their convergent

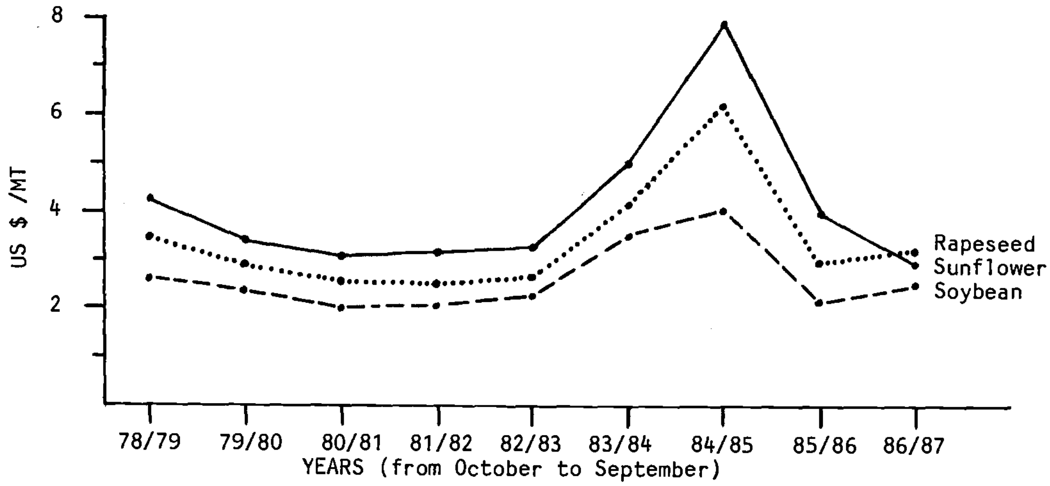

Figure 7. Price Ratios oil/protein in Rotterdam.

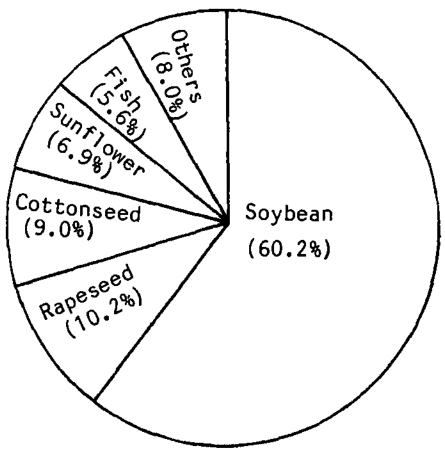

Figure 8. Production of major protein meal 1986/87

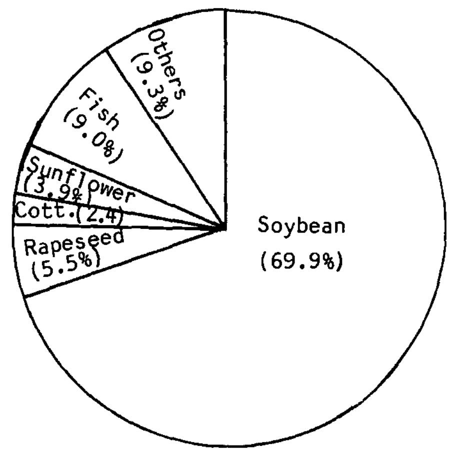

Figure 9. Export of major protein meals 1986/87

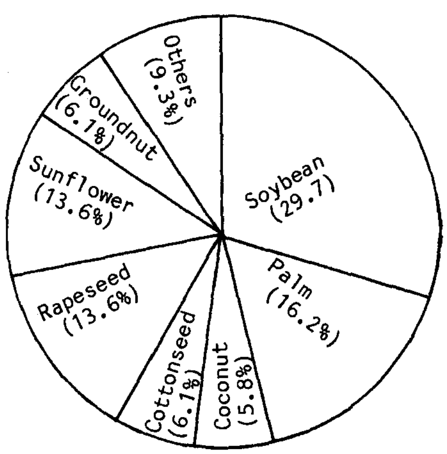

Figure 10. Production of major oils 1986/87

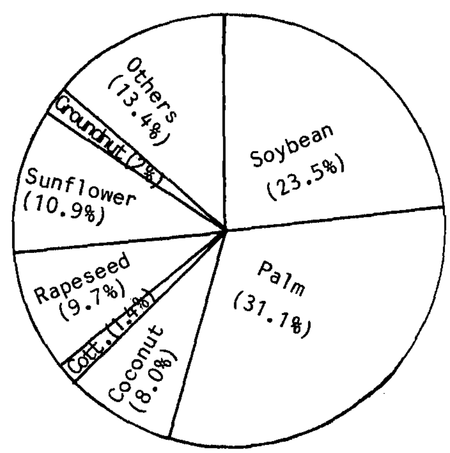

Figure 11. Exports of major oils.

reaction leading to price stability. The lack of response in the quantities produced and consumed exacerbates even more the price variability in what remains of the open market.

Since Kenya imports only a small fraction of the total amount of oil being traded in the international markets, it can not affect those prices. In consequence, the country is a price taker and is bound to suffer from the high volatility of the market.

The Kenyan Situation

Kenyan production of oilseeds is not sufficient to cover its own needs. According to the latest available statistics the country consumes more than 100,000 metric tons of vegetable oils and produces around 20,000 metric tons with the difference being imported.

The main oil crops produced are sunflower, groundnuts, coconut, rapeseed and sesame. Information on area cultivated, yields and production is weak and unreliable. Oil is also obtained from cottonseed and maize germ as by-products of the ginneries and millers respectively.

Several oil-protein related products are imported into Kenya. Table 2 list the main items being imported, with the values expressed in Kshs and can be converted to US$ using exchange rates. As can be observed in the table, oil cake of soybeans, and flour and meals of fish are the most important protein-containing items for animal feeds; tallow is the main animal fat; soybean and rapeseed oils are the main oilseed oils; and, by far the most important product being imported is palm oil, either crude or refined.

Figure 12 presents the trend in the value of the main imports over the last five years. Palm oil does not show any clear trend, while tallow and soybean oil are both increasing and protein cake is decreasing slightly.

The picture is different if, instead of the values, the quantities are plotted in Figure 12. By taking away the influence of prices it is possible to see that the trend is for all quantities to increase substantially, with the only exception of protein cake during the last year.

The present depressed international prices have allowed the importation of cheap palm oil and have helped to keep the price of the vegetable oil and fats staple commodities down for the benefit of consumers all over the country.

The variations in international and domestic yearly average prices can be observed in Figure 13 where the comparison between the price of imported palm oil -including taxes- have been plotted against the price of Kimbo, the best selling vegetable fat.

As it can be observed, the industry suffered a squeeze on margins in 1983/84, but the situation has substantially improved in the last three years. It has allowed the importers, processors and packers to still enjoy substantial profits even while the price to the consumers has been maintained or slightly reduced, not following the increasing price trends of other products.

The Problem

Kenya is importing the cheapest available products in the world. Local oilseed producers can not compete with those low-priced imported supplies

Table 2. Imports of oilseed related products.

Code	Item	Quantity ('000 kg) 1982	1983	1984	1985	1986	Value ('000 Kshs) 1982	1983	1984	1985	1986
081310	Oil-cake of soybeans	800	1512	700	685	237	3672	7038	3177	2479	852
081330	Oil-cake of cottonseed	20	?	?	112	55	9	?	?	109	45
081350	Oil-cake of sunflower seed	?	0	?	?	?	?	10	?	?	?
081370	Oil-cake of coconut (copra)	?	0	?	?	?	?	2	?	?	?
081420	Flours and meals of fish	1437	1100	1719	5198	1077	9706	9147	15573	12486	8780
	PROTEIN FOR ANIMAL FEEDS	2256	2612	2419	5995	1369	13387	16197	18750	15073	9678
222100	Groundnuts	?	?	?	?	0	?	?	?	?	9
222200	Soybeans	0	2	400	211	0	1	12	3242	2484	3
222400	Sunflower seed	1	0	4	4	101	27	28	222	1182	2711
222600	Rape or colza seeds	15	0	0	?	?	498	151	308	?	?
222	Oilseeds	15	2	405	215	101	526	190	3772	3666	2723
411321	Tallow (including premier jus)	7657	4427	8402	9514	15479	55747	36924	78798	97313	126715
423201	Soybean oil, crude	?	?	?	0	?	?	?	?	6	?
423202	Soybean oil, refined	1329	1915	1247	949	5080	13843	26635	20020	21060	69184
423301	Cottonseed oil, crude	3	?	?	?	?	26	?	?	?	?
423402	Groundnut oil, refined	0	0	2	0	0	9	8	22	5	12
423501	Olive oil, crude	?	?	1	0	?	?	?	115	2	?
423501	Olive oil, refined	11	3	9	40	12	444	112	307	1249	612
423910	Rape, colza and mustard oil	583	?	897	583	0	4717	?	5444	10782	0
423920	Sesamum oil	0	0	?	0	?	21	0	?	0	?
424201	Palm oil, crude	67135	71536	59301	82195	95094	395849	843846	581338	802717	707728
424202	Palm oil, refined	1446	1030	459	319	1340	9503	7435	4830	3286	9091
424401	Palm kernel oil, crude	2	0	906	?	0	37	24	7692	?	14
	Edible vegetable oils	70510	74485	62821	84086	101527	424449	878061	619767	839107	786640
	Oil-protein related imports	80438	81526	74047	99810	118476	494109	931373	721088	955160	925755
	Exchange rate Kshs/US$	?	?	?	?	?	12.725	13.796	15.781	16.284	16.042

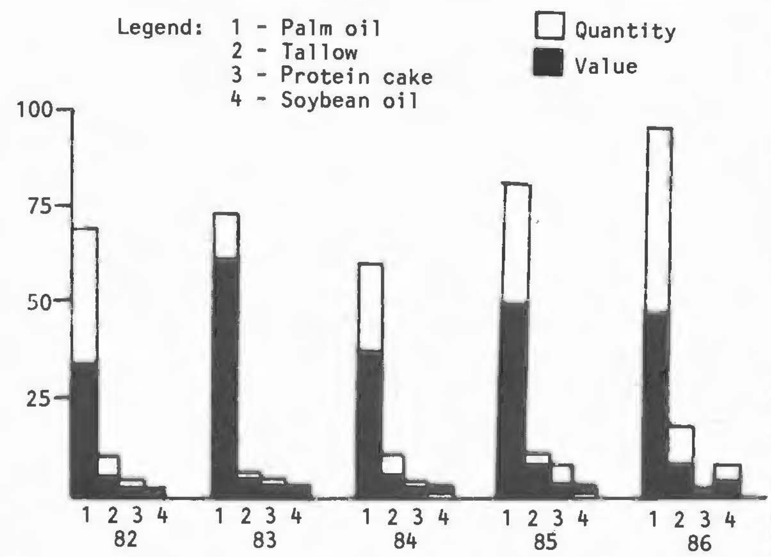

Figure 12. Fats & Oils in years.

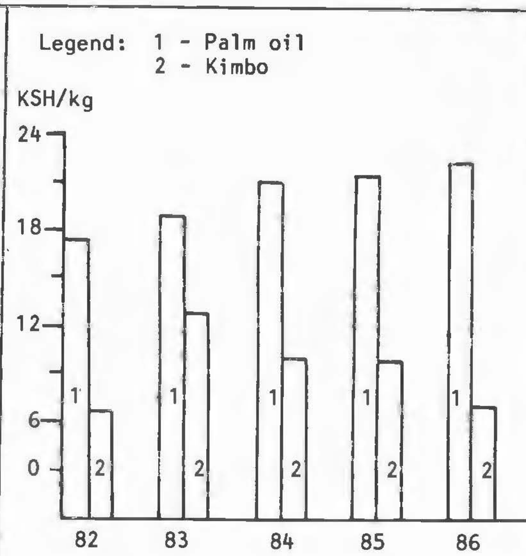

Figure 13. Prices of palm oil and Kimbo.

because, at the present technological level, their costs of production are higher than the income generated from selling the oilseeds.

The importation of palm oil at bargain prices has allowed for high levels of profitability for the refining and packing activities in spite of the relatively low prices to consumers. The fats and oils industry has no economic encouragement to pay the prices required by the domestic producers to make a profit.

Thus, under the present circumstances the production of oilseed in Kenya does not appear to be economically feasible and the importation of oil-protein related products will continue until those circumstances are deliberately modified, shifted by outside forces without local control or unexpectedly changed by unforeseen events.

The Future

The present bonanza for importers is not expected to continue. The latest information available shows that the prices of palm oil are on the rise again and reductions in importers margins could be expected.

If the increments in the international prices are high enough to reduce profitability to undesirable levels, the importers will request higher consumer prices. If the increments are not granted, they will reduce importaion to minimize losses. After a while, scarcity will be felt and government intervention will be required.

If to the eventual need for higher consumer prices, one adds the impending possibilities of a bigger (due to increasing demand and higher prices) and variable (due to price changes) import bill for oil-protein related products, the future situation of the sector does not look promising.

Moreover, since there are no alternative production possibilities in the same agro-ecological areas where oilseed can be produced at a level which is capable of generating the foreign exchange required to buy the oil-protein related products from abroad, the present emphasis on importing these products further depletes the already existing low foreign reserves.

Finally, the increasing importation of oil-protein related products- which are processed and packed in urban centers to satisfy the national demand- is in conflict with the goals set by the government in Sessional Paper No. 1 of 1986, which is entitled "Economic Management for Renewed Growth".

The main related goals are:

- food security
- reduction of the import gap in vegetable oils
- stimulating the growth of non-farm rural activities

How can the government deliberately modify the existing circumstances so as to satisfy its own goals?

Unfortunately, not enough is known about the oils and fats industry, its backward and forward linkages and the direct and derived demands for its products, which enable us to make conclusive recommendations. A better understanding of the complex interrelationships, as presented in a simplified way in Figure 14 is required to determine where interventions are needed by identifying and predicting their outcome.

A comprehensive study is urgently needed and efforts are being made to initiate one in the near future.

One area which can offer some possibilities and hence should simultaneously be analyzed is the small-scale farm and/or village processing. This can generate incentives for the local production of oilseeds and, at the same time, satisfy the national goals of rural industrialization and employment generation.

Figure 15 shows the existing production and consumption system. The oilseeds being cultivated in the rural sector are processed by expellers, refineries and packers in the urban sector, with a substantial part of the products obtained returning to the rural sector for direct consumption -edible oils and fats- or as inputs -protein cake- for dairy and poultry production.

Most of the milk and part of the broilers and eggs produced in the rural sector are sent for processing and consumption to the urban sector. In some cases the milk, once processed in the cities, returns to some small towns and villages in the rural sector for final consumption. This transport back and forth obviously increases the cost of the final products, making them too expensive to the low-income consumer for mass consumption or, at least, the products are being consumed at levels below the desired ones, by the same people who originally produced the raw materials.

If the present importation policy continues and the production of oilseed by the farmers remains an unfeasible endeavor, the undesirable situation represented in Figure 16 could become a reality, where the oilseed producers disappear and all the demand for oil and fat related products is satisfied through importation.

As was mentioned before, a possible alternative to explore is the processing of oilseeds at the farm or village level, presented in Figure 17 as the experimental system.

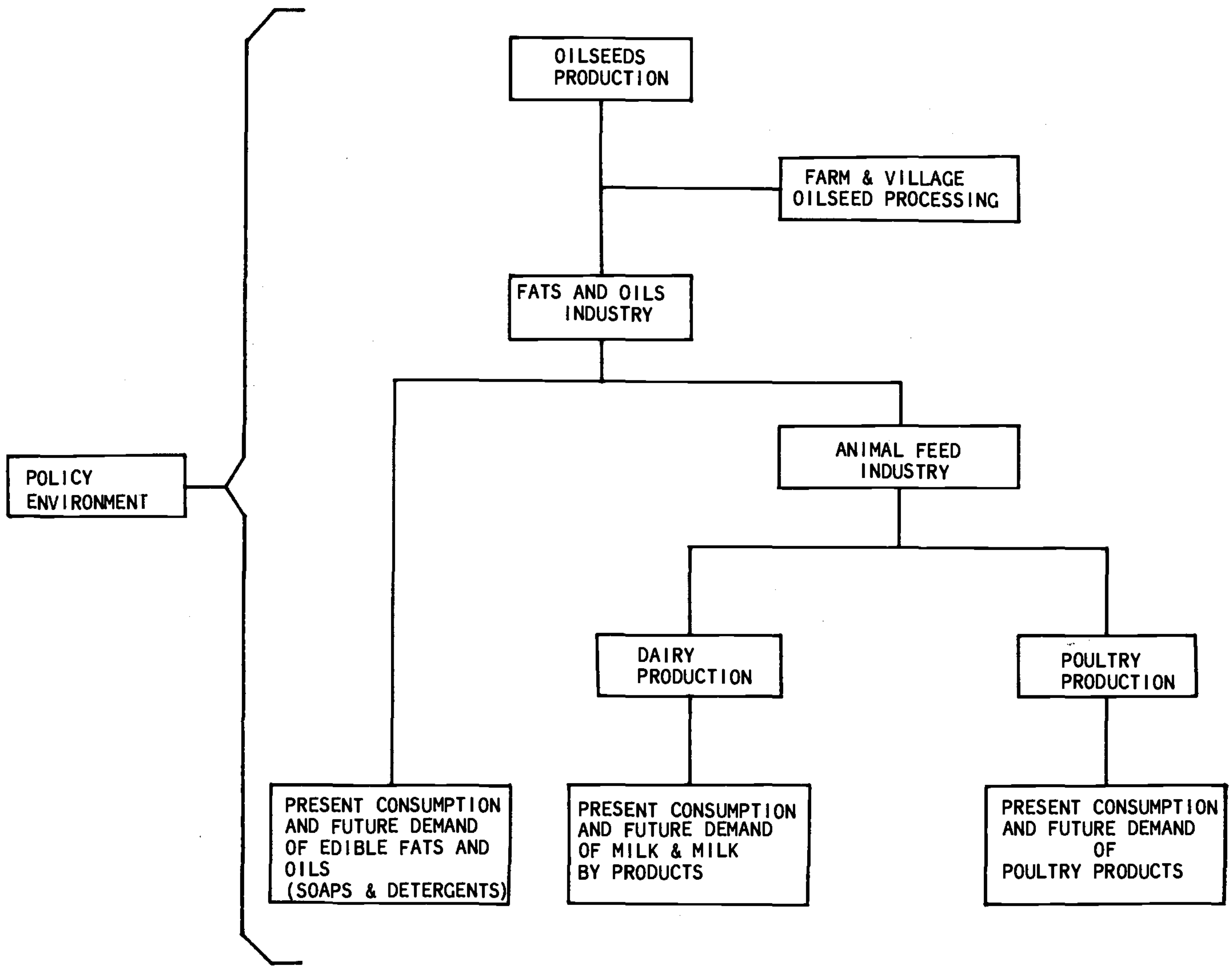

Figure 14. The oilseeds related productive, industrial and consumption activities.

In Table 3 it is possible to see that income derived from selling 100 kg of sunflower seeds is Kshs 280.00 and from selling the same amount of simsim seed is Kshs 500.00.

If the producer decides instead to process the seeds himself and sell the oil and the cake to refineries and animal feed compounders, the income to be derived from 100 kg of sunflower seed will be Kshs 400.00, or Kshs 120.00 more than by selling the seeds unprocessed (the cost of processing has not been included but is expected to be around 60 Kshs/100 kg). In the case of simsim, the income to be derived from selling the oil and the cake after processing is similar to the income obtained by directly selling the seeds.

Now, if the producer decides to process the seed himself, to consume the oil within the household, and to feed the cake to his own animals, he saves -by not having to buy those products in the market- Kshs 725.00 in the case of sunflower,

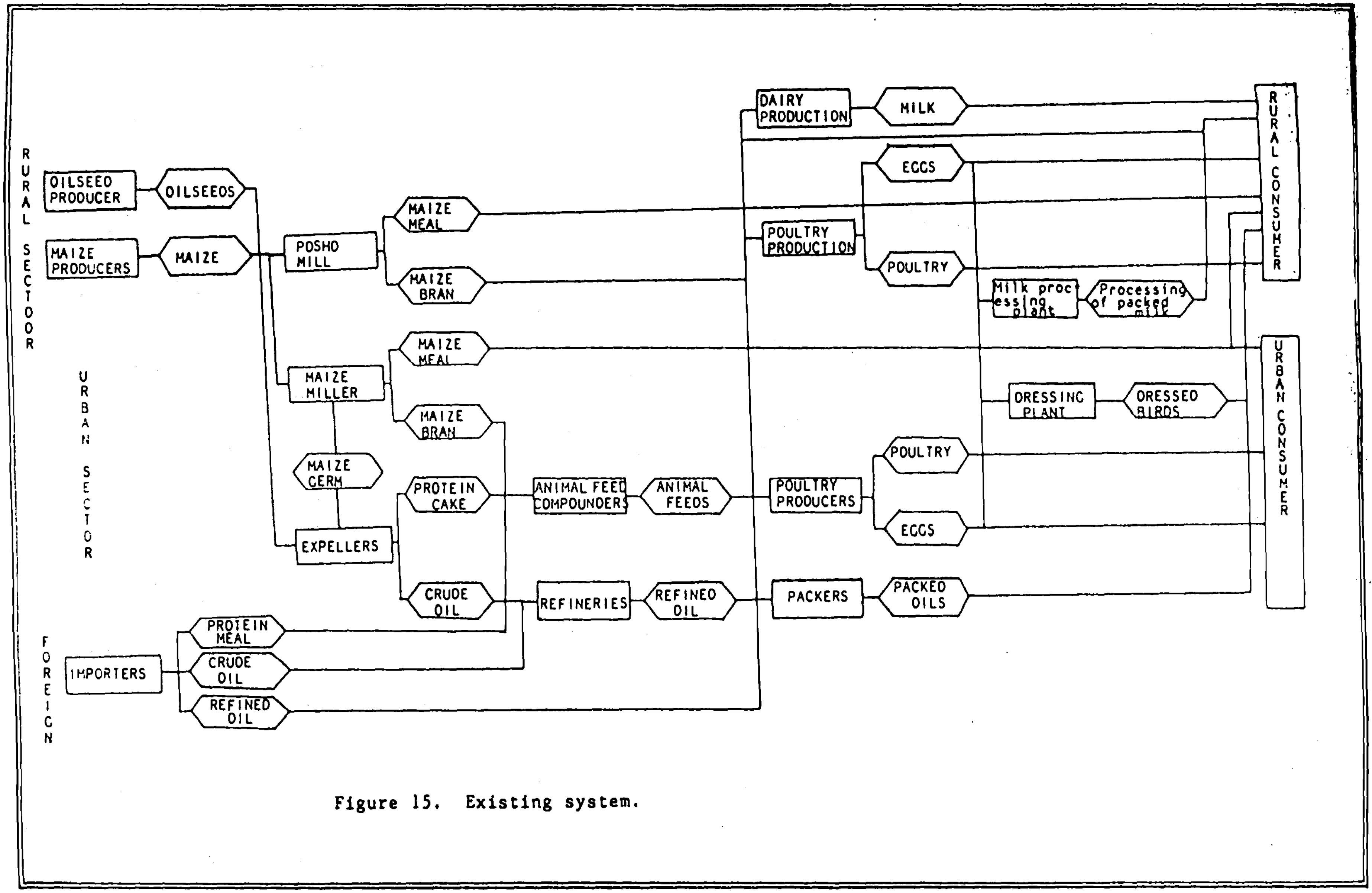

Figure 15. Existing system.

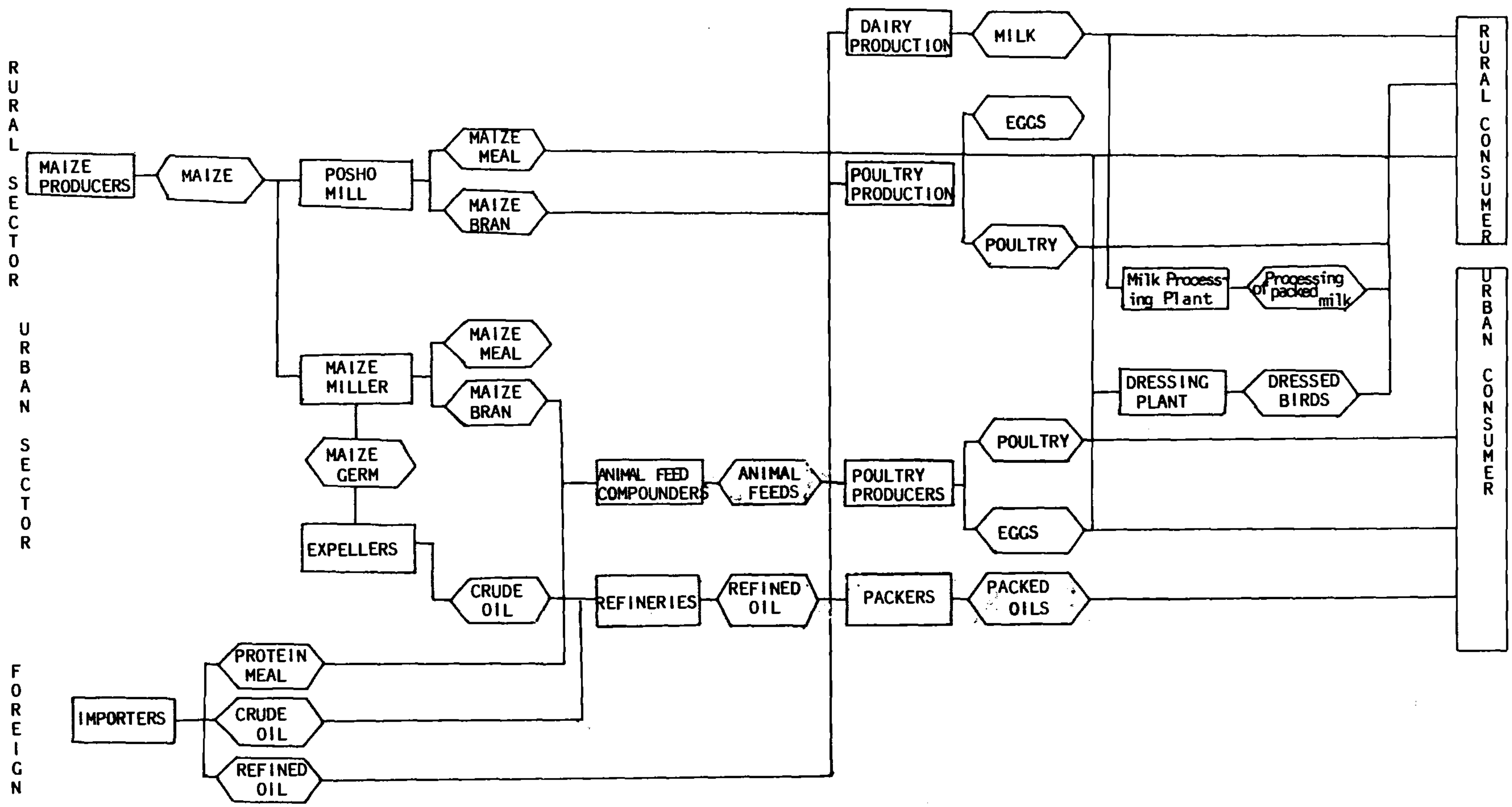

Figure 16. Undesirable system.

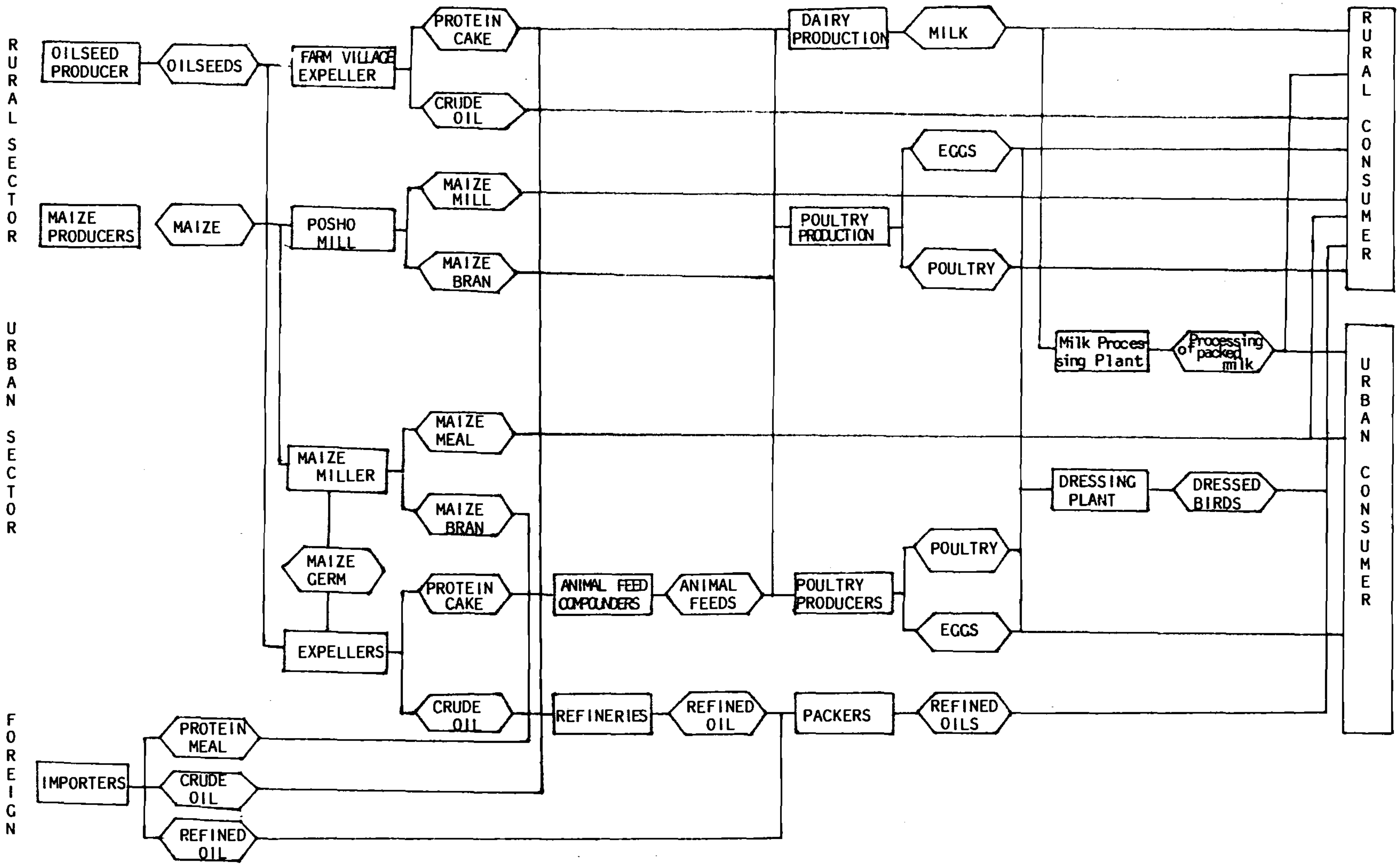

Figure 17. Experimental system.

and Kshs 925.00 in the case of simsim, for each 100 kg of each seed processed. As mentioned before, these values do not include the cost of processing and are highly speculative. Nevertheless, they are high enough to encourage experimentation with simple processing equipment at the farm or village level. This could generate some satisfactory results. The possibilities of custom processing, paralleling the existing posho mills service, should be tried and the reaction of the farmers to be availability of these facilities should be clearly analyzed.

Table 3. Income comparisons.

Assumptions	Unit	Sunflower	Simsim
A) Amount of Seeds Available	Kg	100.00	100.00
B) Extraction Rate - Oil	Kg	30.00	40.00
C) Extraction Rate - Cake	Kg	50.00	50.00
D) Price of Seeds to Producers	Kshs/kg	2.80	5.00
E) Price of Oil to Producers	Kshs/kg	10.00	10.00
F) Price of Cake to Producers	Kshs/kg	2.00	2.00
G) Price of Purchasing Oil	Kshs/kg	20.00	20.00
H) Price of Purchasing Cake	Kshs/kg	2.50	2.50
Comparative Income/Savings			
Income from Selling:			
Seeds (A*D)	Kshs	280.00	500.00
Oil (B*E)	Kshs	300.00	400.00
Cake (C*F)	Kshs	100.00	100.00
Total	Kshs	400.00	500.00
Savings from Consuming:			
Oil (B*G)	Kshs	600.00	800.00
Cake (B*H)	Kshs	125.00	125.00
Total	Kshs	725.00	925.00

A system could be envisaged in the future by which the farmers produce enough protein cake to feed their animals, and sufficient oil not only to satisfy the needs of their families but also to sell to the refineries.

The combination of savings from not having to buy the oil and the cake in the market plus the income generated by selling part of the oil to the refineries could make the production of oilseeds a feasible farming enterprise. It could also benefit farmers, in the less favorable agro-ecological zones where some of the oilseeds could satisfactorily be grown, with a relatively little competition from other more demanding crops.

Moreover, the local production and processing of oilseeds would expand the consumption of vegetable oils in the rural areas by increasing the caloric intake of the population. It would also generate local employment through a process of rural industrialization. Finally, one can visualize a new desirable system, as shown in Figure 18, in which the importation of oil is increasingly replaced by local production, with the consequent reduction of its burden to the balance of payments and the dependency on foreign suppliers.

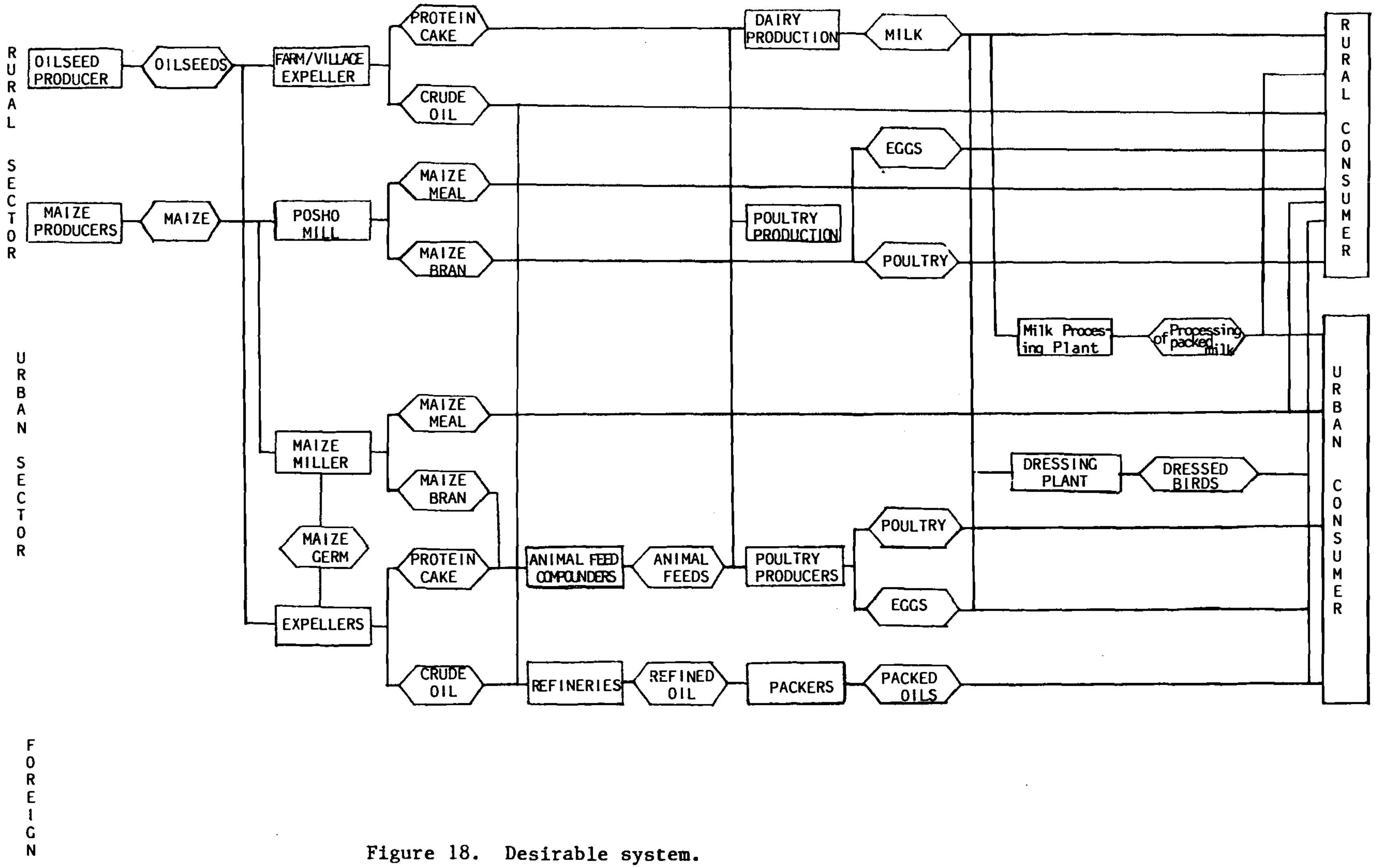

Figure 18. Desirable system.

RECOMMENDATIONS OF THE FIRST NATIONAL OILCROPS WORKSHOP HELD AT EGERTON UNIVERSITY, KENYA, 8-10 JULY, 1987

T.C. Riungu

The first National Oilseed Crops Workshop was organized with the main objective of bringing together relevant bodies interested in oilseed crops in Kenya. There were discussions on the past, the present and the future oilseed crops development, testing, processing, marketing, and the achievements and major production constraints.

After three days of deliberations the following recommendations were made:

1. The oilseed industry has a high potential in Kenya. However, there is a gap between the production costs and returns (profits) obtained from the sale of the produce i.e. seed. The participants recommended that ways should be devised to bridge this gap, possibly involving the government or the consumer through some sort of support or subsidy.

2. The world oilseed crop prices are low and the local produc tion and marketing should be looked into inorder to protect the local industry, particularly by the regulation of the importation of raw and processed products of oil crops.

3. The main constraints limiting productivity i.e. appropriate materials; varieties; agronomic, pathological, entomological and socio-economic problems should be looked into to improve the production through co-operation.

4. The infrastructures of research, production, processing and marketing should be improved to facilitate better means of communications for exchange of ideas and findings.

5. International organizations like the IDRC have to be approached for assistance where necessary and possible.

6. There should be co-operation and participation in germplasm collection, exchange, testing and recommendation. The Ministry of Agriculture/Research Science and Technology should speed up the approval of the recommended and released materials.

7. Research activities should be geared toward the development of varieties that have stable yields (seed and oil), quality and disease resistance.

8. Work on crop nutrition has to be emphasized and studies should be undertaken to screen the germplasm that can do well without the application of fertilizers.

9. More fact-finding research should be undertaken on intercropping.

10. Research should bring more facts about pest management with particular emphasis on the integrated pest management in the intercropping systems.

11. Seed quality services should meet the concerned bodies to formulate seed rules for all crops that have no spelt out rules.

12. The national milling capacity should be established.

13. The current requirement of cake in the country is 150,000 t. Therefore, the livestock industry should be expanded to enhance and sustain the entire oilseed industry. The processing units (milling) should be decentralized to enable farmers to sell their produce and also acquire the cake. The farmers need to be educated by extension services etc. on how to utilize the cake (e.g. mixing with other feeds prior to feeding their livestock).

Specific Crop Recommendations

1. Sunflower
   Open-pollinated varieties with high seed and oil yields, acceptable quality and disease resistance should be developed alongside the hybrids for production by small/large-scale farming communities in marginal or high potential areas.

2. Rapeseed
   a. Studies on small-scale production technology should be undertaken.

   b. There is a lot of seed wastage which could be minimized through developing the technology and equipment appropriate to small and large-scale holders for land preparation, seeding and harvesting.

3. Simsim (Sesame)
   Simsim is a potential crop and research emphasing the production package (eg. varieties, agronomic practices and pest management) should be undertaken.

4. Soybean
   Soybean has low oil and high protein contents and therefore should remain mainly as a protein crop.

5. Safflower
   Safflower has a potential particularly in the marginal areas and its production technology should be studied.

6. Castor
   Castor is a low priority crop and hence more socio-economic studies should first be conducted.

The participants decided that a task force should be formed to:

i. review the past and on-going research work as a basis for the future and other relevant oil crop activities.

ii. focus on the problems of the farmer and determine whether the emphasis on oilseed crops should be on large/small-scale holders or both and which areas/respective crops should be introduced, studied and finally used for production.

iii. involve the public and private sector and set up an evaluation team to ensure that the programmes on which they agreed are carried out.

This session was devoted to discussions on the potentials, constraints and problems of the development of oil crops in Kenya. The presentations covered the agricultural, governmental, industrial and economic points of view. It became immediately obvious that the issues are not unique to Kenya, many nations face much the same situation.

It must be remembered that oil crops are also important protein sources. There are many interactions of the various crops, economic forces and sectors involved. Successful development requires a good balance of government policies, agricultural innovation through research and extension, private industry and marketing organizations.

Would economic forces affect markedly oil and oil seeds prices everywhere? With large supplies of palm oil and soybean oil on the world market and their low prices, it is extremely difficult for the national production to compete with imports. Yet, there are many good agricultural, social and national resources to maintain an adequate level of local production of edible oil and proteins.

The objectives of research and extension must be to increase productivity, reduce costs and to adapt the crops to various niches so that national production will be as efficient as possible, require minimum support and supply the country's needs.

SESSION III

COUNTRY PRESENTATIONS - AFRICA

Chairman: Zhan Yingxian   Rapporteurs: Li Lili
E.Rashed

SESAME GROWING PROBLEMS IN THE SUDAN

M.H. Ahmed and H.M. Ishag

Introduction

Sesame is the country's major oil crop and serves as a source of edible oil. It is a cash crop for export to earn much needed foreign exchange.

Sesame is raised entirely under rainfed conditions (500-800 mm per annum) in the Sudan provinces, namely: Kordofan, Kassala and the Blue Nile. There are two farming systems used in sesame production. The rainfed traditional farming system involves neither machinery nor other modern inputs whereas the rainfed mechanized farming system involves a partial use of machinery but not other modern inputs. The majority of sesame fields (80%) are about 2 ha in area. Fields of 50-200 ha are sown in mechanized schemes and only 2% of the sesame is sown in fields with an area of 200 ha.

The area and total production fluctuated considerably within the last ten years due to the fluctuation in the amount and distribution of rainfall as well as the availability of manual labor (Table 1).

Table 1. Area, production and yield of sesame in the Sudan for the period 1978/79-1987/88.

Season	Area ('000 ha)	Production ('000 MT)	Yield (kg/ha)
1978	864	216	247
1979	832	222	252
1980	845	221	262
1981	825	242	292
1982	841	163	195
1983	911	206	226
1984	753	133	177
1985	1058	134	126
1986	1097	264	240
1987	960	258	269

Source: Division of Statistics Dept. of Agric. Economics and Statistics, Ministry of Agriculture and Natural Resources (1988).

Sesame Growing Problems

The following are some of the factors limiting the production of sesame in the Sudan:

1. All of the sesame grown is of the dehiscent type and, there fore, should be harvested manually which in turn creates a high labor requirement within a very short period of time. It is becoming more and more difficult to secure the necessary labor force to hand harvest the 1.5 - 2.25 million acres of sesame grown. Furthermore, the shortness of the harvest period intensifies the competition among growers to secure labor and results in higher harvesting wages.

2. The planting date of sesame depends on the beginning of rainy season. Because of fluctuations in the initiation of the rainy season, growers often miss the optimum planting date, fail to carry out effective weed control and suffer losses when harvesting. Dry spells during flowering or pod filling limit the yields in some years.

3. Weed control is often inadequate because of the excessively wet conditions of the field and because of the planting system used i.e. broadcasting the seed which eliminates the possibi lity of mechanical row crop cultivation. Chemical weed control has not been used as yet.

4. The low yield potential of cultivated varieties.

Past Research Accomplishments with Sesame

The earlier aspects of sesame research were associatedwith varietal introductions and the testing of crosses made between the local and introduced dehiscent and indehiscent types. There were series of trials at Tozi Experimental Station between 1952 and 1963 which was then moved to Abu Naama for testing the adaptability of introduced strains and developing a package of cultural practices. This research produced recommendations for land preparation, date of planting, seed rates, spacing, seed treatment and crop sequences. It was not possible to come up with recommendations on fertilization, chemical weed control and mechanical harvesting.

Plant breeding research was directed towards the purification of some of the local varieties and their classification, especially in terms of seed colour. This has led to the identification of about 200 strains (Table 2).

Table 2. Classification of Sudanese varieties according to seed colour.

Group	Subgroup	Varieties in each group	Seed-coat colour
Zirra	A1	A/1/1 .... A/1/11	White
(White)	A2	A/2/1 .... A/2/19	Dirty White
	A3	A/3/1 .... A/3/9	Grayish White
Huria	A4	A/4/1 .... A/4/11	Light Brown
(Brown)	A5	A/5/1 .... A/5/20	Brown
	A6	A/6/1 .... A/6/6	Dark Brown
Tozi	A7	A/7/1 .... A/7/3	Light Gray
(Gray)	A8	A/8/1 .... A/8/6	Gray
	A9	A/9/1 .... A/9/4	Dark Gray
Aswad (Black)	A10	A/10/1 .... A/10/3	Black

Purification not only ensured the purity of seed colour but also raised the yield of the variety by eliminating of the low yielding elements in the mixture. This inturn resulted in the development of germplasm with desirable characters. This germplasm has been used in the development of the present commercial varieties (A/1/2, A/1/5, A/1/6, A/1/10 and A/5/13).

In 1974, another project was organized by the close cooperation between Sudan Ministry of Agriculture, UNDP and the University of California. The project was primarily oriented to the mechanization of sesame harvest. Simultaneously a coordinated sesame breeding program was started in California and the Sudan and large number of introduction was made (UCR). Tens of crosses were made to obtain strains with one or more of the desirable characters: short internodes, three pods per axil, eight locules per pod, long pods and nonshattering pods. However, in spite of the great efforts made, breeding for indehiscent types was a complete failure.

In 1980, a 3-year project was organized by the International Development Research Centre (IDRC) and the Agricultural Research Corporation (ARC) and later on it was extended for another three years. The general objective of the project was to improve some of the important oilseed crops (groundnuts, sesame and soybean).

Using the available material at Kenana Research Station (UCR and Local Strains) intensive purification and re-evaluation was started again. Many yield trials, each comprising different strains initiated earlier, were continued. Data collected from these trials were used to assess the stability of yield in rainfed areas. Varieties which gave comparatively high yields and which showed stable performances, even maturity and desirable plant characters were advanced for release. In 1980 three varieties (two local and one UCR) were released for planting in central rain land of the Sudan.

Present and Future Research

In spite of the great efforts made towards sesame improvement, the situation of sesame production in the beginning of the first breeding program is similar to the present situation. The total production or yields per unit area are low and stagnant when compared to the yield of improved varieties obtained at different testing sites, Table 3.

This gap could be attributed to the lack of proper extension service without which the crop is traditionally treated as a minor and marginal crop cultivated under poor soil and moisture stress conditions. The small farmers fail to carry out the cultural operations properly and in time. The varieties used are mixtures of many types with poor quality and the farmers know nothing about the newly released varieties or recommended cultural practices.

Also, out of the major problems emerged mositure supply is the most important one limiting sesame production to some areas. In the Sudan, sesame is grown mainly in area that receive 500-800 mm per annum of rainfall. The total amount of rainfall is decreasing year after year, thus more lands, particularly in the northern part of the central clay plain, has become unsuitable for sesame production (Table 4).

In the last three seasons (1985/86, 1986/87 and 1987/88) there were heavy losses of sesame crop due to the attack of pests, and this was to the extent of a complete damage in some areas. Despite the favourable environmental conditions during the 1985/86 season, sesame production was low in comparison to the average production of 1979/80 - 1983/84 or even to the 1984/85 drought season (Table 3 and 5). This was primarily due to seed bug damage (*Aphanus sordidus*), locally known as Kaok, in Gedaref, Damazin and Kordofan. Since 1985/86, it was observed that the quality of sesame seed and oil was highly deteriorated showing mixed seed colour; light seed weight; dark or dirty oil colour; bitter taste of seed, oil and cake and consequently unsuitability of both seed and oil for industrial uses.

Table 3. Yields in kg/ha of improved varieties at testing sites compared to national average yield.

Varieties	Location	Seasons 1982	1983	1984	1985	1986	1987
UCR 770011-2	Abu Naama	661	768	758	826	88	555
	Agadi	690	230	568	71	98	919
	Samsam	606	468	193	523	123	241
	Mean	652	488	506	473	103	572
A/1/9	Abu Naama	-	637	676	831	139	529
	Agadi	-	257	855	119	59	1002
	Samsam	-	459	199	604	288	299
	Mean	-	384	577	518	162	610
A/1/10	Abu Naama	714	671	706	747	78	423
	Agadi	1194	180	685	81	87	950
	Samsam	573	411	185	366	186	228
	Mean	827	421	326	396	117	533
National average		292	251	226	177	126	240

Table 4. The annual rainfall (mm) for the major sesame producing areas in the Sudan for the years 1984, 1985 and 1986 compared to the average of the period 1950-1980).

Area	1951-1980	1984	1985	1986
El Damazin	707	546	492	564
Abu Naama	564	354	522	432
El Gadarif	586	282	724	567
Kassala	303	97	146	305
El Obeid	370	162	219	376
Kadugli	678	445	604	609

The annual agric. report (1986/87), Ministry of Agriculture and Natural Resources, Wad Medani.

In spite of all the problems and the questions that what type of research is needed to improve sesame production in Sudan, the breeding efforts are organized in such a way that a concentrated attack on these various aspects of the sesame problem could be possible. Thus, the breeding programs were designed to:

Table 5. Area, production and yield in 1985/86 compared with 1984/85 and 1978/79 - 1983/84 average.

	Seasons			% change in 1985/86 compared to	
	1979/80-1983/84	1984/85	1985/86	average	1984/85
Area (1000 fed)	2184	1853	2518	+21%	+35%
Production (1000 mt)	210	133	134	-38%	-
Yield (kg/fed)	103	72	53	-49%	-25%

Source: Agricultural situation and outlook, Vol.4, No.6, October 1987, Dept. of Agric. Econ., Ministry of Agriculture and Natural Resources, Sudan.

1. develop short duration or drought resistant sesame varieties for short rainy season and for marginal rainfall conditions.

2. improve sesame yield as well as seed and oil quality.

3. to carry out on-farm trials.

As a first step, the breeding programs of the last two seasons were directed towards the building up of a genetic stock through the maintenance of the old collections, collection tours over the reachable production areas, variety introduction and testing, and hybridization and selection.

As for quality improvement, no information about the chemical or quality changes was available. To have an idea about the effect of pest attack on seed and oil quality and properties, chemical analysis of seed from different sources was initiated. The 1000-seed weight of the damaged samples was very light and most of the seeds showed incomplete dirty colours. These samples gave low oil content and higher free fatty acids than the normal ones.

According to the results obtained from the chemical analysis agronomic and breeding program will be scheduled to improve cultural practices (sowing dates) and develop early maturing varieties.

Although the local varieties adopted to local conditions by the farmers, they take a long duration (120 days) and start flowering by the end of August in which they miss the rainy period. During the reproductive phase low yield, if not a complete loss, could be obtained if varieties requiring less than 300 mm of rainfall or adopted to short rainy season could be bred or screened. This would be ideal for such marginal and low rainfall areas of the country. Early maturing varieties could also be a solution to problems brought about by erratic rainfall distribution or low rainfall.

On the other hand, since there is no true insect resistance in the cultivated species, (early maturing types that can escape the pests attack) proper screening technique can be identified and used as variety or donor in breeding program.

The performance of 28 sesame strains provided by FAO, (Plant Production and Protection Division-Seed Services) is given in Table 6. Considerable variation was observed between the different types in seed colour, flowering and maturing period, degree of branching, degree of shattering and pod characters. Many of the strains have the tendency of bearing a large number of pods on individual stems due to the shortness of internodes and presence of 3 pods per axil and some have long pod. Mostly they start flowering 4 - 5 weeks after planting and mature in less than 3 months.

Table 6. Performance of F.A.O. sesame collection at K.R.S. 1986/87.

Origin of entries	Entries	Phyllotaxy	Pods/axil	Loc./pod	Days to flowering	Days to Maturity	Branches per plant	Plant height (cm)	Height to 1st pod	No. of pods/plant	Yield kg/ha	Reaction B.L. spot
Greece	Kistabtsa	OP	3	4	31	82	-	63	12	32	907	Res
"	Katy	OP	1	4	31	82	1	62	17	30	715	Res
Mexico	Ciano 2	OP	1	8	34	82	-	62	26	41	755	Res
"	Pachegeno	OP	3	4	38	87	-	68	23	36	855	Res
Korea	Pungmyonggae	OP	3	4	36	87	-	44	14	26	298	Res
"	Danbakggae	OP	3	4	32	82	-	43	14	19	274	Res
China	Zheng	OP	3	4	34	81	-	56	17	27	408	Res
"	YiYand-White	OP	3	4	36	87	-	59	39	41	364	Res
Burkina-Faso	38-1-7	AL	3	4	38	90	1	75	33	35	677	Res
"	30-15	AL	1	4	36	90	2	71	34	32	515	Res

<u>Key</u>: OP = Opposite, AL = Alternate, Res = Resistant, B.L. Spot = Bacterial Leaf Spot.

Selection within these strains for nonbranching plant type, with good high yield and early maturity, and with spacing much closer than needed for the banching Sudanese varieties can be used and greater yields could be expected. Likewise, screening for early maturing varieties could also be a solution to problems brought about by low rainfall and pest infestation that appear on late maturing varieties at the end of the season.

SUNFLOWER: A POTENTIAL NEW CROP FOR SUDAN

Hassan M.Ishag

Introduction

Sunflower is an important crop with a high quality oil. It is grown mainly in temperate region but it can also be adapted to wide range of environments.

The major producers are the USSR, Argentina, Eastern Europe, USA, China, European Community and Spain, Table 1. These seven countries produce about 90% of the world production whereas Africa's share is only 1% (FAO 1986).

Table 1. World production of sunflower (million tonnes).

Country	1978-1983	1983/84	1984/85
USSR	5.08	5.04	4.50
Argentina	1.72	2.20	3.40
Eastern Europe	2.13	1.91	2.20
United States	2.26	1.45	1.70
China	0.83	1.37	1.70
European Community	0.37	0.99	1.11
Spain	0.52	0.75	0.97
Far East	0.15	0.28	0.37
Africa	0.14	0.15	0.17
Near East	0.14	0.10	0.17
Other	1.15	1.17	1.36
Total	14.49	15.41	17.65

Source: FAO (1986) Production Year BooK.

With the exception of Argentina, most of the cultivated areas of sunflower are in temperate regions. Ahahle (1980) indicated the feasibility of sunflower production in Africa.

The most important oilcrops of the Sudan are sesame, groundnuts and cotton. However, sunflower was reently introduced to diversify the cropping system. The first sustained commercial production of sunflower occurred in 1985 when about 840 ha were sown; this area was increased to 17 000 ha and 63 000 in 1986 and 1987 respectively. The government is planning to grow about 420 000 ha within the coming few years. In the Blue Nile Province alone, 1.7 million ha could be planted.

Economic Potential of Sunflower Production in Sudan

Sunflower requires LS 2.77 of domestic resources to earn one US dollar if the hybrid seed is imported. The rate falls to LS 2.53 if the hybrid seed can be produced locally. These figures are based on price-yield combination (US$200/mt, FOB price and 1070 k/ha), Bateson and Tohami (1987).

Sunflower requires more fuel and capital investment than sorghum and sesame. It produces proportionally much more foreign exchange per hectare than sorghum and uses much less labour than sesame.

The net profit of one hectare was reported to be about US$ 214 compared to that US 128 for sorghum (El Sadig 1987).

Sunoil can compete in the Arab oil market due to its lower price (350-400 dollars/ton) compared to 600-700 dollars/ton for groundnut and sesame oils. Sunflower meal which contains 40% protein is also important for the livestock feeding industry.

Environmental requirements

Sunflower grows well in temperatures between 20° and 25°C though English et al. (1979) indicated that the optimum temperature can be between 27°C and 28°C. In Central Sudan day temperatures during the rainy season are around 34°C and night temperatures are around 22°C.

Temperature is known to affect the oil content and oil characteristics of the seed. In the Sudan, under high temperature Ahmed et al. (1983) found a reduction in linoleic acid and an increase in oleic acid, Table 2. These agree with the findings of Robertson and Russel (1972) and Harris et al. (1978) who reported that as temperature, during development, decreases there is an increase in linoleic acid and a decrease in oleic acid.

Table 2. Effect of location on seed-oil composition variety Peredovik.

Location	Fatty acid composition (%)					
	Palmitic	Stearic	Oleic	Linoleic	Linolenic	Other
Canada	6.1	3.7	16.4	73.7	-	-
Minnesota	5.6	6.5	19.1	67.0	-	-
California	7.0	4.5	25.0	61.9	0.1	1.5
Sudan*	6.2	3.4	45.9	44.5	-	-

Source: Robertson and Russel (1972)
Ahmed et al. (1983)

In the central clay plain, rainfall occurres during the period between May and October with a total annual rainfall varying from 400 to 900 mm. Peak precipitation falls during July and August.

Soils

Sunflower grows well on various soil types. In the Sudan, sunflower production proved to be successful in central clay plain. Bunting and Lea (1962) described the soils of the central rainlands as non-saline having up to 70% montmorillonitic clay of PH 8.5-9, with free $CaCo_3$ in the profile and high phosphate and exchangeable calcium values.

Skoric (1983) considered Gedaref and Damazin as the potential region I; Kadugli and Rank as the potential region II for rainfed production; however, Blue Nile, White Nile, Suki and Rahad schemes are potentially favourable for sunflower growing with supplementary irrigation.

Productive practices

A good crop management is a prerequisite for high sunflower yields which is important for profitable production.

1. Rotations
The existing rotation in central rainlands is dominated by sorghum monoculture. Sunflower should not be planted in the same land before four or five years. *M. phaseolii* and *Alternaria Lelianthi* are sunflower diseases present in the Sudan and there is a possibility of adaptation of these diseases to sorghum and cotton. Research is needed to find out the best rotation and the effect of the crop sequence on yield of sunflower.

2. Land preparation
El Awad (1984) indicated that high yields of sunflower were obtained from direct sowing (No-till system) in which weeds were controlled by applying gramaxone before sowing. This to be followed by chiesel plough with flexible tines at the onset of rain and wide level disc harrow at sowing.

3. Sowing date
Khalifa (1981) found out that under rainfed conditions in central Sudan mid-July gave significantly higher grain yield than late sowings. However, in irrigated Rahad scheme high grain yield was obtained from winter sowing particularly with non-hybrids, Table 3 (Beshir *et al*. 1986).

Table 3. Effect of sowing dates on grain yield of hybrids and non-hybrids grain yield (kg/ha).

Cultivar	Sowing date 25/7	25/9	25/11	Mean	SE ±
Hungarian-A	1019	840	2489	1449	
Hungarian-B	1019	771	3311	1702	
Peredovik	1209	1071	2720	1666	
Manchurian	1409	919	2880	1735	(±94.0)
Saturn	1459	840	1690	1330	
Sunbred "265"	3520	1721	2680	2639	
Interstate 7775	2620	531	1630	1595	
Mean	1751	956	2486	1731	(±62.1)

Source: Beshir, Khalifa and Nour (1986).

Sowing dates affected the oil composition. Summer sowing increased the percentage of oleic acid and decreased the percentage of linoleic acid and it was the vise-versa for winter sowing (Table 4).

Table 4. Effect of sowing dates on seed-oil composition.

Oil composition	Summer sown	Winter sown
Saturated fatty acids %	10.4	10.9
Oleic acid %	56.5	34.5
Linoleic acid %	33.1	54.6

Source: Ahmed *et al*. (1983).

4. Plant population

Row spacing of 60 cm with an intra-rowspacing of 45 cm was recommended for rainfed planting and 30 cm for irrigated areas (Khalifa, 1981) with a seed rate of 2.4-3.0 kg/ha depending on seed size.

5. Cultivars

The selection of suitable cultivars combined with high and efficient production practices are the important factors for successful sunflower production.

Hybrids replaced open-pollinated varieties because of their increased yield, pest resistance, uniformity and self compatibility. In rainfed areas (AAAID, 1986) reported that the hybrids 1224, Hysun 33 and 1560 U/A out yielded other hybrids and non hybrids, probably because of less empty seeds, Table 5. The exceptional high yield of the hybrids might also be attributed to high rainfall (900 mm) during the growing season.

Most of sunflower varieties presently available are not sufficiently heat tolerant, and the research in the Sudan may develop better hybrids than are available internationally.

Table 5. Seed yield of hybrid and non-hybrid cultivars and some agronomic characteristics - Agadi Farm 1986.

Name	Yield (kg/ha)	Empty seeds (%)	Wt. of 100 seeds (g)
Hybrids			
1224	2128	25	5.28
Hysun 33	1856	45	5.76
1560 U/A	1771	37	6.02
G.661	1728	45	4.45
G.100	1699	41	6.55
1050 N/A	1628	62	7.41
G.98	1428	55	5.41
Hysun 22	1028	56	7.40
1052	757	83	6.64
Hysun 32	571	79	5.96
Flo-328	257	63	7.78
Non hybrids			
C-204	771	55	5.37
Rodio	771	62	6.29
S.H. 8000	600	71	5.75
Polerco	528	89	7.62
Egnazia	485	65	6.62
Hungarian "A"	300	92	10.17
Hungarian "B"	214	71	8.37

Source: Arab Authority for Agricultural Investment and development (1986).

6. Pollinators

In central Sudan, bees and other insects can encourage the seed setting of sunflower. Bee keeping should be introduced to production areas to increase production.

7. Weeds

Weeds compete with sunflower causing poor growth and yield losses. Sunflower is a good competitor with weeds. However, the first four weeks after emergence are most critical in determining weed competition damage. Fageiry (1984) reported yield losses of 22-100% depending on the intensity and type of weeds.

The most effective weed control is accomplished by an inte grated system which uses both cultural and chemical control.

Among the pre-emergence herbicides tested Ronstar at 1.1 - 1.4 kg/ha was found to be highly promising for weed control. Dual and Stomp at 1.8 - 2.4 kg/ha were more effective on grasses (Fageiry, 1984).

8. Insects

Sunflower serves as host to a number of insect pests. Table 6 shows the major insects which can possibly attack sunflower in the Sudan (Schmutterer, 1969).

Table 6. Insect pests of sunflower.

I - At the seedling stage:	
1 - Epicuata aethiops	
II - At the vegetative growth stage:	
1 - Spodoptera littoralis	5 - Empoasca lybica
2 - Henosepilachna elaterii	6 - Bemisia tabaci
3 - Campylomma nicolasi	7 - Thrips
4 - Anoplocnemis curvipes	8 - Aphids
III - At the flowering and fruiting stage:	
1 - Agonoscelis pubescens	
2 - Heliothis armigera	
3 - Pachnoda interrupta	
4 - Dacus vertebratus	

Source: Schmutterer, H. (1969).

American bollworm (Heliothis armigera HB.) is becoming a serious insect pest in rainfed areas. Green bug (Nazara viridula L.) and Blister beetles (Epicauta aethiops LATR.) are also important insects. Thrips (C.impurus PR.) and whitefly (Bemisia tabaci GENN.) are of minor importance.

Because of its easy accessibility and high nutritional value of its seed, sunflower is particularly vulnerable to brid damage. The two races of dove (Streptopelia turtur turtur (L). and S. turtur isabellina (BP.)) attack sunflower heads and can cause a serious damage.

9. Diseases

Tarr (1955) identified the major diseases which attack sunflower in the Sudan, Table 7.

Table 7. Diseases of sunflower.

1 - Seedling diseases: Damping-off (Rhizoctonia solani)
2 - Foliar diseases:
a - Powdery mildews (Oidium Sp.)
b - Rust (Puccinia helianthi)
c - (Cercospora bidentis)
3 - Head diseases:
(Phyllody)

Source: Tarr, S.A.T. (1955).

Principal limitations to sunflower production

As sunflower is a potential oil crop for the Sudan, the following factors should be investigated to increase its production:

1. Selection of cultivars and hybrids adapted to Sudanese environment,

2. Empty seeds are found usually at the head centres. The percentage of empty seeds can reach 80% depending on many factors, such as:

   a. cultivars grown,
   b. water stress,
   c. american bollworm, and
   d. rainfall during flowering.

   Nur (1978) reported that the percentage of empty seeds was correlated to plant height, head diameter and days to mature.

3. Availability of inputs i.e. seeds, machinery, spare parts, fuel, insecticides ... etc. at the right time,

4. Remoteness of production areas from industry and export,

5. Inadequate credit facilities,

6. Storage and marketing.

There remain a great number of unknown factors and questions which need an intensive research. It is also expected that with the increase in commercial production, more problems will arise and thus careful monitoring will be required.

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ASSESSMENT OF SUDAN'S MECHANICAL HARVESTING OF SESAME

Khalid El-Jack Salih and Ali Gadoum El Ghali

Introduction

Sesame (Sesamum indicum L.) is the most important oilseed crop in the rainfed areas of the Sudan. Harvesting is a manual operation and has been estimated to claim 60-70% of the total cost of production (Khider 1981). Sesame production problems are low yield, high cost and sometimes unavailability of labor for hand harvesting, and excessive seed loss when harvested mechanically. Because of these problems sesame production has not expanded (Table 1). Mechanical harvesting is a problem due to uneven ripening which in turn results in the shattering of ripe capsules while green capsules are not yet ready. High costs and shortages of labour for manual harvesting are encouraging the industry to reconsider mechanical harvesting.

Table 1. Area, Production and Yield of Sesame in the Sudan (1975/76 - 1985/86).

Year	Area (1000's ha)	Production (ton)	Yield (Kg/ha)
1975/76	854.5	232,717	243
1976/77	943.3	237,193	252
1977/78	993.7	263,061	264
1978/79	857.2	215,878	252
1979/80	831.2	302,025	364
1980/81	844.6	221,000	262
1981/82	858.5	242,000	281
1982/83	839.6	163,000	195
1983/84	914.3	206,000	226
1984/85	767.8	130,000	169
1985/86	1039.1	131,000	126

Source: Department of Agricultural Economics, Planning and Agricultural Economics Administration, Ministry of Agriculture.

Research on Mechanical Harvesting

Attempts have been made to harvest sesame through different techniques. Mahmoud (1979) reported that the Danish Seiga reaper/binder tried at Tozi in the late 1950's and early 1960's was promising though there were problems with the cut plant orientation and the machine knotting mechanism.

The Polish tractor binder "Warta 2" was successfully tried in 1987 at Sim Sim project, south of Gedaref. The binder is pulled by a tractor (minimum of 25 HP) equipped with a power takeoff unit. The machine efficiently cuts and knots bundles of approximately 18 cm diameter and good cut plant orientation were achieved. Depending on field conditions the machine's work rate was between 1.3 and 2.0 ha/hr.

An approach to full mechanization of sesame harvesting was launched in 1976 at Kenana Research Station. A modified combine that had been used successfully on a commercial scale in California, Mexico and Venezuela was tried at Wad Medani in 1977 (Mahmoud, 1979). The system performed satisfactorily, although two serious problems were faced:

1. the crop was not desiccated properly,
2. row planting of a specific spacing was required.

Sief El Din (1986) reported that trials on direct mechanical harvesting were conducted at DAAPCO and Agadi farms (Damazine) in 1982 and 1986 respectively. Claas Combine engineers have been attempting to adapt a class header for sesame. The prerequisites of the trials were:

1. well prepared and leveled land
2. planting the crop in rows of 533 mm (21") or 600 mm (24")
3. spraying the crop with a desiccant after physiological maturity is reached.

Results obtained were as follows:

- percentage loss for the 1982 header was 28.22%
- percentage loss for the 1986 header was 18.7%.

Sim Sim Project Research, 1987

Objective

The objective of the research was to compare hand and machine harvesting of sesame in relation to yield losses and to observe the Polish binder as a replacement for hand cutting.

Materials and Methods

A field trial was conducted at the Sim Sim Dryland II Project in 1987 on a randomized block design with four replications. There were three treatments, each having a plot size of 140 m wide by 150 m long. The treatments were:

- hand harvesting (control), sheaves threshed by MF Combine
- swathing and combining
- direct combining, Massey Ferguson 850.

Results and Discussion

The results in Table 2 show that the percentage loss with respect to hand harvesting as a standard measure was 47% for swathing & combining and 24% for direct combining.

Table 2. Yield and losses of Sesame

Treatment	Yield (kg/ha)	Loss (kg/ha)	Loss[1] (%)
Hand Harvest (control)	461	0[2]	0
Swath and Combine	246	215	47
Direct Combine	339	112	24

[1] Losses with respect to hand harvesting.
[2] Losses from hand harvesting were not measured.

From observations the Polish binder "Warta 2" proved to be the efficient and promising approach to the partial mechanization of sesame harvest. Both cut plant orientation and knotting were successfully achieved, making it better than the Seiga binder tried earlier at Tozi. Manual labour is still required for bundle collection and threshing.

In 1986 results from Agadi with a modified class header showed losses as low as 18.76%. This was less than the losses measured using direct combining in 1987 at the Sim Sim Project (Table 2). Despite the low losses from the modified Claas header, extra inputs are required for row crop planting as well as preharvest desiccant spraying. These are not currently practical in the rainfed sector. The high losses from swathing and combining were mostly due to the shattering of seeds during picking of the swaths.

Conclusions

1. Swathing is not suitable for sesame harvesting.
2. Direct combining has a potential and needs to be further investigated.
3. Further research should include partial mechanization using the Polish binder.

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VERIFICATION OF IMPROVED LINSEED PRODUCTION PRACTICES ON FARMERS' FIELDS

Hiruy Belayneh and Nigussie Alemayehu

Abstract

Research endeavours made on station in the past have identified linseed varieties which are important for small farmers than the currently cultivated land races. The basic management practices required have also been made available by the time the varieties were ready for release. Though very great progress has been made in research areas it has not yet been realized by the small farmers. The study was, therefore, carried out to familiarize farmers with applicable new technologies that have been proved to increase yield substantially and help them adopt these technologies. The merits of farmers' traditional way of production and research-based management practices were investigated for two seasons (1985 and 1986) using two improved linseed varieties and a local check. The researcher's package resulted in higher seed yield than the farmer's traditional method. In linseed production management practices are more important. The two improved varieties were superior to the local check.

Introduction

Linseed (Linum usitatissimum L.) is one of the major oil crops of Ethiopia (2). Small farmers are the principal producers of the crop in the highlands above 1800 meters of elevation (4). Despite the long history of production of the crop in the traditional agriculture of the highland, due attention was not given to it both by farmers and researchers.

Farmers generally broadcast the seed late in the season on marginal land which is ploughed once. Insecticide and fertilizer are seldom used. Farmers seldom weed their linseed. Consequentely yields are very low (1).

Since the beginning of a well organized research on highland oil crops, some promising linseed varieties with fairly wide adaptability and high stable oil yield have ben made available. The optimum cultural practices for the varieties have also been established. Substantial yield has been obtained by the use of optimum seed rate and two weedings (3).

A great deal of effort however is needed to understand the farmers' circumstances and influence them to adopt new technologies sofar generated on the station, depending on the system compatibility. The package testing trial was undertaken to materialize these objectives.

Materials and Methods

Two improved varieties (CI-1525 and CI-1652) and one local check of linseed were tested for two seasons (1985 and 1986) under both farmers' traditional and researcher's management practices at Holetta Research Center and three other farmers' fields (Misrak Sholla, Welmera Goro, and Illala Gojo). The target groups were initially identified and selected by the farming system research and socio-economics team of the research center.

The researcher's management practices included: one early (3-4 weeks after planting) and a mid-season weeding, a seed rate of 40 kg/ha, and a fertilizer level of 23/23 kg/ha of N/P2O5 applied at planting. The farmers' judgements of fertilizer level (no application), seed rate (19-40 kg/ha) and one midseason weeding were considered for the farmers' method. The varieties were planted between 24th of June and 1st of July in blocks with two replications. The plot size used was 200 m2. In both methods land preparation was done with local plough and seeding was done by broadcasting. The agronomic and yield data were recorded for all treatments. Seed oil percentage was determined by Nuclear Magnetic Resonance (NMR) on a 40 ml dry sample taken from each plot.

Results and Discussion

Research results of several years from a number of locations in replicated trials reveal that improved linseed varieties are slightly superior to the local checks both under fertilized and unfertilized conditions, Table 1. Depending on the location the varieties responded to fertilizer (especially to nitrogen) although not pronounced (3).

Table 1. Summary of seed yield, oil content and oil yield of linseed varieties in the national and extension yield trials grown at 16 sites with 23/23 kg/ha of N/P205 fertilizer (F1) or without (F0).

	Seed yield (kg/ha)		Oil content (%)		Oil yield (kg/ha)	
	F1	F0	F1	F0	F1	F0
Improved	1232	1066	35.8	36.9	441	393
Local	1024	898	33.7	33.6	345	302
Mean	1128	982	34.8	35.3	393	348

Linseed yield is much more affected by weed control and sowing date than either fertilizer or seed rate, Table 2. As linseed is poor competitor to weeds, the first early weeding (three to four weeks after planting) is very critical. A delay in sowing date from mid-June to mid-July cause a yield loss as high as 30%, Table 2. In general, proper management practices are more important in linseed production.

Table 2. Seed yield increase due to optimum cultural practices as compared to the farmers' production option.

	Management options	Percent increase
1	Fertilizer: Recommended/No application	11
2	Sowing Date: 15 June - 15 July	30
3	Seed Rate: 40-10 kg/ha	10
4	Weed control	
	Hand weeding once (Early)	85
	Hand weeding once (Late)	16
	Hand weeding twice (one early, one mid-season)	89

As can be seen from Table 3, the researcher's package resulted in substantial yield increase over the farmers' traditional method. The lower yield obtained from the farmers' method of production could likely be due partly to delayed weeding practiced after the crop has already become weak and partly too poor establishment Table 4 which can be attributed to lower seed rates coupled with lower fertility and weed competition.

Under both management levels, the two improved varieties yielded better than the local check, Table 3. CI-1525 and CI-1652 are large-seeded, tall with a relatively higher resistance to diseases, but slightly late as compared to the local one, Table 4. The improved varieties have higher oil content than the local, Table 3 which indicates that oil content is influenced by seed size. CI-1652 was more responsive to management practices than the other two. CI-1525 showed superiority under farmers' way of production.

Table 3. Mean seed yield, oil content and oil yield of three linseed varieties in the on-farm trials grown in 1985 and 1986 using researcher's package (RP) and farmers' method (FM)

Varieties	Seed yield kg/ha			Seed oil content %			Seed oil yield kg/ha		
	RP	FM	Difference	RP	FM	Difference	RP	FM	Difference
CI-1525	978	635	343	36.5	37.7	-0.8	357	239	118
CI-1652	937	554	383	36.9	37.4	-0.5	346	207	139
Local	882	514	368	32.6	32.6	0.0	288	168	120
Mean	932	568	364	35.3	35.9	-0.4	330	205	125

Table 4. Mean across sites for different agronomic characters of three linseed varieties in the on-farm trials grown in 1985 and 1986 using researcher's package (RP) and farmers' method (FM)

Varieties	Days to mature			Plant height (cm)			Powdery mildew (0-5)			Stand %			1000 Seed weight (gm)		
	RP	FM	Mean	RP	FM	Mean	RP	FM	Mean	RP	FM	Mean	RP	FM	Mean
CI-1525	155	156	156	78	73	76	1.5	1.4	1.5	89	77	83	6.0	5.9	6.0
CI-1652	154	157	156	81	73	77	1.6	1.6	1.6	87	72	80	6.4	6.2	6.3
Local	141	143	142	54	49	52	3.0	3.4	3.2	87	74	81	3.5	3.5	3.5
Mean	150	152	151	71	65	68	2.0	2.1	2.1	88	74	81	5.3	5.2	5.3

Conclusion

Linseed is grown in a minimal input monocropping system. Research results indicate that management practices are more important in linseed production. For good establishment and better yield, the timely planted crop should receive the optimum level of fertilizer, one early weeding followed by another mid-season weeding and the recommended seed rate. In general, fertilizer increases seed yields only on poor soils. The improved linseed varieties have higher seed and oil yields than the local check and appear to have some promise in the cropping system followed by farmers.

Further, intensified research work is needed to generate technologies in the area of seed bed preparation, cropping systems alternative weed management practices, etc. that would technically and economically be feasible and compatible.

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SUNFLOWER RESEARCH ACHIEVEMENTS IN ETHIOPIA

Solomon Eshete

Introduction

Ethiopia is one of the countries known to be centers of diversity for different crop species. Niger (Guizota abyssinica), linseed (Linum usitatissimum), Ethiopian mustard (Brassica carinata), castor (Ricinus communis) and crambe (Crambe abyssinica) are known to be indigenous oil crops used for different purposes in Ethiopia. Eventhough various oil crops are indigenous and are produced in the country, shortage of edible oil is a chronic problem yet to be solved. The annual edible oil per capita is one liter. Therefore, high yielding and high oil content species and varieties of oil crops are greatly needed.

Currently, niger occupies the highest hectarage in the oilcrop production in Ethiopia. Indeed more than 50% of the annual oil supply is coming from this crop (3). On the other hand, the introduced oil crops such as sunflower and groundnut are the main oil bearing plants in the southern and eastern provinces, respectively. Special attention is given for sunflower because of its wide adaptability, high yield and ease for mechanization when produced under state farms. Since 1981, the research program on sunflower and its introduction to the farming community was strengthened with the financial and technical support of IDRC. The objectives of the research were to develop through intensive breeding, high yielding sunflower cultivars with a minimum loss from diseases, insect pests, weeds, etc. The effort of sunflower research team was quite successful in achieving the above mentioned goals. Research findings of the team are therefore the means to alleviate the short-comings of edible oil in the country.

Sunflower Research Activities

During the 1983 Oil Crops Network Workshop, the research achievements of the sunflower research team were reported (5). However, in this paper the findings of the team from 1983 onwards will be covered according to the different research disciplines.

Breeding

The sunflower breeding program includes the development of varieties through hybridization, selection and testing of cultivars. Based on the different agro-ecological zones of Ethiopia, the testing of varieties was conducted at 14 locations. The tests made between 1982 and 1984 confirmed that sunflower is widely adaptable to the different agro-climatic zones of the country from the lower altitude of Melka Werer (700m) upto the higher elevated area of Robe (2400m). The varieties tested in the national program in the past indicated that Argentario, Sungro-380A and Amiata were found to be widely adaptable and good in yield. On the other hand, the commercial variety Russian black is still good yielding even when unfertilized, Table 1 & 2. The above mentioned varieties will be ready for release after being verified in large-scale trials.

Since 1983, a selection program to develop synthetic varieties was proposed. The program was successfully caried out. The developed synthetics have been tested under the different agro-ecological conditions and some results were obtained, Tables 3 & 4. The mass selection program to improve the uniformity and yield of varieties (Russian black, Hesa, Pop-158, Chxgene pool I and Gene pool

Table 1. Mean seed yield in kg/ha of sunflower national variety trial grown at seven locations from 1982/83 - 1984/85 cropping season, fertilized (F1) 41:46 N/P_2O_5 and unfertilized (F0).

Tr. No.	Treatment	Herero F1	Herero F0	Shenka F1	Shenka F0	Kulumsa F1	Kulumsa F0	Debrezeit F1	Debrezeit F0	Awasa F1	Awasa F0	Upper-birr F1	Upper-birr F0	Bako F1	Bako F0	Mean F1	Mean F0	Rank F1	Rank F0
1	Hemus	1096	1507	1037	687	2342	1601	1931	2043	2003	1704	3382	2588	1678	1549	1924	1668	3	7
2	Argentario	1439	1324	1001	840	2406	1816	1831	2015	1818	1842	3010	2346	2271	1476	1968	1666	1	8
3	Sunki-301-A	1428	1521	1109	623	2332	2116	2063	1837	1792	1783	2990	2525	1526	1511	1891	1702	5	5
4	Sungaro-380-A	1502	1591	1300	733	2307	1835	1800	1861	2337	1907	2818	2429	1563	1665	1947	1717	2	4
5	Amlata	1445	1621	907	842	2238	1862	1991	1688	2343	2096	2911	2735	1351	1846	1884	1813	6	1
6	Vnimik	1427	1328	991	880	2206	1752	1965	2074	1868	1768	3029	2663	1627	1686	1873	1736	7	3
7	L C I	1590	1410	1069	731	2088	1728	1724	1490	2016	1680	2910	2657	1891	1594	1898	1613	4	9
8	Novisad-20	1619	1392	930	730	2376	1369	1610	2240	1916	1824	2910	2936	1524	1323	1841	1688	8	6
9	Russian Black	1551	1475	964	705	2270	1649	1477	1926	1981	1981	2962	2396	1640	2035	1835	1738	9	2
10	Eliodoro	1218	1107	789	873	2127	1614	1568	1567	1713	1420	2322	2378	1507	1284	1606	1463	10	10
	Mean	1432	1428	1010	764	2269	1734	1796	1874	1979	1801	2924	2565	1658	1597	1867	1680		

Table 2. Mean of agronomic characters in national variety trial grown at seven locations from 1982-1984 with 41/46 kg/ha of N/P_2O_5 fertilizer (F1) and without fertilizer (F0).

Tr. No.	Treatments	Days to flower F1	Days to flower F0	Days to mature F1	Days to mature F0	Stand count at harvest F1	Stand count at harvest F0	Disease infection score* D.M % F1	D.M % F0	SCL. % F1	SCL. % F0	Rust F1	Rust F0	Plant height in cm F1	Plant height in cm F0	Head diam. in cm F1	Head diam. in cm F0	Lodging % F1	Lodging % F0	1000 seed weight in gms F1	1000 seed weight in gms F0
1	Hemus	87	90	136	137	27	27	2	3	1	0	2	1	261	252	21	24	9	8	62	60
2	Argentario	88	88	138	138	28	27	2	2	1	2	2	2	227	217	20	24	10	10	63	58
3	Sunhi-301-A	88	89	139	140	28	27	1	2	0.9	1	2	2	204	229	19	24	10	9	57	54
4	Sungaro-380-A	91	90	139	143	30	30	2	1	1	1	2	1	242	245	20	25	10	9	60	53
5	Amiata	88	92	138	141	26	27	3	2	0.8	0.8	2	2	227	228	20	25	9	7	57	58
6	Vinmik	87	90	136	136	27	26	3	2	1	1.3	2	1	230	239	20	24	12	9	63	57
7	L C I	87	89	136	139	27	29	3	2	2	1.2	2	2	225	225	20	25	10	10	64	57
8	Novisad-20	90	90	138	141	30	27	2	2	1	1	2	2	237	236	21	23	10	8	64	59
9	Russian Black	92	90	142	146	29	28	2	1	1	1.2	2	1	250	243	22	26	9	8	62	56
10	Eliodoro	80	91	131	135	27	26	3	1	1	0.8	2	2	233	202	20	22	8	8	62	57

* D.M. = Downy Mildew, SCL = Sclerotinia.

Table 3. Mean across four locations of different agronomic characters of eight sunflower varieties in synthetic variety tiral grown from 1985-1986 cropping season without fertilizer application.

No.	Treatment	Stand count at harvest	Days to flower	Days to maturity	Disease (0 - 5) infection % D.M.	Disease (0 - 5) infection % Rust	Plant height in cm.	Head diam. in cm.	Lodging %	1000 seed wt. g
1	Synthe - NSH-D3	51	67	107	1	1	167	20	2	56
2	Synthe - NSH-37	47	68	106	1	1	160	20	2	48
3	Synthe - NSH-2	50	70	107	1	1	169	19	2	58
4	Synthe - INRA-7702	44	70	106	1	1	164	20	3	62
5	Synthe - NSH-25	47	61	107	0	1	192	21	1	56
6	Che x Gene pool I	45	66	102	1	1	152	20	3	59
7	Che x Gene pool II	45	65	102	2	2	148	19	3	61
8	Eliodoro (Standard Check)	44	71	106	3	2	171	20	2	65

Table 4. Mean seed yield in kg/ha of eight sunflower varieties in synthetic variety trial grown at four locations from 1985 - 1986 cropping season without the application of fertilizer.

No.	Treatment	Awasa	Kulumsa	Upper Birr	Melka Werer	Mean	Rank
1	SYNTHE - NSH - D3	1829 (6)	2016 (7)	2659 (3)	2443 (8)	2236	7
2	SYNTHE - NSH - 37	1971 (4)	2273 (4)	2647 (4)	2838 (3)	2437	3
3	SYNTHE - NSH - 2	2070 (3)	2175 (6)	2843 (1)	2728 (4)	2454	2
4	SYNTHE - INRA - 7702	2202 (2)	1812 (8)	2429 (5)	2686 (5)	2232	8
5	SYNTHE - NSH - 25	2280 (1)	2449 (1)	2795 (2)	2921 (1)	2611	1
6	Che x Gene pool I	1693 (8)	2301 (3)	2361 (7)	2598 (7)	2238	6
7	Gene Pool II	1860 (5)	2236 (5)	2425 (6)	2856 (2)	2345	4
8	Eliodoro (Standard Check)	1694 (7)	2437 (2)	2274 (8)	2670 (6)	2269	5
	Mean	1925	2213	2554	2718	2352	
	Altitude (m)	1700	2200	1690	750		
	Soil type	Sandy loam	Light clay	Red clay	Brown alluvial		

Rank in parenthesis

II) was carried out in the past four years. Most of the varieties attained their uniformity. However, it was not possible to reduce the height of Russian black. The variety ChxGene pool I was found to be promising in less rainfall areas. It matures in 120 days exploiting the short rainy season (8).

Agronomy

Sowing sunflower from 7 to 27 June was recommended for the farmers around Awassa (6).

A population density ranging from 44,000 to 53,000 plants per hectare was recommended for long cycle cultivars with a row spacing of 75 cm and 25 cm between plants (9). For short cycle sunflower cultivars, a population density ranging from 53,000 to 88,000 plants per hectare was recommended depending upon varietal resistance to downy mildew and Sclerotinia rot (7). The study on depth of planting with a range of 3-6 cm was found to be excellent in yield (10).

Variety trials conducted with and without fertilizer application indicated no significant difference in yield in many of the testing sites, Table 1. Indeed fertilizer trials (NP) at Awasa, Herero and Sheneka farms confirmed that fertilizer application does not have positive effect on yield of sunflower. In the past, sunflower was produced in both state farms and research centers with the application of 100 kg/ha of DAP at planting and 50 kg/ha of Urea 4-6 weeks after germination, which is at the rate of 41:46 kg/ha of N/P2O5, respectively. This practice contradicts with the recent research findings. Verifi-cation trials on 20 ha using two sunflower varieties (Russian black, late maturing; ChxGene pool I, early maturing) was conducted with the application of the above rate and without fertilizer. At Awasa, higher yields were obtained for both varieties from the unfertilized treatments. Consequently, it was recommended not to apply any type of fertilizer for sunflower production in major sunflower producing areas. Hence, both state farms and research centers have for the third time harvested sustained yield of sunflower without fertilizer application. This resulted in the saving of both fertilizer and unnecessary costs of production (3).

Pathology

Disease surveys have been undertaken in sunflower growing areas of the country. During this period a number of diseases were identified: downy mildew (Plasmopora halstedii Farlow, Berl. et de Toni), stem and head rot (Sclerotinia sclerotiorum Lib de barry) rust (Puccinia helianthi Schw), leaf spot (Alternaria zinial Pape), leaf blight (Fusarium equisetii (Corda) Sacc), Sclerotinia spp., bacterial leaf spot (Pseudomonas helianthi, Kawamura savulesuc), powdery mildew (Oidium spp.) and unidentified viruses (8, 11). Among the various diseases, the economically important ones are: downy mildew, stem and head rot, rust and leaf blight.

An experiment was carried out to study the effect of sowing date on downy mildew incidence for three years. Results revealed that downey mildew incidence increases with the delay of sowing dates. The lowest disease incidence (3%) was obtained from the first sowing date (June 7) and the highest disease incidence (50%) was obtained from the last sowing date (July 7). The variation of disease incidence of the different sowing dates have shown a direct effect on yield. The highest yield of 19.4 and 19.2 q/ha were obtained from the second and first sowing dates respectively. Therefore, it is suggestd that sunflower should be sown from the first week upto the third week of June with the onset of early rain (6,11).

Varietal screening for downy mildew resistance was carried out in a developed sick plot. Local collections and introduced lines having a history of resistance were tested. Preliminary results obtained indicated that RHA-274, RHA-296, RHA-297, HA-821, DM-BR-53, DM-74, DM-134 and BR-51 were found to be free of downy mildew. Lines such as HA-822, DM-77, RHA-298, Sputnik, DM-188, CMS-HA-287, DM-52, DM-263 and 83-1171 have shown 0.5 - 3.0% infection. Most of these resistant lines have the branching character. All of the local collections were found to be completely susceptible to downy mildew (Table 5). At present the existing races of downy mildew are not known. The screening of seed dressing chemicals that control downy mildew indicated that metalaxyl at the rate of 210g a.i/100 kg seed gave complete control of the disease (11).

Table 5. Evaluation of sunflower varieties/lines for the degree of resistance to downy mildew disease at field condition from 1984-1986 (Awasa).

Tr. No.	Treatments	Infection % 1984/85 Systemic	1984/85 Local	1985/86 Systemic	1985/86 Local	Mean Systemic	Mean Local
1.	RHA-274	0	0	0	0	0	0
2.	RHA-296	0	0	0	0	0	0
3.	RHA-297	0	0	0	0	0	0
4.	HA-821	0	0	0	0	0	0
5.	DM-BR-53	0	0	0	0	0	0
6.	DM-74	0	0	0	0	0	0
7.	DM-134	0	0	0	0	0	0
8.	BR-51	0	0	0	0	0	0
9.	HA-822	(-)	(-)	0.4	0.5	0.4	0.5
10.	DM-77	(-)	(-)	0.2	0	0.2	0
11.	RHA-298	(-)	(-)	0.4	0.3	0.2	0.3
12.	Sputnik DM-188	(-)	(-)	1.0	0	1.0	0
13.	CMS-HA-287	0	0.5	0.3	1.0	0.15	0.75
14.	DM-52	(-)	(-)	2.3	0.2	2.3	0.2
15.	DM-263	(-)	(-)	2.0	0.2	2.0	0.2
16.	83-1171	(-)	(-)	1.7	1.3	1.7	1.3
17.	Russian Black	6.5	21.5	(-)	(-)	6.5	21.5
18.	Eliodoro	11.0	12.5	(-)	(-)	11.0	12.5
19.	Ac.No. 202492	28.5	28.0	52.8	36.0	40.65	32.0
20.	Ac.No. 202494	23.0	23.0	66.8	24.0	44.9	23.5
21.	Ac.No. 992001	35.5	18.0	77.0	0.2	56.25	9.1
22.	Ac.No. 202498	28.0	25.0	62.8	22.0	45.4	23.5

(-) = Data is not available.

A preliminary study on artificial inoculation of stem and head rot was undertaken. Before executing the inoculation, attempts were made just to develop isolation and culturing methods. The best method of isolation and culturing obtained was by sterilizing the sclerotia of the pathogen with 1% Hgcl solution for 30 seconds and rinsing it with distilled water, then planting the sterilized sclerotia on barley or PDA media and incubating at 25°C. Mycelium develops within three days and sclerotia within six days. The inoculation study is under way and preliminary results indicated that root collar and seed inoculation methods were promising (11).

Weed science

According to the survey in the south and south-eastern region, the most important weed species identified were: Nicandra physalodes, Cyperus spp., Commelina bengalensis, Galinsoga parviflora, Guizotia scabra. In the south-eastern regions, Galinso parviflore, Guizeta scabra, Tagates minuta, Chenopodium spp., Cyperus spp. and Amaranthus hybrides were found to be the most dominant ones (2, 8). The parasite (Orobanche spp.) was observed in some of the south-eastern sunflower growing areas. Trials initiated to assess losses due to weed competition in sunflower at Awasa were terminated with a recommendation of weeding: first at 25 days after emergence and the second 50 days after emergence. The herbicides screening trial executed at Awasa has identified

Phenoxalin 3.0 kg. pro/ha and Lasso 5 kg.pro/ha as the two best pre-emergence herbicides in controlling the weed flora at Awasa. The variety screening for Orobanche resistance indicated that Russian black was found to be tolerant. Indeed the parasitic weed appeared late in the growing season of sunflower, at flowering stage (2).

Entomology

According to the survey made in different sunflower growing areas of the country, more than twenty species of arthropod insect pests were identified associating with sunflower.
Economically the important species was african boll worm (Heliothis armigera) which attacks the crop at the early growing period and at flowering. Based on the survey findings, a screening program was initiated in 1986 and the experiment is in progress (1).

Future Plan Of Research

The overall objective of the Ethiopian Oil Crops Improvement Project remains to be the same as in Phase I and Phase II i.e. developing self-sufficiency in edible oil production for the growing population and providing raw materials for agro-industries. The specific objectives of the sunflower program are:

a. Continuing the breeding program to develop high seed and oil yielding sunflower cultivars, having a character of tolerance or resistance to downy mildew disease, ealry to medium maturity, short height for combine harvesting and other related agronomic characters.

b. Initiating new agronomic trials for better management of sunflower, i.e. minimum tillage practice, rotation, double cropping and others.

c. Extending the survey of insect pests and weeds to the important sunflower growing areas of the north and north-western regions.

d. Screening of varieties to the important diseases of sunflower head and stem rot and downy mildew so that resistant or tolerant cultivars could be developed. The screening program will be started both at field and laboratory (green house) conditions. The biology of the disease will also be studied.

e. Initiating the screening of resistant/tolerant varieties to african boll worm and assessing the loss due to pest attack.

f. Evaluating the package findings on large-scale farms so as to demonstrate them for the users and study the cost of production.

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THE CURRENT STATUS AND FUTURE TRENDS OF SESAME RESEARCH IN ETHIOPIA

Elias Urage

Introduction

In Ethiopia, sesame (*Sesamum indicum* L.) is grown in the low-lying regions bordering the Sudan and Somalia. It is a well-established crop in the north and north-western plains adjacent to the Sudan (5,6,7,8,9,10). In most cases, it is grown in varying densities as a companion crop with cereals, depending on the soil type and precipitation. However, in the Setit Humera district, a large tract of the arable land used to grow sesame only in the previous years (9).

At present, the area under large-scale sesame production was dramatically decreased as the state and private farms specialized on sesame became nonfunctional or operating on a minimum scale. This is due to the lack of labour at harvest, drought and other management and social problems (1). Hence the current production of sesame is carried out only by small farmers.

In the 1960's and 1970's, sesame stood first among the oilseeds exported (7). The decrease in the production area has affected the sesame seed export. However a considerable amount of sesame seed is still being exported, and the remaining is consumed at home (7,11).

As it is true for East African countries (4), the major problems of sesame production in Ethiopia include primitive cultural practices, low yielding varieties, insect pests and diseases, harvesting difficulties, shortage of trained manpower, and drought.

Research Activities and Achievements

Although research activities on sesame date back to the late 1960's, much was not achieved until the advent of the team approach in the early 1980's. Currently, encouraging results are obtained and much more is expected in the future.

The financial and material support obtained in 1982 from the International Development Research Centre to promote lowland oil crops research in Ethiopia have greatly contributed in achieving the objectives of sesame research.

The present research activities are designed to tackle the problems of primitive cultural practices, low yielding varieties, disease and pest conditions, shattering and drought.

Crop improvement

In order to enrich the germplasm resources of sesame, the collection of indigenous germplasm was undertaken in collaboration with the Plant Genetics Resource Center of Ethiopia (PGRC/E) (10). As a result, more than 350 accessions were fully characterized and well preserved for future use. Promising lines were also selected and evaluated. In this scheme, the varieties such as SPS No 111518 and SPS No 111519 were among the notable genotypes that have given quite impressive yields under irrigated conditions and high rainfall areas. In the western part of Ethiopia, where bacterial blight is a serious problem, SPS No 111519 has shown a marked tolerance to bacterial blight (*Xanthomonas sesami* and *Pseudomonas sesami*) (1).

Selections from northern Ethiopia were found to resist drought. These are the collections from Woldia, Kobo, Gobyo and Shoa Robit areas that producd relatively better yields under moisture stress conditions (1).

Breeding programs to develop partial shattering, disease resistance and high yielding sesame lines are in progress at Melka Werer Research Center. Encouraging results were obtained and some lines have been promoted to preliminary yield tests (1).

So far, four varieties of sesame were released. These are T-85, E, S and Kelafo-4. The latter is a landrace collected from Kelafo district in Ogaden region. Varieties E and S are known to be tolerant to bacterial blight. The landraces SPS No 111518 and 111519 are in the pipeline to be released.

Currently, the crop improvement section is undertaking characterization of collections and introductions in collaboration with PGRC/E, regular testing of varieties on multilocation basis under different agro-ecological zones of the country, and a screening program against drought in areas where moisture shortage is a repeated phenomenon.

Agronomy

The plant population study has shown that 250,000 plants/ha is optimum, the spacing being 40 cm between rows and 10 cm between plants. A fertilizer study was made and there was no response in most places. The irrigation study at Melka Werer Research Center and Gode indicated that 4-5 irrigations at two weeks interval with the amount of 10 cm at each application is optimum (3). At Melka Werer, the study of harvesting stage has showen that when 1/3 to 2/3 of the plant parts turn yellow it was the right time of harvest without affecting seed yield and oil content, and with minimum or no shattering loss.

Crop protection

Weed science: crop-weed competition study on sesame has indicated that the critical period starts from crop emergence and extends up to 30-35 days of its establishment. Therefore, a single early weeding 4-5 weeks after emergence is recommended for optimum yield.

Herbicide trial indicated that pre-emergence application of alachlor and prometryne gave very good control of weeds with highest seed yield at the rate of 4 kg a.i/ha and 1.5 kg a.i./ha, respectively.

Entomology: Sesame webworm (*Antigastra catalaunalis*) which attacks the crop from early stage of growth to flowering period is a major insect pest (sporadic in nature) recorded to cause up to 25% yield loss at Melka Werer Research Center. The green peach aphid (*Myzus persicae*) was found to be the next major pest. Annually, insect pest surveys were made to identify important pests on major growing areas, and an insecticide screening trial against sesame webworm is being carried out at Melka Werer Research Center.

Pathology: Bacterial blight and phyllody are the major diseases in Ethiopia, and screening sesame varieties at field condition against bacterial blight and phyllody is in progress at Bisidimo and Melka Werer Research Center. respectively.

In laboratory screening trial using *Pseudomonas sp* isolates, two sesame varieties (Oro short and Morada) were found to be tolerant (2).

Future Research Needs

- Hybridization to develop non-shatering, high yielding and disease resistant sesame lines.

- More collections and introductions of sesame materials to broaden the genetic base for further breeding.

- Screening program against important diseases, pests and drought.

- Developing suitable varieties for different agro-ecological zones of the country.

- Introduction of sesame to non-traditional but potential areas to boost its production.

- Training of high level personnel in research as well as extension activities.

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CROP LOSS ASSESSEMENT DUE TO WEED COMPETITION IN SESAME UNDER IRRIGATION[1]

Tadesse Eshetu and Yebio W/Mariam

(Read by Elias Uragie)

Abstract

A crop-weed competition study on sesame was conducted for three consecutive seasons at Melka Werer Research Center to determine the critical period of competition. The results clearly indicated that the critical period of competition was during the first 4 - 5 weeks after crop emergence. A single early weeding done 4-5 weeks after emergence consistently resulted in a similar yield to that of weed free and early + mid weedings. This indicates that single early weeding is essential and economical. Further, the results showed considerable yield reduction when the weeding operation was delayed. The longer weeds were allowed to grow with the crop, the higher the competition became and the lower the yield was obtained. Moreover, treatments consisting of "early" weeding have shown significant yield increment as compared to treatments with mid and late weedings. The overall crop loss due to weed competition amounted to almost 77%.

Introduction

Sesame (Sesamum indicum L.) is one of the most important oil crops in Ethiopia. Cobley argued that Ethiopia is the orginal home of cultivated sesame (1). Production in the early 1970s was considerably high. However, crop management including weed control caused the cultivated area to fall to 5000 ha in 1985.

As it is the case with other crops, weeds in sesame cause adverse effects such as reduced yield, increased pest and disease incidences and interference with cultural practices such as irrigation, fertilizer application and harvesting (4). The extent of damage caused by weeds depends on the type of weed species, weed population and time of weed removal (4,5). Competition also decreases plant height, delays maturity and in some cases reduces plant population (2).

Growers often assume wrongly that removing weeds from cultivated fields any time during the growing season solves the problem. But, substantial evidence indicates that the time of weed removal is as important as removal itself (6). Defining the critical period of competition is very important and efforts must be made to control weeds within that period. Weed control within the critical period of competition could reduce crop damages, and also the extra cost due to late removal.

In the Middle Awash, information on the critical period of crop-weed competition is very much limited. This report summarizes the results of a 3-year crop-weed competition study in sesame conducted under irrigation at Melka Werer Research Center (MWRC).

Materials and Methods

Six weeding schedules including a control or no weeding were used in this experiment. These were: weed free, early weeding (30-35 days after emergence), mid weeding (50-55 days after emergence), early + mid weeding, late weeding, and mid + late weeding.

Treatments were arranged in a randomized complete block of four replications. A plot size of 10m was used in all seasons and the variety used was T-85. Seeds were hand-drilled on both sides of the 80 cm wide ridge. Thinning was done shortly before the second irrigation to a spacing of 10 cm between plants. The method of irrigation was furrow at 10-12 days interval. Weed counts were made before each weeding operation using a 35x35 cm quadrat. Weeding operation was carried out using both hand-pulling and hoe-weeding.

In order to perform cost analysis study, the time taken to weed the plots was recorded. This was converted to man-days per hectare. Yield, stand count, plant height and 1000 seed weight were recorded at harvesting. Finally, the data was subjected to statistical analysis.

Results and discussion

The dominant weed species recorded in this study were _Sorghum sundanense_, _Portulaca oleracea_, _Zelya pentaundra_, _Echinocloa colonum_, _Cyprus rotundus_, _Launea cornuta_, _Corochorus fasicularis_, _Gynandropsis gynandra_, _Eragrostis aethiopia_, _Eriochloa fatemensis_, _Ricinus sp._ and _Datura stramonium_. In Tables 1, 2 and 3, results and summary of the three seasons and cost/benefit analysis are shown. The parameters measured were grain yield, percent yield loss and cost of weeding.

As showen in Table 2, it is clear that if weeds are allowed to grow uncontrolled throughout the growth cycle they will decrease the yield potential from 10.3 q/ha to 2.4 q/ha. In terms of yield loss this amounts to 77%. The highest mean yield was obtained from frequent weeding, i.e. when the crop was kept weed free throughout the growing season. However, there was no significant yield difference between weed free, early + mid weeding and single early weeding since their mean yields were 10.3, 10.0 and 9.7 q/ha respectively. In consequence there is no substantial yield increment achieved whether the crop is kept weed free or single early weeding is supplemented at mid-growth stage of the crop. In general single early weeding is supplemented at mid-growth stage of the crop. In general, single early weeding in the season protects the crop from intensive competition with weeds until it produces sufficient canopy to supress further germination and growth of weeds.

In comparison, mid-weeding gave low mean yield of 5.5 q/ha which is 47.0, 45.0 and 43.0% less than "weed free", early + mid, and single early weeding respectively. This indicates that the more weeding operation is delayed the less the crop tolerates early germinating weeds. Furthermore, mid-weeding was found to be superior to late weeding and significantly different from no weeding. On the other hand, late weeding was slightly better than no weeding.

Similar results were obtained in some other countries; for example, in the Sudan, Khidir found that the critical period of competition was during the first 4 weeks after emergence. He also found that yield was high with early weeding and low with late weeding (3).

As far as the cost of weeding is concerned, single early weeding showed the lowest cost (167 Birr/ha) followed by early + mid and frequent weeding with 243.0 and 249.0 Birr/ha respectively. The highest costs of 475.0 and 322.0 Birr/ha were incurred by late and mid weeding practices. These high costs can be attributed to the fact that during these periods the weed stands were dense and strong demanding longer time to remove them which in turn resulted in a high cost of weeding.

Table 1. Sesame grain yield, percent loss, and cost of weeding for the years 1984, 1985, 1986.

Treatments	1984				1985				1986			
			Cost				Cost				Cost	
	Yield q/ha	% loss	Man-day/ha	Birr /ha	Yield q/ha	% loss	Man-day/ha	Birr /ha	Yield q/ha	% loss	Man-day/ha	Birr /ha
No weeding	1.53	72.0	-	-	1.05	91.0	-	-	4.57	67.0	-	-
Frequent weeding (weed-free)	5.47	-	68.0	138.35	11.63	-	150.0	305.0	13.85	-	149	303.0
Early weeding (30-35 days after planting	4.25	22.0	48.0	97.0	12.26	5.0	102.0	207.0	12.46	10.0	97.0	198.0
Mid weeding (50-5 days after planting	3.34	39.0	102.0	209.0	4.93	58.0	258.0	527.0	8.18	41.0	113.0	230.0
Early + mid weeding	4.48	18.0	62.0	126.0	12.27	5.0	167.0	340.0	13.3	4.0	128.0	260.0
Late weeding (70-75 days after planting)	2.0	63.0	-	-	1.21	90.0	332.0	678.0	9.0	35.0	134.0	273.0
Mid + late weeding	4.23	23.0	98.0	200.0	4.08	65.0	213.0	435.0	11.35	18.0	120.0	244.0
CV%	32				29				10			
S.E.	1.0				1.0				0.5			
LSD 5%					5.0				3.0			

Table 2. Average yield, percent yield loss, and cost of weeding for 6 weeding schedules for the years 1984, 1985 and 1986.

Treatments	Yield q/ha	% loss compared against weed free	Cost of weeding Manday/ha	Cost of weeding Birr/ha
No weeding	2.4	77.0		
Frequent weeding (weed free)	10.3	-	122	249.0
Single early weeding (30-35 days from emergence)	9.7	6.0	82	267.28
Mid weeding (50-55 days from emergence)	5.5	46.6	158	322.32
Early + mid weeding	10.1	2.0	119	243.0
Late weeding (70-75 days from emergence	4.1	60.0	233	475.0
Mid + late weeding	6.6	36.0	147	300.0

Key: Cost of weeding/man-day = 2.04 Birr (= about one US$)

Table 3. Cost/benefit analysis.

Treatments	Yield	Yield increase over control q/ha	Gross return Birr/ha	Cost of weeding Birr/ha	Net additional Birr/ha
No weeding	2.4	-	-	-	-
Weed free	10.3	7.9	632	249.00	+ 383.00
Early weeding	9.7	7.3	584	167.28	+ 416.72
Mid weeding	5.5	3.1	248	322.32	- 74.32
Early + mid weeding	10.1	7.7	616	243.00	+ 373.00
Late weeding	4.1	1.7	136	475.00	- 339.00
Mid + late weeding	6.6	4.2	336	300.00	+ 36.00

Price of sesame seed (1987) = 80.0 Birr/ha
Source: Ethiopia Low Land Oil Crops Improvement Project (ETLOCIP).

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PROGRESS AND OUTLOOK OF SESAME STATUS IN SOMALIA

Abdulkadir Mohamed Abikar and Omar Sheikh Mohamed

Introduction

Sesame is one of the ancient oil crops grown for its oil in Somalia. Presently, sesame is the only vegetable oilseed grown extensively, and the production potential is far from covering the country's needs for edible oil. Nevertheless, it is the most preferred vegetable oil by the Somali people.

The cakes after oil extraction are considered to be supplementary feed stuff for livestock. The dry stover of sesame is also feed stuff for livestock in dry seasons when the availability of green pasture becomes very poor. Sesame seed is utilized in confectionery preparation by the local people.

Sesame is grown as a sole crop in Der season (October-December), as a relay crop planted with maize or sorghum, or raised as a sole crop under residual soil moisture at the end of Gu season (April-June).

The local variety is characterized by various seed colors (white, reddish, brown, black). Seeds of the local variety are contained in capsules of four to eight locules with uneven seed maturity resulting in a lot of shattering.

Physical environment of the crop growing areas

Generally, the climate of Somalia is from arid to semi-arid tropics. Rainfall is low, for instance, a mean rainfall data over a seven year period at the Afgoi station shows an average of 600 mm/year, and its bimodal distribution pattern is extremely varying in space and in time, Table 1. There is no month in the year when average rainfall exceeds evapotranspiration. The risk of rainfall variability is somehow minimized by the excellent storage capacity of the deep alluvial soils in both irrigated and rainfed areas.

Production potential

Sesame is grown in the southern part of the country, particularly in the regions lying at the interriverine area. Growing regions are Lower Shebelle, Middle Shebelle, Hiran, Lower Jubba, Middle Jubba and Gedo. Table 2 indicates that about 73% of the total production is raised in Der Season. The yield does not show the national average of sesame productivity; it is overestimated.

Production practices are still traditional and the present sesame yield is low, Table 3. The resources used in the production process are not combined effectively. Thus, there is more room for substantial improvement of the input/output combinations. Yield could be increased from 0.35t to 1.0t/ha through improved practices.

Land preparation

Traditionally, large bunds of various sizes are raised by the help of buldozer. Once the bunds are raised they will last long until they are renewed. Thereafter, farmers flood water in the field and leave it to stay for about 15-30 days. After this period the field is either disc-ploughed or disc-harrowed combining the seed-bed preparation with the sowing operation.

Table 1 Mean rainfall data over a seven-year period 1977-83 at the Afgoi station near Mogadishu.

Month	Rainfall (mm) Average	Highest	Lowest
January	6.3	31	0
February	1.0	6	0
March	23.6	71	0
April	87.9	180	1
May	86.0	145	28
June	70.6	180	20
July	54.7	109	22
August	25.3	43	0
September	13.4	90	0
October	77.0	166	18
November	120.0	198	18
December	57.7	122	0
Total (Average Annual rainfall)	622	818	309

Table 2 The area under sesame crop and seasonal production of the crop growing regions in Gu and Der of 1986.

Growing regions	Cropped area ('000 ha)		Production ('000 M.T.		Yield kg/ha	
	Gu	Der	Gu	Der	Gu	Der
Hiran	2.5	4.8	1.3	2.4	520	500
Middle Shebelle	18.3	20.0	11.0	10.0	601	500
Lower Shebelle	1.9	36.7	1.0	18.3	579	499
Lower Juba	0.6	5.2	0.2	2.6	333	500
Middle Juba	0.7	5.1	0.3	2.6	429	510
Gedo	0.8	3.7	0.4	2.2	500	595
Total	24.8	75.5	14.3	38.1		

Source: Ministry of Agriculture & Dept. of Planning Statistics.

Planting method

Sowing operation is accomplished while the field is slightly wet, and seeds are broadcast behind tractor equipped with disc plough or disc harrow. If tractors are not available or the farmer cannot afford to hire, hand hoe is used for sowing operation. Seeds used by the farmer are still of the local traditional variety used for generations.

Weeding operation

Hand weeding is the only common practice farmers follow at present. One hand weeding is done if the field is disc-ploughed after flooding, otherwise two hand weedings are done.

Table 3 Area under production & productivity of sesame from 1976-1985.

Year	Area ('000 ha)	Production ('000 M.T.)	Productivity (kg/ha)
1976	117	35	299
1977	136	41	299
1978	136	40	294
1979	135	41	301
1980	128	38	300
1981	90	27	301
1982	170	57	335
1983	150	60	350
1984	150	45	300
1985	154	45	292

Source: FAO Processed Statistics Series 1984-1985. The data presented in this table is reflecting the real picture of production status of sesame in Somalia.

Irrigation method

Flooding is a method of irrigation practiced by farmers. The period of flooding in August-September takes advantage of the natural or controlled gravity of the water flow of the river.

Crop protection

Sesame webworm causes a considerable damage to sesame crop; nevertheless, chemical control measures are rarely taken by farmers. The poor management practice is one of the reasons for low yields of sesame crop in Somalia.

Seed marketing

Before January 1984, the Agricultural Development Cooperation (ADC) was the only legalized and responsible body for the purchases and sales of sesame seeds. Both the sales and producer prices were fixed by the government. In 1981 and 1982 the ADC price for sesame was 900-1200 So.Sh./quintal.

At present the sesame seed is sold to the local village oil processors using camel-driven units or expellers by small machines. The bulk of the seed is sold to private traders who operate in Mogadishu and other main towns. For sesame seed price there is no reliable statistical data but some fluctuating prices over the years Table 4.

Research on Sesame

Research activities on sesame for boosting the domestic oil crop production focused on the development of appropriate irrigation and agronomic practices. For instance, varietal trial at the Central Agricultural Research Station (CARS) did not give better results than the local variety (CARS, 1965, 68, 69; and FAO, 1975). Table 5 shows exotic varieties against the local check.

Table 4 Sesame seed prices 1980-1985.

Year	So.Sh./q
1980	400-900
1981	900-1200
1982	900-1200
1983	2000-3000
1984	5000-8000
1985	4500-6000

Source: Report on market study on vegetable oils prepared by Som. Consol-Project Studies and Management Advisory, April 1985.

Table 5. Varietal trial on sesame in GU and DER seasons.

Variety	Yield q/ha GU	Yield q/ha DER
Giza 23	3.8	1.4
Giza 24	3.8	1.0
Giza 25	3.5	1.1
Local	5.8	5.3
C.D.at 5%	1.5	0.2
Sowing date	23/4/74	10/9/74
Irrigations	3	4
Fertilizer N	100	80
P	50	50
K	50	50

Source: UNDP/FAO, 1975

Planting date & Population

Results of plant population and sowing date conducted in both Gu & Der at the Mordile Pilot Project for Irrigated Agricultural Development on the Shebelle River indicate that the Der sesame should be sown before 30 September and for the Gu sesame as early as possible in April, Tables 6 and 7.

Other results of plant population triails at the Central Agricultural Research Station indicated that 60 cm between rows and 30 cm between plants with four plants/hill gave average yields of 8 q/ha (CARS, 1984, 85 and 1986).

Fertilizer & irrigation

Experience at the Mordile Irrigation Project in 1974, indicated that yield of sesame in both Gu & Der increased with increase in levels of both nitrogen and phosphorous, Tables 8 & 9, and the optimum number of irrigations is three and four, for the Gu & Der, respectively, Table 10.

Table 6 Mean seed yield in q/ha of sowing date x plant population trial on sesame GU season.

Hills Number	Spacing (cm)	Sowing dates 15/4/74	1/5/74	15/5/74	Mean
26000	50	5.6	6.0	5.8	5.8
33000	40	7.3	6.9	6.6	6.9
44000	30	8.2	7.8	8.0	8.0
Mean		7.0	6.9	6.8	-

- Variety:local; fertilizer: N100-P50-K50 kg/ha; Irrigations: 3; Row spacing: 75 cm; 8-10 plants/hill.
- Differences due to sowing dates: not significant
- Interaction: not significant
- Population: significant; C.D. for population at 5%: 0.3 q/ha.
- Source: UNDP/FAO, 1975.

Table 7 Mean seed yield in q/ha of sowing date and population trial in sesame DER season.

Population/ha	Sowing dates 20/8/74	10/9/74	30/9/74	Mean
P1 200 000	3.4	3.5	2.6	3.2
P2 300 000	4.0	3.8	3.6	3.8
P3 400 000	4.6	4.7	4.2	4.5
Mean	4.0	4.0	3.4	-

- Variety:local; Fertilizer: N80-P50-K50 kg/ha; Irrigations: 3: row spacing: 75 cm.
- C.D. at 5% level for sowing date and population: 0.2 q/ha.
- Interaction: not significant.
- Source: UNDP/FAO, 1975

Table 8 Mean seed yield in q/ha of N-P fertilizer trial on sesame Gu season.

levels kg/ha	N0	N50	N100	N150	Mean
P0	3.3	4.1	5.3	5.8	4.6
P50	3.3	4.6	5.8	6.4	5.0
P100	3.4	5.1	6.6	7.0	5.5
Mean	3.3	4.6	5.9	6.4	-

- Variety:Local, Sowing date: 23/4/74, K50 kg/ha, Irrigations 3.
- Differences due to N and P: significant
- Interaction: not significant
- C.D. at 5% for N: 0.4 q/ha N150 N100 N50 N0
- C.D. at 5% for P: 0.4 q/ha P100 P50 P0
- Source: UNDP/FAO, 1975.

Table 9 Mean seed yield in q/ha of N-P fertilizer trial on sesame Der season.

Treatments	N0	N50	N100	N150	Mean
P0	1.9	3.5	4.4	4.6	3.6
P50	2.5	3.9	4.7	5.1	4.0
P100	2.7	4.5	5.4	5.8	4.6
Mean	2.4	3.9	4.8	5.2	-

- Variety:Local, Sowing date: 10/9/74, Irrigations: 4.
- C.D. at 5% level for nitrogen : 0.2 q/ha N150 N100 N50 N0
  for Phosphorus: 0.2 q/ha P100 P50 P0
- Interaction: not significant.

Table 10 Irrigation trial on sesame Gu season.

Irrigations		Yield	Remarks
Frequency	Age (days) of application		
A - 1	40	5.0	Differences: significant
B - 2	30, 50	6.1	C.D. at 5%: 1.3 q/ha
C - 3	15, 30, 50	7.0	
D - 4	15, 30, 50, 70	7.9	D C B A

- Variety:Local, N100, P50 and K50 kg/ha, Sowing date: 20/4/74.
- Source: UNDP/FAO, 1975.

Weed control

Presently, hand weeding is the only practice to control weeds in sesame crop.

Pests & Diseases

In the area of diseases nothing has been done, but experience at the Central Agricultural Research Station have shown that the pesticide "Carbaryl" controls sesame webworms.

Conclusions

Generally, oilseed research in Somalia was inconsistent and inconclusive, partly because of discountinuity of research work and insufficient funds to carry on effective research work. So far, research on sesame is limited to increase yield of the local variety through agronomic practices. Nevertheless, inherent low yielding ability of the local variety, problems of seed shattering and uneven maturity are slowing down production potential of the crop.

Recently a need to develop a high yielding variety having field tollerance to major pests and diseases of economic importance, through screening techniques have come into existence at CARS. For this purpose, we started sesame germplasm collection from the crop growing regions by the help of oilseeds Network of the International Development Research Center (IDRC).

We are very grateful to the International Development Research Center for continuing to support oilseed research programs so as to ensure sufficient production of edible oils in Somalia. Presently the country relies on imported edible oils which are unlikely to be sustained at the present level. Table 11 shows imported edible oils.

Table 11. Imported edible oils 1980-1984.

Year	Quantity (Mt)	Value ('000 So. Sh.)
1980	12599	151.661
1981	19834	49.350
1982	7232	72.906
1983	12152	79.478
1984	82734	555.232

Source: Ministry of National Planning Statistics Dept.

Proposed Future Research Plan for irrigated and Rainfed Areas

The major objective is to develope high yielding varieties of sesame, groundnut and other oilseed crops (safflower and sunflower) having tolerance to major pests and diseases of economic importance.

The preliminary research work includes:

1. Germplasm collection of local varieties (sesame & groundnut).
2. International variety trial against local varieties.
3. Agronomic studies on the promising oilseed crops (optimum planting date, plant density, planting and harvesting methods, fertilizer and water requirement and weed control).
4. Economic evaluation of the promising oilseed crops under farmers condition and their suitability into improved cropping systems (rotation, sequencial cropping and intercropping).
5. Oil extraction processes (suitable methods of oil extraction, oil content and quality of the promising oil crops).

Sesame and groundnut improvement through breeding program is included in the future plan. This program will be started after thoroughly evaluating the benefits of the preliminary research work.

To achieve the above and to facilitate the preliminary research work, we request the International Development Research Center (IDRC) to continue its financial and technical support that are needed to run the oilseed research in Somalia. The following are the general aspects of the assistance we need:

1. Post-graduate training for researchers involved in the program (M.Sc and Ph.D).
2. In-service training for field technical staff.
3. Transport facilities.
4. Field research equipment and facilities.
5. Incentives for researchers and field technical staff involved in the oilseed research program.

We believe that the IDRC will assist Somalia in her efforts to produce edible oils and we are certain that the IDRC will accept the proposed oilseed project taking into consideration the shortage of edible oilseed in the country.

Finally, a detailed joint research program can be worked out by the Directorate of Research and the Regional Oilcrops Network Consultant.

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SESAME RESEARCH IN TANZANIA: PROBLEMS AND RESEARCH HIGHLIGHTS

J.Y. Chambi

Abstract

In Tanzania, sesame yields have remained as low as 200 kg/ha. This crop is mostly produced by poor farmers who cannot afford to buy expensive inputs such as pesticides and fertilizers. Because of the fluctuation in yields and the low returns, this crop is not getting the attention it deserves from better off farmers who invest in other crops. In order to solve this peoblem, it is necessary to develop low cost production techniques including cultivars resistant to the key diseases and insect pests with improved yielding potentials and adaptability to the areas of production. Problems affecting improved production and the research findings aimed to solve them are summarised.

Introduction

Sesame (Sesamum indicum L) yields in Tanzania have remained low, estimated average of 200 kg/ha with a range of 120-400 kg/ha. This is a cause for concern because of the rising demand for edible oil in the country and also many small oil mills dependent on sesame seeds are facing an acute shortage of raw materials.

The low level of productivity of this crop is attributed to the following factors:

1. The farmers are still using mediocre low yielding cultivars as these are more adapted to the farmers conditions than improved ones.

2. Disease and insect pests cause a large proportion of yield reduction because farmers do not use pesticides.

3. Sesame is grown in arid areas with low and erratic rainfall.

4. Sesame is predominantly grown in combination with food crops such as tall and late maturing sorghums, and sesame is treated as a minor crop. In addition, sesame is sown by broadcasting the seed on a poorly prepared seedbed with the inherent problems of establishing a uniform plant stand.

Because of low yields and unreliable returns, this crop has failed to attract better off farmers who can afford to invest in costly inputs such as pesticides and fertilizers and improved production techniques. This situation is not likely to change much unless better methods of production which can gurantee higher returns comparable to those of alternative crops can be provided.

In this paper a summary of results of research work aimed to solve some of these problems are presented.

Results

Selection and evaluation of varieties

Weather, particularly rainfall has an important influence on crop growth, the kind of varieties that can be grown and the development of diseases and insect pest. In this respect, the main sesame-producing areas were divided into two main agroecological zones on the basis of the prevailing pattern and duration of rains during the growing season as shown in Figure 1. A large number of sesame cultivars has been assembled and evaluated for yield and adaptability to the two agro-ecological zones in addition to other useful characters.

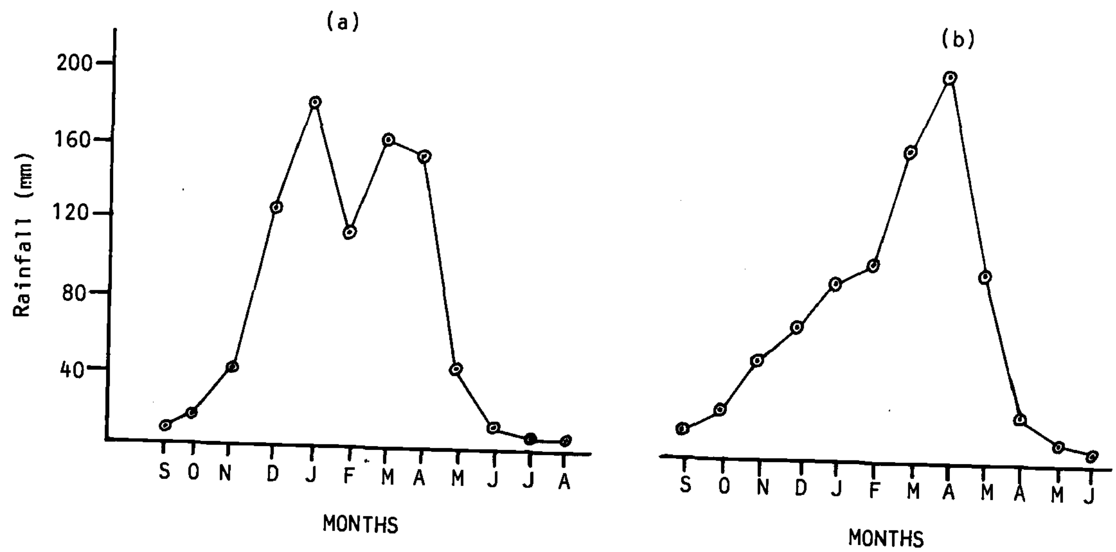

Figure 1. Forty year average monthly rainfall totals:
(a) Mtwara (Mikindani) - Long season zone in the south east.
(b) Morogoro - Short season zone in the north.

Based on this evaluation, cultivars were divided into four main groups:

a. Late maturing cultivars: These are mostly traditional cultivars characterised by tall plants (up to 2m), profusely branched and maturing in about 130-150 days. This group is inherently low yielding but strongly drought tolerant.

b. Medium maturing cultivars: These are improved local cultivars derived from Morada x Local backcross selections showing a high degree of variability in many characters, and having high yielding potential than the cultivars in group (a) with a reasonable level of drought tolerance. They have a medium height and they mature in 110-130 days.

c. Early maturing cultivars: These are introduced varieties characterised by short and compact growth habits. They mature in 90-100 days and have a higher yielding potential than (a) and (b), but they are more susceptible to drought particularly during the reproductive phase.

d. Extra-early maturing cultivars: These are also introduced varieties with a short stature (0.75m or less) and a compact growth habit. They mature in 70-85 days and they have a good yield potential. However, they are very susceptible to drought in all stages of growth.

It was proposed that with this wide range of maturity periods, it would be possible to utilize fully the growing season particularly in the south-east using relay cropping and a short term sesame cultivar in the cropping system. Similarly, the frequent January/February dry spells could be avoided by sowing early maturing cultivar after the drought. An experiment to determine the optimum sowing date and the effect of delyed sowing on cultivars differing in maturity periods was conducted in 1978-79 and 1979-80 seasons. Data for the first season is presented in Table 1. In this season an early season drought December/January prevented earlier sowing date (planned 20 Dec, 1978).

Table 1. Sesame date of sowing; mean yield (kg/ha) 1978-79.

Variety	Maturity (days)	Date of sowing 20/1	9/2	23/2	9/3	24/3
Morada-2	115	767	641	626	284	46
USA-271	125	797	743	581	391	78
USA-197	90	763	809	619	345	156
Local	140	603	464	372	12	6
Mean		732	664	549	258	71
SE Sowing dates	±29.0					
CV	26 %					

The data presented indicate that early sown crops had higher yields than the late sown ones. Also, the late maturing cultivar was more sensitive to late sowing than the early maturing ones. However, the early sown crops were exposed to a large number of the flea beetle (Alocypha bimaculata) and therefore the use of insecticides once weekly for more than 5 weeks after germination was necessary. Later on in the season, the population of flea beetle was much lower allowing a good crop establishment without protective measures. Farmers sow their sesame crops late probably due to the same reasons. Moreover, the early maturing cultivars matures before the end of the rains creating harvesting problems and the incidence of Cercoseptoria sesami was higher on late sown crops.

Based on these results and other observations, it was concluded that the best variety for south-eastern Tanzania should have a minimum maturity period of 130 days with an optimum sowing date of late December/early January. The problem of developping such a variety arises from the fact that plants in this maturity group are naturally tall with more vegetative growth and less seed production. In the north and north-eastern part of the country, early maturing cultivars (90-110 days) fit well in the rainy season; but due to frequent dry spells during the growing season such cultivars should possess strong drought tolerant characters. A hybridization program was initiated in 1982-83 in an attempt to develop the required type of variety; some plants in F4, derived from this program, appear to be promising although they are still far short of the desired goal.

Disease problems

In the south-east, diseases of economic importance are fungal leaf spots particularly those of Cercoseptoria sesami, bacterial blight (Xanthomonas sesami), and leaf curl virus. Pseudomonas sesame has also been reported (Auckland 1981). C.sesami is widely distributed and appears every season but becomes very serious in a continuous wet weather.

Table 2 presents the results of the experiment showing the relative importance of this disease on 5 cultivars. Fungicides used were chlothalonil (as Daconil) and Maneb (as Dithane M-45).

Table 2. Sesame yield loss assessment; seed yields (kg/ha) 1983-84.

Variety	Maturity (days)	Seed yield With fungicide	Seed yield No fungicide	Relative yield loss %
Nal.79.111.9	90	973	714	27
Maporal	90	686	354	48
SSBS 7	130	607	338	44
28.759.1.2	130	544	326	40
Chihangu (Local)	140	397	319	20
Mean		641	410	36
SE Fungicide Mean		±26.4		
CV		21%		

There was a significant loss of yield (36%) between the control and spray treatments. In spite of the fact that the local cultivar (Chihangu) was generally low yielding, it appeared to have a better tolerance to this disease as indicated by the low relative yield loss. Several varieties have been found to have some degree of tolerance to this disease. These include Nal.79.111.9, Bora (commercial variety) and 79.309.16. These are being used in a breeding program to incorpate resistance/tolerance to Xanthomonas sesami from another breeding line (SPS 80.8) which is susceptible to Cercoseptoria. However, breeding for resistance to bacterial blight (Xanthomonas) is making a slow progress since it depends on natural inoculum in the field which is not always uniform on test materials. Leaf curl virus is potentially dangerous but does not appear frequently. In the 1982-83 season it caused an estimated loss of 20% on experimental materials. In the north and north-east powdery mildew (Oidium sp) has attained prominence. No previous studies have been conducted on this disease, and hence a large number of cultivars will be screened this season.

Insect pests

The sesame flea beetle (Alocypha bimaculata) is by far the most important pest in south-eastern Tanzania. If this pest is not controlled it can cause 100% loss to early sown crops. Currently, use of insecticides sprayed once weekly for more than five weeks after germination is recommended. However, this method is expensive and beyond the economic reach of the small farmer. Emphasis is now given to the study of the biology and ecology of this pest inorder to develop cultural methods which may be more convenient to the small farmer.

Aphids and mites (Hermitarsonemum sp) are serious pests in the north and north-east particularly during prolonged dry spells. The commercial cultivar Bora was developed by mass selection from Morada-2. This cultivar (Bora) is composed of two populations differing mainly in the degree of hairiness. In the 1986-87 season, a high incidence of mites attacked the glabrous plants of this variety exclusively while the more hairy type was not affected indicating that it may be possible to develop varieties resistant to this pest. A similar mechanism of resistance to white flies (Bemisia tabaci) have been reported (Van Rehenen 1974).

Conclusion

The position of the farmer, who is the recipient of our research findings and recommendations, dictates that we develop low cost techniques for sesame production. These techniques include the development and use of resistant cultivars to the key pests and diseases. Such varieties should be well adapted to the agro-ecological and management conditions in which they will be used.

This is a goal which may be difficult to achieve by using conventional breeding procedures. It requires continuous inputs of a large number of new genotypes. At Naliendele, we realize that to develop a variety which can remotely ressemble the ideal type in this situation will require a team work approach and the co-operation of other researchers working on similar problems elsewhere.

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SUNFLOWER PRODUCTION: PROBLEMS AND RESEARCH PROGRESS IN TANZANIA

A.B.C. Mbiza

Introduction

Sunflower is thought to be introduced in east Africa early in this century and particularly the southern zone of Tanzania is suggested as a centre of secondary diversity. Currently sunflower is widely grown in almost all regions of the country. The diverse potentiality, low labour requirement and the relative drought hardiness contribute to its popularity among farmers.

The crop contributes significantly to the oil industry together with cottonseed, coconut, sesame and groundnuts. It is also grown for domestic uses. Prior to the 1970s official efforts to encourage sunflower production were viewed in terms of export gains. For example, in the early 1970s Tanzania was a net exporter of 14,800t oil equivalents per annum but by 1976-77 it was a net importer of 4,300t oil equivalents per annum. This drastic change was attributed mainly to the reduced production of both cottonseed and coconuts which are most important oilseed crops in Tanzania. Although it is not possible to alleviate easily the situation of these two major crops so as to meet the increasing demand for edible oil, much attention has been paid to sunflower because of its being more promising than sesame which has limited expansion possibilities.

Thus, problems of sunflower production together with the importance of the crop as a source of edible oil necessitated urgent and appropriate research work. Although research work on oil crops started early in Tanzania, it was neither continuous nor well financed, particularly when compared to grain legumes. In view of this, the Sunflower Research Project supported by Overseas Development Administration (ODA) of the British Government was effectively started in 1985 at Ilonga Agricultural Research Institute. We hope that the project will be able to fulfill our national objectives by improving and strengthening the oil industry.

Production Trends

In terms of official purchases, sunflower production has been increasing over the past four years. However, prior to this period, the production was drastically decreasing. This is evident from the data of the total regional purchases of sunflower presented by the General Agricultural Products Export Corporation (GAPEC), Table 1. In the season 1986/87 the purchase was expected to be 14,500 tonnes of sunflower. However, this data is not a ture reflection of the country's total sunflower production, since a large part of the production is domestically processed into oil (especially in Iringa) instead of being sold to the official buyers. It suffices here to indicate the increasing trend in production over the period. In the year 1985/86 purchases have been done by co-operatives after the dissolution of the parastatal.

Main Areas of Sunflower Production

In Tanzania, sunflower is produced largerly as a cash crop. It grows in a wide range of altitudes (500-1600m a.s.l.). The crop is mainly produced on small holdings by farmers who commonly intercrop it with maize, sorghum and other crops. Some farmers grow it in pure stand and a small proportion is produced on large-scale farming in private holdings. Although the crop is widely distributed all over Tanzania, the main areas of production are Dodoma, Singida, Morogoro, Iringa, Shinyanga, Ruvuma and Tabora regions. According to GAPEC/Co-operatives

Table 1. Regional purchases of sunflower seed (tonnes) from 1979/80 to 1985/86.

	Seasons						
Regions	79/80	89/81	81/82	82/83	83/84	84/85	85/86
Morogoro	1467	1357	1191	499.1	168.0	286.8	277.9
Dodoma	5107	2469	1540	686.3	1120.0	1588.9	2318.0
Singida	1769	2507	2628	2579.1	1877.0	3429.0	3773.5
Iringa	2697	1647	1157	119.6	150.0	322.8	687.1
Mbeya	266	190	35	0.6	118.0	6.7	25.7
Rukwa	102	362	44	2.7	5.0	7.6	4.1
Ruvuma	264	48	314	239.9	233.0	70.4	1166.2
Lindi	776	2	1	1.2	0.3	0.7	0.6
Mtwara	606	5	2	0.3	-	0.4	3.0
Kigoma	-	-	18	17.1	9.0	-	2.0
Tabora	1689	1236	583	522.9	239.0	464.8	575.7
Shinyanga	2000	2092	1243	703.4	503.0	638.1	1126.1
Mwanza	806	342	389	209.0	49.0	109.3	337.2
Mara	-	-	13	11.7	6.0	65.5	5.9
Kagera	-	-	12	0.5	-	-	-
Tanga	161	25	12	27.3	7.0	3.0	2.5
Kilimanjaro	56	69	5	1.3	-	-	0.3
Arusha	335	373	184	73.3	50.0	108.5	207.7
TOTAL	18,101	12,724	9,371	5,716.3	4,534.3	7,102.3	10,513.5

Source: GAPEC/CUT.

data, most of the purchase have been dirived from Singida and Dodoma with 3,429.0 and 1,588.9 tonnes in 1984/85 and 3,773.5 and 2,318.0 tonnes in 1985/86 respectively.

Sunflower Utilization

Sunflower is one of the major sources of edible oils in Tanzania. At present it ranks second after cottonseed followed by coconut. Other sources include sesame, groundnuts, soybean and oilpalm although the latter two are of minor importance in Tanzania and for groundnuts much of the production is consumed whole. Domestically, sunflower is processed to extract oil by a hot water floatation method. This practice has increased tremendously since the mid 1970s when the shortage of cooking oils became acute. The method involves the heating of sunflower seed until it becomes hard and brittle, pounding the hot seed followed by continuous sieving to obtain a very fine flour. Then the fine flour is boiled with water for about six hours until the oil emerges and floats on the surface. The oil is skimmed off or alternatively the boiling continues until all the water evaporates leaving behind oil and residues.

This is a practice throughout Iringa which has increased quite remarkably over the past five years resulting in a very little sunflower seed left for the official buyers. Recently this practice has also been started in Dodoma and is spreading throughout Singida. However, the oil produced by this method is thoutht to have poor storing qualities and should therefore be consumed shortly after processing.

Apart from cooking, the oil can be used in the manufacture of margerine and in the production of paints. The seed cake left after oil extraction can be used as animal feed. In Europe and America sunflower seed is also used as bird seed. Alternatively the whole kernel can be used as food or can be pounded to produce a high protein flour.

To facilitate domestic oil extractions, the Institute of Production Innovation (IPI) at the University of Dar es Salaam has developed hand-operated oil presses and seed decorticators in two sizes. Among these, the larger press has a capacity of 100 kg of seed in an 8 hour day, with two strong men. The smaller press has a capacity of press 30 kg of seed per day. Also the Dutch government has supplied 9 small German-built expellers to the Small Industries Development Organization (SIDO) estates and are considering to import hand-operated machines in Arusha region. There is a village sunflower project started by the support of the Appropriate Technology International/Lutheran World Relief and the Ministry of Agriculture so as to provide hand-operated sunflower oilseed pressing machinery and other technical support to farmers. This Project has developed another type of hard press, the Bielenberg ram press, which is smaller and less complex than the IPI machinery. It has the capacity to press 50 kg sunflower seed per day.

Farmers' Constraints in the Production of Sunflower

As the crop is mainly produced on small holdings, there are some problems associated with its production and leading to its low yield. One of the major constraints is insufficient markets. The sole official purchaser of the crop was GAPEC now substituted by the regional co-operatives after the dissolution of the former. The purchasing prices offered to farmers are relatively low, thus, forcing them to process their produce at home or sell it to unofficial buyers who are willing to offer higher prices. This could also force the farmer to decrease the sunflower acreage in the subsequent years.

Lack of improved seeds which are high yielding and resistant to diseases is the other constraint. Local varieties are low yielding and vulnerable to many diseases. Moreover, these local varieties have mixed seed colors which can lower their prices in the market.

Another problem is that of diseases and pests. Birds and rats have been the major pests, but American bollworm (Heliothis armigera) has become a serious pest in some areas. Rats dig up and eat sown seeds thus leading to poor plant stands while bird attack starts from seed filling and may continue up to harvesting.

Diseases such as rugose mosaic and yellow ring spot, both with virus symptoms, are common in Morogoro, Kilimanjaro and Singida region where they cause considerable yield losses. Rust is serious in Singida, Dodoma and Arusha regions while Sclerotinia head or stem rot is mainly found in Iringa and Arusha regions. In the southern highlands (Iringa and Mbeya) and Singida Septoria leaf spot is a major disease. At Suluti (Songea) in Ruvuma region the serious disease problems experienced are Alternaria and Septoria leaf spots.

How These Constraints Are Being Combated

In an attempt to overcome the problem of markets farmers have resorted to domestic extraction of oil from sunflower seed. This enables them to obtain cooking oil and thus reserve some income which could be used to buy the same commodity.

Regarding improved seeds, Tanzania Seed Company (TANSEED) and Regional Seed Farms are making efforts to multiply and distribute them to farmers. Currently two improved varieties, Jupiter and Record, are produced and distributed by TANSEED. Jupiter is a non-oilseed variety with grey and white striped seed of a fairy uniform size suitable for export market. Record is a variety with a high oil content, black and grey-striped seeds and has lower seed yield potential than Jupiter. Oil content for Record ranges from 34 to 48 per cent depending on growing conditions in many parts of Tanzania. In Morogoro, research activities are going on at Ilongo Agricultural Research Institute. These activities include the breeding of high oil content, disease resistant and high seed yielding varieties which are well adapted to the diverse growing conditions of Tanzania. If a variety combining all these desired qualities could be achieved it will highly contribute to the combating of the constraints described above.

Research Progress

Background:

Sunflower research in Tanzania has a tendency towards being intermittent and localised. In 1978 a national program was started under the Oilseed Research Project based at Naliendele Agricultural Research Institute (Mtwara). The work comprised the introduction of exotic varieties, nationally distributed variety trials and agronomy trials at Naliendele and the two substations: Nachingwea and Suluti. An Naliendele, there were severe difficulties and most of the imported material got lost due to failure in establishment. This led to the abandonment of variety introduction in 1980. Suluti (Ruvuma region) continued to be the site for sunflower trials because the crop grew well there.

From 1981 to 1984 the sunflower research at Suluti has concentrated on agronomy trials and the evaluation of local sunflower accessions from Ruvuma, Iringa and Morogoro regions. A limited number of exotic varieties were continued to be tested nationally at different sites. Many local accessions outyielded Record (the commercially available variety) in terms of seed yield but all had lower oil contents. Fertilizer trials showed linear response to nitorgen up to 80 kg/ha (in one instance seed yield increased from 386 to 1284 kg/ha with split application).

In January 1985 the sunflower researh was transfered to Ilonga Agricultural Research Institute which is centrally located and related to the main areas of production.

Research objectives

The sunflower research has four main objectives:-

a. to identify and produce sunflower varieties adapted to conditions in the main production areas of Tanzania, with high oil content and high yield potential, good resistance to disease and desirable agronomic characteristics,

b. to find the recent methods of growing sunflower, the constraints of production and the types of improved varieties required by farmers,

c. to identify best cultural practices for each of the small holder and estate sunflower growers, and

d. to identify important disease and pest problems and find appropriate methods of control.

These objectives are diverse in nature but are necessary since the research conducted on sunflower to date is limited.

Current research activities at Ilonga

The sunflower research at Ilonga Agricultural Research Institute was effectively started in 1985 following the transfer of the project from Suluti. The research involves open-pollinated varieties rather than hybrids due to some problems associated with hybrids e.g. seed production and maintainance. The work on sunflower breeding, agronomy and the identification of serious diseases and pests are in progress.

Concerning the breeding activities, variety evaluation trials are being done to evaluate some new introductions obtained from different countries e.g. Zambia, Canada, Europe, Kenya, Malawi, Argentina and the U.S.S.R. Regional Variety Trials (RVT) are also being conducted to assess the performance of promising varieties under Tanzania's diverse growing conditions. In the 1986/87 season breeders variety evaluation trial were conducted at different sites. In terms of seed yield, variety CCA 75 was the best performer accross locations, Table 2. In the Regional Variety Trials at six sites CCA 75 was found to be the best performer followed by CCA 81, Table 3. In all trials the design used was randomised complete block design (RCBD) and the plot sizes were 3.75m x 6.0m and 2.25m x 5.4m for gross and net plots respectively. Sowing was done at a spacing of 75 cm between rows and 30 cm between plants.

On the agronomy side, much attention has been paid to both trial programs and farm visits for surveying of disease, pests and other problems facing farmers. The programs include sunflower fertilizer trials, harvesting method evaluation, sunflower/sorghum intercropping, assessment of sunflower as a crop to precede maize, studies on the incidence of virus symptoms, optimum plant density, spacing and arrangement of sunflower etc.

Apart from these activities, seed multiplication also continues at Ilonga, Suluti and Njombe and a selection program is being carried out. This involves selection within variety CCA 75 (a Zambian composite) for uniformly colored seed. The composite is bred in Zambia and contains a mixture of seed colors. This, however, cannot be released as a recommended variety in Tanzania as it doesn't conform to the national seed release requirements.

Results of variety trials from the past two seasons indicate that variety Ko 30A (a Kenyan confectionery variety) gives high seed yield with a maximum oil content of 36% of dry matter. Variety CCA 75 from Zambia gives reasonably high yield of both seed and oil with a maximum oil content of 40% of dry matter. On the other hand, although variety Record has been shown to give a relatively low seed yield, it has high oil content of up to 50% of dry matter depending on its growing conditions. So far, no single variety has been known as high yielding in terms of both seed and oil.

Table 2. Breeders variety evaluation trials summary of seed yield (kg/ha) for 5 sites, 1986/87.

Variety	Arusha	Ismani	Mdoleia	Suluti	Ilonga	Mean across locations
Black Chalowe	1705	1541	1033	709	753	1148
Mangandale	1431	1015	1142	661	742	998
Kilagwa	1729	1414	1006	459	577	1037
CCD 85	1584	1546	1782	803	651	1273
CCD 84	951	1402	1532	792	663	1068
CS 85-2	1501	1606	1549	867	695	1244
CS 85-4	1592	1557	1612	592	545	1180
CCA 85	1298	1619	1718	820	669	1225
AC 1140	1151	1252	753	405	501	812
AC 1144	703	1906	928	418	758	743
Pehuen INTA	1265	1430	1073	629	725	1024
Zelenka	1192	1294	1089	517	552	929
Majak	1359	1596	1310	479	712	1091
Armavirsky	1674	1345	1491	512	648	1134
Record	1613	1623	1135	684	778	1167
CCA 75	1760	1969	2170	556	781	1447
Mean	1407	1445	1333	619	672	
SE	142.22	191.49	141.88	68.71	73.22	
CV %	20.2	26.5	21.4	22.2	21.8	

Table 3. Regional variety trials summary of seed yield (kg/ha for 6 sites 1986/87.

Variety	Arusha	Ilonga	Hombolo	Ismani	Ndoleia	Suluti	Mean across locations
CCA 81	1847	1179	1243	1550	1992	826	1440
CCA 81-2	1502	720	1440	1379	1712	878	1284
Impria INTA	1540	1301	1415	1554	1466	838	1352
Record	1438	956	1394	1449	1411	739	1231
CCA 75	1842	1106	1520	1662	1836	806	1470
KO 31A	1698	1235	1582	1010	1808	787	1353
Jupiter	1443	1236	1154	1552	1719	919	1337
Local	1302	1072	1420	883	2020	982	1307
Mean	1576	1109	1396	1380	1752	846	
SE	131.40	107.08	108.14	128.32	123.68	54.66	
C.V. %	18.3	21.6	21.0	20.8	15.8	14.4	

Problems

The main problem faced by the sunflower research project is the inadequate staff position. The few staff cannot cater for the large amount of work required. However the staff position is slowly improving. Another problem is that of transport. This has been a serious problem for the past two years hindering the movement of staff members to assess research activities in different locations. Nevertheless this problem, too, is being gradually solved. The relatively small number of breeding materials available is also a major problem. Presently, there are less than ninety varieties available for breeding and these are inadequate as compared to the diverse objectives to be achieved.

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SUNFLOWER RESEARCH PROGRAM IN ZAMBIA: PRESENT STATE AND ACHIEVEMENTS

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Abstract

The organizational structure, functions, and achievements of the sunflower research program in Zambia are discussed, in the perspective of promoting crop production to attain selfsufficiency in cooking oil. The program follows a multidisciplinary approach involving breeding, plant pathology, agronomy and extension. All these disciplines share a common goal of promoting sunflower prduction although they have specific strategies to address the objective. Through the efforts of the program sunflower production increased from 124 mt in 1973 to about 30,000 mt in 1987, indicating the significant impact of the program. Seed yields increased from the potential of 1.5 to 2.5 mt/ha, which corresponded to an increase from 500 to 800 kg/ha on small-scale farmers' fields. The oil content of varieties was increased from 32% to 40%. Disease tolerance has been introduced in breeding populations and some varieties under cultivation.

Introduction

Sunflower (Helianthus annuus) was recognized as a potentially viable cash crop for small-scale farmers in Zambia as early as the 1960's because of the fact that it had more general application and could be locally processed into high value products. Until then the crop was grown mainly as a poultry food and ornamental crop (Anon., 1961). In the same period (1961) the Ministry of Agriculture started varietal trials of sunflower on a limited scale as a way of promoting the crop (Bosse, 1961). Although documents on the progress of sunflower between 1963 and 1970 are lacking, the Zambian government has recognized the need of oilseed crops in the country and started the National Oilseeds Development Program (NODP) with the help of UNDP/FAO in 1972. The program aims at enhancing the progress towards self-sufficiency in oilseeds through developing, providing and promoting the cultivation of improved oilseed crop (sunflower, groundnuts and soybean) cultivars, developing and providing cultural practices packages for economic production and indeed developing supportive infrastructure for the research, seed production and extension undertakings.

Through the efforts in the program the production of sunflower has increased from 124 mt in 1972 to 45,000 mt in 1985 (F.A.O., 1986) with the current production of around 30,000 mt. Most of the production (>90%) is carried out by small-scale farmers. This increase is directly related to the achievements of the program in providing the appropriate and improved crop varieties and production technologies resulting in popularization of the crop. Currently, sunflower is the major source of cooking oil and the second most important source of livestock feed.

This paper describes the Zambian sunflower program in relation to its present organizational status, functioning and achievements.

Program Structure

The program includes breeding, agronomy, pathology and extension components. Each of these disciplines complements the others in the overall objective of generating technologies that improve seed yield and oil content of sunflower by adopting a multidisciplinary research approach.

Breeding

The breeding component is responsible for the introduction and screening of germplasm, forming breeding populations, and initiating selection programs to identify superior material. Characteristics sought for are high grain yielding ability, high oil content, reduced plant height, and disease resistance. The germplasm in the program comprises materials from temperate and tropical regions. The Zambian collection is predominantly tropical, slightly diluted by the temperate material. Although the tropical material is characterized by vigorous, tall and late maturing plants possessing seeds with thick husk and low oil content, it has a good adaptability. The temperate material, on the other hand, lacks in its adaptability and is highly susceptible to diseases though it has a very high oil content. These materials have been conveniently grouped into breeding populations on which all breeding activities are centered.

Selection is carried out using the recurrent selection method for general and specific combining ability with four generations in two years. Testers of temperate and tropical background on cytoplasmic male sterility are used, and top crosses obtained are evaluated in multilocation trials (Evaluation = EVT. Primary = PT and Preliminary = PVT) in the country. Selection is population specific addressing specific objectives.

Agronomy

The major objectives of agronomy are to identify the potential yields of sunflower under various environments and management conditions to identify constraints affecting potential yields, to generate appropriate cultural practice packages for economic production and to promote the adoption of these appropriate packages by farmers in conjunction with extention service, ARPT, and industry. The agronomic research activities include verification trials (National Variety Trial = NVT and on-farm trials) and investigational trials addressing specific production practice constraints and providing new information for improved production.

Pathology

Monitoring of important diseases, assessing yield losses due to diseases and adopting appropriate screening and selection strategy to address the disease constitute the major activities in plant pathology.

Extension

The information packages from the agronomists and pathologists are disseminated to farmers by the extension personnel. The involvement of the extension expert in the program was to facilitate the linkage between research and farmers.

Functioning of the Program

By adopting a multidisciplinary research approach, all the disciplines mentioned above work on the same materials, but at different stages of the development of the material. Essentially materials are exchanged among the different disciplines.

Breeding

Germplasm materials are obtained through exchange with other research institutions or by request from research institutions, seed companies and/or international organizations e.g. FAO. The material is screened at the headquarters of the Sunflower Research Program (Mt. Makulu Research Station, Chilanga). As a means of maintaining the germplasm, materials with desirable characteristics are composited into complex populations. These populations are subjected to selection for superior material through recurrent selection. The tester of temperate background is used with populations of tropical material and vice versa.

The output of the selection program is sets of inbred lines that are subsequently used in hybrid combinations and/or composited into open-pollinated varieties. At this stage, the material in hybrid combinations or composite varieties passes to verification trials. Traditionally 10% selection pressure is employed, but about 1% of the evaluated material qualifies for verification trials.

Another function accomplished here is that of maintanance breeding to keep elite stock of materials (breeder seed) that are commercially grown.

Agronomy

Breeders usually handle large numbers of materials and hence the testing is conducted at few locations. This is due to the limitation of facilities which is a characteristic of most breeding experiments. To further test these materials, verification trials are required. In the Zambian program these are in four stages, namely: Primary Variety Trial, Preliminary Variety Trial, National Variety Trial (NVT) and on-farm trials.

Primary Variety Trials are conducted over four to six locations and include 50 to 75 entries. Being the first step in the verification trials, emphasis is given to outstanding performances in terms of yield, of the recommended varieties. Materials proving superior in these trials are passed on to the preliminary variety trials which include only 25 entries but are conducted at 10 to 12 locations across the country. The movement of material from primary to preliminary trials is based on satisfactory superior performance over two years or outstanding performance in one year. Good performing material are passed on to NVT which includes 16 entries and is conducted at 12 to 16 locations across the country. This constitutes the final and general verification test before the on-farm trials which involve one or two entries and a check i.e. the recommended variety, and are area specific. These are conducted at many locations (farms) and are usually conducted in conjunction with farming system research team (Adaptive Research Planning Team ARPT) agronomists. This stage of testing constitutes an important aspect towards the final formulation of the cultural practices recommendations and indeed in the decision of appropriate variety to be recommended for release.

The agronomic research activities also include carrying out experiments aimed at answering production constraint(s). In the past, experiments on planting date, weeding frequency and timing, fertilization and variety choice have been conducted. Additionally investigational experiments are conducted to address new areas such as the importance of boron in sunflower, limiting micronutrients, liming, intercropping and critical soil phosphorus and potassium level as affecting sunflower growth and development. Information from these experiments helps in the refining of production practice packages. Currently this work is made possibly by an expert (agronomist) from the USAID (Zambia Agricultural Research and Extension = ZAMARE). Though not exclusively, the agronomist's role in promoting sunflower by disseminating information and giving advise to the farming community during field days is one of his important activities.

Pathology

Concentrated efforts in this areas started in 1977 with the provision of a full-time sunflower pathologist/breeder by the Belgian Aid.

Based on an earlier survey of diseases prevalent on sunflower in Zambia, a program was initiated to select for disease resistance. As mentioned above, the material worked on here is the same as that in the breeding program. There is a close exchange of material between this program and the breeding program. Populations which were found to be weak in disease (leaf spot, *Alternaria helianthi*; leaf blotch, *Septoria helianthi*; white mold, *Sclerotinia sclerotiorum*; yellow ring spot virus or others) are divided into two and a portion is given to the pathology program while the other remains with the breeding program. Yield loss assessment is done to measure the importance of a disease.

For important disease(s) selection for resistance is initiated in the population using a modified recurrent selection. Seed yield, oil content, and other desirable characteristics are also included along with disease resistance as the selection criteria. The superior output of this program follows the same channel as that of the breeding program.

Populations with improved disease resistance are given back to the breeding program so as to continue in the selection program emphasizing seed yield and oil content along with other desirable agronomic characteristics.

In sunflower pathology, the other important activity is the development of a scoring system for the various diseases that can be used in Zambia. Besides, disease monitoring is the other activity carried out along with the advisory work on sunflower diseases.

Extension

The function of the extension is to popularize the recommended sunflower varieties and cultural practices through demonstration plots and field days.

Other Supportive Infrastructure

The functions of the sunflower research program are of little use unless they are related to what happens to the material produced.

Superior materials are released for commercial cultivation through a Variety Release Committee. After this stage the material is handed over to Zambia Seed company (ZAMSEED) for multiplication, distribution and marketing. Back-up material is retained by the program and used as breeder seed. ZAMSEED is responsible for the production of basic and certified seed.

The produce from farmers is purchased by Provincial Cooperative Unions, the National Marketing Board and/or the processing industries.

Achievements of the Program and Future Research Areas

The fact that the production of sunflower has increased from 124 mt in 1972 to about 30,000 mt at present, more than confirms the success of the sunflower research program in Zambia. Since it's inception, a total of 13 sunflower varieties have been released out of which three are currently being grown and account for over 80% of the sunflower cultivated. The potential seed yield of the old (1973) varieties was approaching 1.5 mt/ha. However, the levels for the new varieties are over 2.5 mt/ha, Table 1. Such yields compare very well with levels elsewhere in the world. Seed yields of 3.0 mt plus per ha have been recorded. Because of the introduction of new varieties, the average seed yield on farmers' field has been increased from 500 kg/ha to 700-800 kg/ha. The oil content has been improved from 28-32% to 35-44 %. On a country-wide basis the oil content is approaching 40%.

Table 1. Comparison of varieties tested in 1973, 1976 and 1986 for their seed yield and oil content.

1973 a			1976 b			1986 c		
Variety	Yield kg/ha	Oil Content %	Variety	Yield kg/ha	Oil Content %	Variety	Yield kg/ha	Oil Content %
1 K030A	1090	30.4(331)*	CCA73	1500	30.0(450)	CCA81	1102	36.9(407)
2 K112	1320	32.8(433)	CH214	1840	32.8(604)	CCA75	1172	34.9(409)
3 GOR	830	40.8(339)	CH230	1230	36.0(443)	CH258	1320	38.1(503)
4 RECORD	720	42.0(302)	GBG	1620	25.0(405)	CH284	1748	39.9(697)
5 VNIIMK8931	710	44.6(317)	K126	1160	30.1(349)	CH301	1767	38.0(671)
6 PEREDOVIK	1010	43.3(437)	VNIIMK 8931	900	38.2(344)	CH311	1595	38.3(611)
Max. Yield	1320			2100			2740	

a Oil content determined by Oleometer Source: Annual Report 1972/73 (NVT)
b Oil content determined by Sahxlet method Source: Annual Report 1974/75 (NVT)
c Oil content determined by NMR Source: Annual Report 1985/86 (NVT)
* Figures in brackets represent oil yield.

Breeding populations and inbred lines being used currently have moderate to high tolerance to Septoria and/or Alternaria leaf diseases. Several sunflower diseases of importance in the country have been described and control measures defined.

There are two processing plants in the country with a total capacity of 107,000 mt per year representing 70% of Zambia's rated crushing capacity for seed (USAID, 1987). The remainder of the crushing capacity is taken up by medium-scale and small scale processors. There are about 40 small expellers at the village level across the country who produce about 32 litres of oil per day. This participation of a wide range of processors in the extraction of oil is indicative of the success of the sunflower program.

The program, though successful, is not without constraints. One of the important problems in sunflower production is the shortage of labour at the time of planting, weeding, and harvesting. This is due to the poor relative advantage of sunflower producer price which lead to farmers attending to the crop after other cash crops.

Table 2 shows the relative advantage of sunflower producer price when compared to soybean and maize for the period between 1973 and 1987. Clearly, the producer's price of sunflower has not been favourable relative to either soybean or maize. On the other hand, soybean, the other important oilseed crop, has been priced more favourably relative to sunflower.

Table 2. Relative producer price advantages of sunflower compared to soybean and maize from 1973 to 1987.

Year	Sunflower vs Maize Index*	Sunflower vs Soybean Index	Sunflower vs Maize Index
1973	1.00	1.00	1.00
1974	1.06	1.01	1.05
1975	0.90	0.91	1.26
1976	0.85	0.66	1.28
1977	0.85	0.66	1.28
1978	0.98	0.65	1.51
1979	0.81	0.61	1.32
1980	0.78	0.57	1.36
1981	0.67	0.54	1.22
1982	0.69	0.55	1.26
1983	0.63	0.53	1.18
1984	0.62	0.46	1.02
1985	0.53	0.51	1.02
1986	0.42	0.42	0.97
1987	0.45	0.39	1.15

* Index calculated as the ratio of producer prices of the crops being compared in 1972 to producer prices of the particular year.

$$I_n = \frac{Y_n}{X_o n} \times \frac{X_o}{Y_o}$$

where X_o = Producer price of crop other than sunflower in 1972, X_n = Producer price of crop other than sunflower in the n^{th} year, Y_o = Producer price of sunflower in 1972, Y_n = Producer price in the n^{th} year.

Indeed, the sunflower program in Zambia has made significant strides towards the national goal of attaining self-sufficiency in cooking oil. However, more work is required in the areas of tolerance to new diseases, training of local staff, producing varieties for large areas with specific and unique problems (regional approach) and strengthening the various links in the promotion of production and processing.

Collaborative research is a system that the Zambian sunflower program needs to get into in order to share formally the experiences and materials of other sunflower research programs in tropical Africa. The Zambian program takes this opportunity to extend its invitations to all sunflower researchers to visit the program as an initial step in the exchange of scientific information and materials.

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AGRONOMIC CONSTRAINTS TO SUNFLOWER PRODUCTION IN ZAMBIA

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Abstract

The sunflower research program in Zambia has made some significant advances in adapting the crop to local conditions. Potential yields and oil contents are comparable with those in other sunflower producing areas of the world. On-farm yields remain low often below 500 kg/ha. Agronomic constraints that contribute to these low yields have in most cases been identified and prioritized for each of Zambia's sunflower growing regions. In some cases the constraining issues are beyond the scope of the sunflower program to deal with, but where possible, alternative technologies appropriate for the small-holders, who currently produce most of Zambia's crop, have been investigated and recommended.

Introduction

Sunflower (Helianthus annuus L.) has historically been produced in the low rainfall areas of the temperate zones. This oil crop is believed to have its origin in subtropical America. Within the past two decades several countries in the tropics and sub-tropics have initiated sunflower research. The sunflower program in Zambia is now 16 years old, and significant advances in adapting sunflower to the high rainfall, acid soils, and small-holder farming systems have been achieved.

Several levels of farmers produce sunflower in Zambia, and each is faced with a different set of agronomic constraints. When grown under medium to high management levels, sunflower yields with hybrid seed often exceed 2 mt/ha which is comparable to the top sunflower-producing areas elsewhere in the world. Oil contents average 38-42% for hybrids which is slightly below that attained in less tropical areas. Commercial and small-scale commercial farmers produce very little of Zambia's sunflower crop. Over 95% is produced by small-holders who have few or no resources to allocate to the crop. It is the constraint faced by this group of producers that will be dealt with in this paper.

Identifying and Prioritizing Constraints

The sunflower project in Zambia has been carrying out variety trials throughout the country since its inception in 1971. At first, the agronomic practices used were those known for the sunflower grown in other areas of the world. Gradually, however, through agronomic studies and a trial and error by both farmers and researchers, cultural practices have been refined and now compliment the locally-bred varieties to produce high yields in most parts of the country.

Because the breeding team often wants to know the genetic potential of their material for a given region, early generation variety trials are conducted under fairly high levels of management. As these trials are carried out year after year in all of the agro-ecological zones of Zambia, agronomists are given a fairly clear picture of the potential yield of sunflower for that region. By conducting on-farm surveys in the same region, data on farmers' actual yuields and management practices are collected. Potential and actual yields for a given region are then compared with respect to the management practices that have contributed to each. It may be observed that some of the agronomic practices that have gone into acheiving the potential yields on experiment station variety trials, are not practical for small farmers. Economic returns and labor inputs are rarely considered by the experiment station scientists but of course, they are utmost considered in the small-holders' decision-making process. Indeed, it is not expected that small-holders will achieve experiment station yields - the purpose of the exercise is merely to identify their major constraints to increase yields.

After the agronomic practices for potential and actual yields are recorded, they are compared for purposes of constraint identification. Often, exploratory on-farm trials are required to accurately prioritize the identified constraints. These trials also serve to quantify yield losses due to a particular constraint, elucidate interactions and suggest appropriate alternatives. Prioritized constraint lists may differ widely for the various regions of the country depending on local farmer practices, availability of credit and inputs, and soil types. A typical list for Zambia is summarized below for Region II - Kabwe Rural District. Potential Yields = 1980 kg/ha (source - average yield of hybrids in National Variety Trials at Kabwe RRS, 1978-1987. Actual Yields = 494 kg/ha (source - Central Prov. ARPT survey of 34 sunflower growers in Kabwe Rural, 1984-85).

Prioritized Constraint List - Kabwe Rural District

1. Planting Date: Potential Yield (PY) fields planted on Dec. 28 on average. Farmer fields planted on Feb. 1, a delay of almost 6 weeks.

2. Planting Method: PY fields row-seeded to final population of 40,000 plants/ha. Farmer fields broadcast-seeded to final population ranging between 28,000 and 85,000 plants/ha.

3. Weeding: PY fields weeded twice, once at 6-leaf stage and again at 12-leaf. Farmer fields not weeded at all.

4. Variety: PY fields use new hybrid seed. Farmer fields have retained local seed, open-pollinated type which has no disease resistance and requires 2 more weeks to mature.

5. Soil Fertility: PY fields have 200 kg/ha of 10-20-10-10(S) applied basally. Farmer fields have no fertilizer.

The reason why so much care and effort is taken to correctly prioritize the constraints for each region is two-fold. First, the extension service in the field wants a simple message to convey to farmers. A single extension worker may be servicing more than 100 sunflower growers, each at a slightly different level of management. The sunflower team wishes to give the extension staff an easy-to-follow production ladder for their area by which they can readily identify where an individual farmer is on the ladder and determine what his next step in increasing yields should be. For example, in the constraint list given above for Kabwe Rural District, if a farmer is getting very low yields and seems to be confronted with all of the listed constraints, the extension advisor will first try to get him to change his planting date as much as possible. For a farmer already planting on time, seeding in rows, and doing one weeding, the advice will be to try a new variety and perhaps some fertilizer. By following this type of production ladder, an extension worker is less likely to advise the purchase of expensive seed and fertilizer to a farmer who plants late and doesn't weed, under which conditions we would not expect a response to the purchased inputs. Such mistakes in the field are not only economically detrimental to the farmers, but also result in the losing of their confidence in the extension service.

Also, it has been shown in developing countries that the whole of new technological packages are rarely accepted by traditional farmers, except in cases where the crop is entirely new to the area or the financial inducements are overwhelming. Their decision making progress is largley based on their own calculations of risk-analysis and resource allocation from past experiences. A new cultural practice for improving sunflower yields is much more likely to be accepted by the small-holders if it deviates only slightly from their current practices, so that they may intelligently calculate the risk involved with the new practice.

The constraint list also helps to keep the sunflower agronomy research programs in tune with real problems faced by small farmers. Feedback from the Adaptive Research and Planning Teams (ARPT) scientists in the field helps to ferret out inappropriate treatments or constraints that appear to be important but uneasy practical to overcome for some nontechnical reason.

Once the constraints have been identified and prioritized by means of survey and exploratory trials, the actual agronomic program for that area is formulated. It may be conducted by the provincial ARPT, the central sunflower team, or a combination of the two. A summary of results from selected trials follows.

Trial Results

1. Planting Dates

Yield loss due to late planting is the number one constraint to good sunflower yields in most of Zambia. Most Zambian varieties mature in 105 to 125 days, and optimal yields are achieved when more than 640 mm (an approximate figure) of rainfall is received during the growing season. Distribution of the rain is of course important, as a crop in the high rainfall area of Zambia may receive more than 800 mm of rain during its growth but none during the last month of seed fill, if it is late-planted. As a result, yields will be poor. Conversely, yields as high as 1500 kg/ha have been realized on less than 300 mm of rain when it has been well-distributed on a soil with high moisture holding capacity. Late-planting of sunflower in Zambia is due to largely labour-shortages during the start of the rains, pushing back land preparation and the planting of subsistance crops.

2. Weeding

Most of the sunflower in Zambia is not weeded. Time of weed removal studies have shown that if only one weeding is possible, it should be done 3-4 weeks after planting, which corresponds to the 8-leaf stage of sunflower. If the field is cleaned at this stage, the canopy will naturally close before a second flush of weeds develops. Trial results also showed that farmers who were not weeding were probably losing 30-80% of their potential yield, and the economic returns to hiring the weeding done could be as high as 20 to 1 (sunflower weeding does not occur during a peak labour period).

3. Planting methods

Although more than half of Zambia's sunflower growers now plant in rows with the same plant spacings they use for maize, a large portion is still broadcast-seeded behind the plow resulting in unpredictable plant populations. Exploratory trials revealed that the farmers' broadcasting methods did not lead to as large as yield reduction as researchers believed. Some achieved quite accurate spacings and populations. Also, under unweeded conditions, local seed broadcast outperformed improved varieties seeded in rows. Broadcast-seeded fields are never weeded, due to the awkward plant arrangement and fertilizer can not evenly distributed to the base of the plant. Also, many farmers do not achieve the desired populations, and lose the whole crop because of it. For these reasons, row seeding is highly encouraged as an initial step to improve small-holders yields.

4. Soil Acidity

Much of Zambia's sunflower is grown on highly weathered oxisols with inherently low pHs. Liming studies have determined a critical pH of about 4.8 ($CaCl_2$) for sunflower. Growth at lower pHs will be restricted mainly due to poor root development. Further investigations have shown that the Al saturation percentage is more important than the soil pH, and that there can exist a wide range of germplasm tolerance. Zambian varieties are able to attain 80% of maximum yield with Al saturation up to 25% while tested temperate varieties fall below 80% yield at 15% Al saturation or less. As lime is expensive and difficult for small farmers to obtain, only small quantities are recommended for those soils with a pH of less than 4.8. Usually as little as 500 kg/ha will be sufficient to neutralize the Al for one or two years.

5. Soil fertility

Low soil fertility conditions prevail in much of Zambia's sunflower growing area. Fertility studies have indicated good response to basal fertilizers, but topdressing studies have been inconclusive. Though still in early stages of investigation, the sunflower agronomists would rate growth-limiting nutrients in the order of P,B,N, and K. Boron deficiency is widespread in Zambia, and appears to be enhanced by dry spells. Most Zambian soils test low for P but have moderate levels of K.

6. Variety

As sunflower is not indigenous to Zambia, what is referred to as "local" varieties is actually farmer-retained seed from early open-pollinated releases by the sunflower program. The newly developed hybrids, however, have many distinct agronomic advantages over these older releases, Table 1.

Table 1. A comparison of "local" and improved seed.

Character	Local seed	New hybrids
Ave. seed yield (kg/ha	400-1200	1500-3000
Oil content (%)	32	40
Leaf spot resistance	no	yes
Leaf blotch resistance	no	yes
Maturity (days)	140	120
Plant height (m)	2.6	1.8

Recent on-farm studies have shown that the new hybrids also outperform the local seed even under low management conditions and often as much as doubling yield.

DISCUSSION - SESSION III

The discussion is detailed in the form of question (Q), answers (A) and comments (C).

SUDAN

Q. You mentioned that acreage to sunflower increased from 850 ha to 17,000 ha. What is the production yield of sunflower in the Sudan?

A. Sunflower is a new crop in the Sudan, there are no indications of yields in farmers fields. The figure for research station yields is approximately 700 kg/ha.

Q. Do you use desiccants with the combine?

A. No, the 24% loss is without disiccant.

Q. On sunflower, you mentioned the change in fatty acid composition with temperature. This is usually a highly inherited trait. Please explain.

A. Proportion of fatty acids is influenced by both heredity and environment, in particular moisture and temperature. Linoleic acid is particularly affected by high temperatures. There is a higher proportion of linoleic acid with cool temperature, thus better oil quality. Several factors affect the proportion of fatty acids. For example it also depend on how seed filling is done.

Q. What is oil content of sesame and how is it processed in the Sudan?

A. Oil % varies between 48 and 52%. Regarding processing, there are two methods: in villages oil expellers are used while in cities mechanical extraction is common.

Q. What is the scale of sunflower production in the Sudan?

A. Sunflower is very new in Sudan. Cultivation started 2-3 years ago in private farms. There are usually very large farms of more than 30,000 acres. Small farmers and the government do not produce yet.

ETHIOPIA

Q. Brassica: you indicated that moisture stress does not affect seed yield of rapeseed. Other data does not support that?

A. Moisture stress is not important if it occurs at the end of the growing season as long as development is good during the growing season and up to the time when there are petals on the boll, seed yield is not affected. For oil content, however, it is the reverse, and oil content was largely reduced with both moisture stress and wide gap between minimal and maximal temperatures in that year (83/84).

Q. Sunflower: You have indicated the lack of response to fertilizer addition (N and P). In the morning session there were indications of large requirements of micro-and macro-element fertilizers. Can you describe the soil types you were working on?

A. The trials were conducted on volcanic soils, which are very rich and deep (1.5 m). In other locations soils are mainly sandy loams and fertilizers are required. However, I mentioned that the main problem of sunflower in Ethiopia is bird damage.

Q. Sesame: What selection criteria do you use for drought resistance?

A. We select our material from drought affected areas.

C. Sunflower response to fertilizers: there is usually an increase in disease incidence with fertilizer addition. It is possible the lack of response to fertilizers is a reflection of higher disease incidence.

Q. Sunflower: You mentioned that Orobanche was not a serious problem on sunflower because it appeared at maturity. On most crops this is usually the case. In Nepal we found that Orobanche starts affecting the host before appearing above the soil surface.

A. We had a set of trials on linseed, rapeseed, sunflower and niger. On sunflower we counted one weed/plant while on rapeseed infestation may be up to hundreds/plant. Discussions with Orobanche specialist, Mr. Chris Parker, indicated that the Orobanche species which devastate sunflower in other countries do not exist in Ethiopia.

Q. Sesame: What could be the effects of introducing the non-shattering character in relation to labour requireents, particularly hand harvesting costs?

A. The aim is not to introduce completely non-shattering types, but to get partial shattering.

C. In the Sudan, we have developed non-shattering types for mechanical harvesting. Non-shattering trait usually comes with low yields and woody pods which necessitate mechanical harvesting. I also think that partial shattering cannot be reached; either it shatters or not.

<u>TANZANIA</u>

C. The sesame varieties sent to Tanzania from Ethiopia were S and E, originally from Uganda. I suggest that the newly identified bacterial blight resistant lines from western Ethiopia might be tolerant to bacterial blight in Tanzania, such as SPS 111519.

Q. Sesame: Is there a difference in the root system between the late and the early varieties that can account for the difference in drought resistance?

A. There is a general popular belief that late maturing varieties have a deeper and more prolific root system. We did not study the root systems, but it may well be the case. The late and early maturing varieties cannot be compared only on basis of root systems. They grow and experience different weather conditions. For example, late maturing cultivars flower and mature during months with relatively low temperatures and corresponding low evapo-transpiration rates while early cultivars flower during hot weather with higher evapo-transpiration rates. This may also interfere with the comparison.

Q. Sunflower: Why are you testing sorghum/sunflower intercropping and maize/sunflower only as relay crops? What is your experience so far with sunflower/sorghum intercrop? Does the sunflower/sorghum system lower the bird problem?

A. a) the common practice of farmers is to intercrop either with sorghum or maize. We carry these trials to verify if the practice is recommendable and, if so, to find ways of improving the system.

b) as regards production, data for one season have shown no negative effect on either sunflower or sorghum yields. These results need to be confirmed.

c) we did not attempt to assess bird damage during the last seasons. This is planned for the coming season.

Q. <u>To all sunflower workers</u>: All presentations on sunflower have highlighted the problems of birds. I have been informed in another forum that if the crop is grown on a large scale, the problem is not very serious. What measures are being taken to control birds in the case of small farms?

A. <u>From Kenya</u>: There is no simple answer to the question. There are no fool-proof methods for controlling bird damage whether on a large or small scale. An integrated approach employing various methods should help reduce bird damage. One of the methods alluded to by the question is to concentrate or saturate an area with the crop. Varieties used should be of uniform maturity and should be sown at the same time in the area. Losses would thus be spread over many farmers and hence minimize losses per farmer. This is the practice adopted in India for sunflower and for other crops prone to bird damage like sorghum, rice and wheat in Kenya.

SESSION IV

NETWORK AND SESAME

<u>Chairman</u>: A.Omran

<u>Rapporteurs</u>: K.Riley
B.Singh

THE OILCROPS NETWORK

Abbas Omran

The Past

Edible oilseeds rank second in importance among food crops after cereals. However, they have been largely neglected by the international scientific community. Soybean and groundnut have received notable attention while sunflower, rapeseed and cottonseed have received moderate attention. The third group (sesame, safflower, niger seed, castor and linseed) has received little attention from the developed as well as developing countries. This third group are key crops for millions of small-scale farming families in developing countries.

Recognizing this situation, IDRC has made considerable efforts to support national programs on annual edible oilcrops in China, Sri Lanka, India, Pakistan, Egypt, Ethiopia, the Sudan, Tanzania, Malawi and Mozambique. It was realized that countries could benefit from linking the efforts of the various projects into a research network. Thus, IDRC took the lead in establishing this international oil crops network for scientists in Eastern Africa and South Asia.

Thus, after two phases of hard work, the Network has started to achieve many of the original objectives. Contacts among scientists in the IDRC-supported oilseed projects are established through newsletters, workshops, and a few visits between them. However, many scientists in self-supported national projects are still working in remote stations facing scientific as well as psychological problems of isolation.

The concept of the Network started to reach these isolated scientists and their response was great. The network advisor/coordinator has visited many of these scientists making them feel part of the world again. As a result, they started contacting, through the Network, their colleagues in their respective disciplines and working on the same crop.

Thus, network participants started to realize that this is their Network. The Advisor is trying to encourage and guide the young scientists and they have now a strong voice in the workshops and the newsletter. Most of the advisor's activities are based on the participants' recommendations.

Objectives of Phase I (1981-84)

The general objective of Phase I was to establish effective and practical liaison between the IDRC oilseeds projects in India, Pakistan, Egypt, the Sudan, Ethiopia and Sri Lanka while assisting the Ethiopian oilseeds projects.

Achievements of Phase I

The Network Advisor has helped the development and start-up of the Ethiopian Highland Oil Crops Project (nigerseed, linseed rapeseed with related brassicas, and sunflower) until it came under the direction and control of the project leader. The advisor continued his help as a plant breeder in aspects of the project as the project leader saw fit. In addition, he has rendered his help in the formulation and start-up of the Ethiopian Lowland Oil Crops Project (groundnuts, sesame, safflower and castor) and has participated in the collection of Ethiopian germplasm. A library for oil crops was developed, and computer references on oil crops are being regularly received.

The advisor has visited, at least once annually, every project in the network establishing correspondence with the project leaders, and providing critical, helpful and encouraging comments on the annual reports of each project. Exchange visits between project scientists were started, and visits of consultants and specialists to a number of projects were arranged. Visits for oil crops project scientists in International Agricultural Research Centres (IARC's) and strong oilseeds research program in other countries were arranged.

An Oil crops Workshop was held in Cairo, (September 3rd - 8th 1983) for project leaders in which three specialists on sesame, sunflower, and brassica have also attended. Thus, the importance of such workshops was highly recognized by all participants who got the opportunity to exchange their views and experiences.

Objectives of Phase II (1984-87)

The general objectives remained the same as in Phase I except the emphasis shifted from establishing the network to servicing and operating it. Specifically, the project advisor aimed to continue working with the Ethiopian highland and lowland oil crops projects, to visit each project in the network, to keep program officers in good touch with the situation, to publish an annual newsletter, to arrange for exchange of visits between scientists, to help in germplasm exchange and to organize small workshops.

Achievements of Phase II

The advisor was continuosely helping the research activities of the Ethiopian lowland and highland oil crops and has offered courses in statistics/experimental design to research officers/technicians of the Institute of Agricultural Research and to graduate students of Alemaya University of Agricultural Sciences.

The network has distributed cover pages of the most important international journals to all stations and has sent back photocopies of requested papers for oilseed and non-oilseed crops. Also, computer printouts of references, abstracts and papers to be used by oilseeds researchers were arranged and classified.

The network, with the help of the concerned IDRC program officers, has arranged a consultancy (Dr. Hugh Doggett) for Ethiopia, the Sudan, Egypt and Nepal so as to advise and assess the project developments.

The network has made efforts to link together scientists from different projects who study on the same crops and share similar problems; a visit of Dr. Thangavelu (sesame, India) with Mr. Yebio Woldemariam (lowland oil crops, Ethiopia) and Dr. H.Ishag (Oilseeds, Sudan) proved very fruitful in strengthening the links.

The program officer responsible for the network in India arranged a visit for Dr. Sawant (safflower, India) to safflower work in USA, Mexico and Spain.

The network has contributed to a cooperative program with Agriculture Canada (Anther Culture Project) by sending the network assistant and an Indian professor to work on the project for 2 years.

The advisor has visited non-IDRC supported projects and helped to secure small research grants to ease the bottlenecks in the on-going research

(Tanzania), to start germplasm collections (Somalia) and to help organize a national oilseed workshop (Kenya).

The network has organized a training course in India on sesame/safflower for 15 junior research assistants/technicians from Africa and Asia. The advisor has participated in teaching and has coordinated the course with the Directorate of Oilseeds Research, Hyderabad.

Workshops: The advisor has coordinated two workshops and has edited the proceedings which were published in IDRC Manuscropt Reports:

1. second workshop held in Hyderabad, India, February 1985 with participants from India, Ethiopia, Nepal, Egypt, the Sudan, Uganda and Tanzania, with guest speakers from U.K., Canada, USA and Philippines (IDRC-MR 105e).
2. third workshop held in Addis Ababa, Ethiopia, October 1986 with participants from Ethiopia, Egypt, the Sudan, India, Nepal, Pakistan and P.R. China, with guest speakers from Canada, U.K. and Sweden.

Oilcrops newsletter: The advisor has edited and published four issues for the years 1984, 1985, 1986, 1987. More than 600 copies from each issue were also dispatched to oilseeds workers around the world.

The Present and Immediate Future

National Program Support

The advisor will continue to devote 30-40% of his time working with the Ethiopian oil crops program. More emphasis will be given to supporting the lowland oil crops and sunflower programs.

The advisor will review annual technical reports from projects, and will visit programs regularly to keep in touch and discuss oil crop improvement programs with the national oil crops scientists. More emphasis will be given to interacting with programs which do not have the IDRC support.

In collaboration with the IDRC program officer, the advisor will pursue possible further IDRC support for national programs. Where necessary, National Program Support funds will be allocated from the project. National scientists will be encouraged to visit each others' projects. The use of consultants from the network region will be considered.

Germplasm Exchange

The dialogue between Indian and Ethiopian germplasm officials will be followed up by the advisor to ensure that bilateral exchange continues between these two countries. Other network countries with few constraints to exchang germplasm will be encouraged to exchange on a bilateral basis.

The collaborative nursery, as recommended at the 3rd workshop, will be instituted using Ethiopia as a base for receiving the seed samples and distributing the nursery. So far, only the following seeds have been received:

1. nigerseed from Ethiopia (Asmara), Nepal
2. sesame from Somalia, Nepal, Sri Lanka, Philippines, Egypt, FAO Italy
3. groundnut from Nepal
4. brassica from Nepal, Sweden, India
5. linseed from Nepal

6. safflower from Egypt.

The process of the nursery receipt and dispatch will be continuous. In some cases, seeds will need to be multiplied in Ethiopia before dispatch. All network members are now urged to participate. The feasibility of 3-way germplasm exchange, with a third country such as Canada involved to ensure that mutual and fair exchange occurs, will be pursued.

Information

The network advisor will ensure that the flow of relevant information continues. This includes:

- compiling the annual oil crops newsletter in association with FAO.

- making sure that national programs receive oilseeds abstracts, computer profiles and searches when needed.

- organizing a workshop at 1-2 year intervals.

- reviewing the books and journals received by the network for relevant articles to be distributed.

- organizing a multi-authored monograph on nigerseed, possibly followed by sesame or safflower monographs.

- negotiating the publication of a bibliography on sesame diseases in 1988.

Training

There will be emphasis on developing oilseed technician training. Training in one or more countries at a time, training of trainers as well as training in a single crop will be considered. The trainees at the recently concluded training in Hyderabad recommended a longer duration with more time for practical field-based training. This will be considered for the next training courses.

The oilseed projects are advised as to where to send their trainees. Sudan needs to train 1-2 researchers for farming systems in Zimbabwe. Ethiopia needs to train the sunflower breeder; Canada is suggested.

As recommended by the Brassica Committee, Mme Zhang Yan suggested a training on quality in China. I handed this over to the chairman and we think it can be done in 1988 because of the high cost which needs a special budget. More details will be presented by the Brassica sub-network chairman.

New Network Forms and Activities

Several new approaches and activities were recommended at the third oilseeds workshop. The following proposals are subject to discussions by the participants:

Oilcrops Committees

Similar to the Brassica sub-network, it is suggested that the following three similar sub-networks be discussed and formed during this 4th workshop:

1. Sesame sub-network
2. Sunflower sub-network

3. Other-oilcrops sub-network (linseed, niger, safflower, castor)

The four sub-committees can decide their activities and meetings. It is suggested that each can meet once a year and that the chairman and co-chairman participate in the common workshops with selected members from each sub-committee as relevent to workshop themselves.

The sunflower sub-network can suggest that certain member countries be supported to attend the 12th International Sunflower Conference (Yugoslavia, July 25-29, 1988) in order to establish relations and coordination with the sunflower associations and to publish sunflower research papers/articles in Helia and sunflower year book.

The steering committee of the network will include 10 members:

2	members (chairman	and	co-chairman	of	brassica	sub-committee)		
2	"	"	"	"	"	sesame	"	"
2	"	"	"	"	"	sunflower	"	"
2	"	"	"	"	"	other crops sub-committee		
1	member (network adviser as general secretary)							
1	" (IDRC program officer responsible for the network)							

The network steering committee can meet once between each two workshops. So, the first meeting will be at the end of Workshop 4 in Kenya and the second before the end of 1988.

Collaboration with FAO

FAO has agreed to join the "Oilcrops Newsletter" with their "Sesame and Safflower Newsletter". Dr. Pineda and the network advisor will coordinate the collection of material and will discuss the ways of publication which will insure wider distribution.

FAO is formulating an international sesame project. The main objective is to support sesame producing countries in their efforts to improve the agricultural production and the socio-economic status of their populations through sesame improvement. The project aims also to strengthen national institutes, build strong genetic basis for sesame, build an efficient network for information and material exchange. Negotiations are going on between IDRC and FAO on how this project and the proposed unit (described below) can be collaborated.

The far future or may be Phase IV of the Network

With establishment of the netwqork steering committee and the four sub-networks, the activities will be better organized.

The project can be attached to the proposed oilseed unit as a satisfactory base for the network and to help the unit in their regional activities. The adviser can participate in research as a member of the unit.

The Proposed Unit

As mentioned earlier, some oilcrops are receiving considerable attention from international organizations like groundnut (ICRISAT) and soybean (INTSOY and IITA), and some are receiving moderate attention like rapeseed/mustard (GCIRC) and sunflower (International Sunflower Association of Australia and of FAO). Yet some crops are receiving little or no attention like sesame, linseed, nigerseed, safflower and castor.

IDRC contacted several donors who showed interest, then IDRC thought to start a nucleus of an international oil crops research unit. The objective is to develop a small, flexible, multi-donor-supported research unit to provide scientific and technical back-stopping and coordination to researchers primarily in eastern and southern Africa and South Asia working on annual oil crops.

Initially the unit would concentrate its research activities on sesame, then niger, sunflower, safflower and others. The support for these and other annual oilcrops will expand as additional resources become available over time.

In addition to the coordinator, the unit will comprise, initially, a full-time breeder and a post-doctoral fellow. Other positions supported by additional donors will be added later. The unit would also employ short-and medium-term consultants.

The initial efforts will be:

a. to screen germplasm and to generate more variability for national projects.
b. to incorporate important resistances into good national material.
c. to distribute nurseries for testing, including to NGO's where appropriate.
d. to develop male-steriles and breeding populations; and assess the practicability of hybrids in due course.
e. to develop and use tissue-culture technology as needed to facilitate the above.
f. to study the possibility of resistance breeding against *Orobanche* and *Cascuta*.
g. to offer training which will be one of the main activities after the unit is well established.

The above are but proposals for this forum to discuss and guide us and give us the "Go Ahead".

SESAME BREEDING: OBJECTIVES AND APPROACHES

Amram Ashri

Abstract

Sesame is an important oil crop of warmer areas and is a typical crop of smallholders, nearly all its area grown in developing countries (99.9%). Its yield, tolerance to diseases, pests and environmental stresses must be improved. Breeding has been recommended by several authors and by three FAO expert consultations (1980, 1984, 1987) as the best way to achieve better performance. This paper reviews sesame breeding objectives and discusses the various breeding approaches. A mutant for determinate growth habit induced by 50 Krad of gamma rays is described; and the breeding program to transfer the mutant allele into many different cultivars adapted to various conditions is discussed. It is concluded that sesame yields can be significantly improved by enhanced research effort, international cooperation and wider exchange of germplasm and breeding materials.

Introduction

Sesame is an important plant among the annual oil crops, Table 1, especially in developing countries in the southern latitudes where it is usually grown by small holders in small plots. Thus, 99.9% of the world's sesame area (6,670,000 ha in 1985) is found in developing countries, Table 2. Countries with the largest areas are India, Burma, China, Sudan, Nigeria and Mexico. The crop has important agricultural advantages: it grows well in tropical to temperate climates, it can set seeds and yield well under fairly high temperatures, it can grow on stored soil moisture without rainfall or irrigation, it is a good crop in the rotation, it can be grown as a companion crop and it is grown with low inputs (Brar and Ahuja, 1979; Joshi, 1961; Mazzani, 1983; Rehm and Espig, 1984; Weiss, 1971).

The mean yields of sesame are very low, Table 2, although potentially they could be considerably higher. Sesame seed yields are low due to various factors, especially: lack of improved varieties; susceptibility to diseases, pests and environmental stresses; seed shattering; non-uniform ripening of the capsules; poor rainfall; lack of inputs. Improvement has been slow due to the lack of widely based germplasm resources, lack of research, shortage of trained personnel for research and extension, short duration of research projects with insufficient continuity, limited international cooperation and limited exchange. Sesame research in its main areas of adaptation is limited and in developed countries it is a very minor crop with little research attention. Also, it should be emphasized that sesame is not dealt with by any of the CGIAR international agricultural research centers.

Theoretically, sesame areas could decrease and be used for other crops. However, in many sesame growing areas, the crop cannot be replaced due to the lack of other suitable oil or food or export crops which are adapted to the climatic and edaphic conditions and to the cropping systems. Improvement of the yield of sesame is thus very important, hence the activities of national organizations and international ones can be very significant.

Breeding Objectives

It is generally agreed that for low input conditions (which are typical for sesame), breeding improved varieties is one of the few promising approaches. Breeding the adapted and more productive sesame varieties was recognized as the key to its enhancement by three Sesame Expert Consultations called by the FAO, in 1980 (Anon. 1981b), 1984 (Anon. 1985a) in 1987 (Ashri, 1987) and by various

Table 1. 1985 world production, areas and yields of sesame and the other major annual oilseeds in developing and developed countries (Source: FAO Production Yearbook, Vol. 39, 1985)

Crop	Area harvested, 1000 ha				Production, 1000 MT				Mean Yield, kg/ha	
	Developing	Developed	Total	% Developing	Developing	Developed	Total	% Developing	Developing	Developed
Sesame	6666	4	6670	99.9	2351	2	2353	99.9	353	606
Soybean	25421	26947	52368	48.5	40799	60034	100833	40.5	1605	2228
Groundnut	18038	918	18955	95.2	19053*	2206*	21260*	89.6	1056	2405*
Rapeseed	9566	5402	14968	63.9	9098	9789	18887	48.2	951	1812
Sunflower	5410	9179	14589	37.1	6897	12182	19078	36.2	1275	1327
Safflower	1130	183	1313	86.1	682	158	840	81.2	603	865
Cottonseed**	27059	8106	35165	76.9	20721	11496	32217	64.3	765	1418

* In the shell.

** Area harvested figures are for sed cotton which incides both fiber and seeds; production figures are for clean cottonseed, i.e. after ginning.

Table 2. Sesame seed production, 1985. (Source: FAO Production Yearbook, Vol. 39, 1985).

Region or country	Area 1,000 ha	Production 1,000 MT	Yield Kg/ha
World total	6670	2353	353
Developed countries	4	2	606
Developing countries	6666	2351	353
Regions			
Latin America	370	201	541
Far East	3247	809	249
Africa	797	275	346
Near East	1309	353	270
Major Producers			
Mexico	189	100	528
Venezuela	93	45	484
Turkey	68	41	603
Syria	42	12	283
Afghanistan	40	32	800
Bangladesh	35	20	571
Burma	800	232	290
Thailand	39	26	675
India	2200	450	205
Pakistan	34	14	396
Sri Lanka	33	15	455
China (P.Rep.)	901	692	768
Korea	73	41	562
Burkina Faso	25	6	240
Central Afr. Rep.	38	12	316
Egypt	22	21	955
Ethiopia	63	36	571
Nigeria	250	75	300
Somalia	153	45	293
Sudan	1103	228	207
Uganda	80	38	475
Tanzania	60	18	300

national research organizations. It is expected that as new varieties are developed, appropriate agronomic practices will be established by cooperative research, as it has been the case with other crops.

An expert consultation convened by the FAO in September 1987 (Ashri, 1987) discussed at length the main breeding objectives bearing in mind the many and varied conditions in the different sesame growing areas, e.g. low vs high inputs, monocropping vs mixed cropping, growing under irrigation or rainfall or on stored moisture. It was concluded that in order to obtain higher and more stable yields of desirable quality (in different environments), a combination of the following characters equally applicable to both low- and high-input conditions of cultivation should be sought.

1. Seed characters

- large or medium-large, well filled, shape and color to satisfy market demands, especially for confectionary use.
- seed coat rough and easily removed by dry decortication.
- oil and protein composition and content satisfactory to meet consumer demand; high sesamin and sesamolin (anti- oxidants) content; reduced oxalic acid content, and
- seed dormancy appropriate for the local cropping system.

2. Seedling characters

- fast, vigorous germination and emergence with strong hypocotyl elongation.
- rapid growth in early stages of growth to give good stand establishment.
- ability to germinate and withstand lower temperatures in early stages of growth in temperate production areas

3. Plant characters

a. Roots
   - rapid root growth
   - deep taproot penetration with a well distributed secondary root system for maximum exploitation of soil moisture.

b. Leaves
   - medium to broad at the base and narrow lanceolate towards the apex.
   - short petioles.
   - higher photosynthetic efficiency.
   - abscission early and complete at maturity.

c. Stems
   - "uniculm", if inputs medium to high or moderately branched at lower nodes under low input conditions.
   - internodes short with corresponding adjustment of capsule angle.
   - height varying with conditions and seasons.

d. Growth habit
   - determinate with a uniform and short capsule ripening period or indeterminate (with prolonged ripening period), according to local needs and farming systems; under low input conditions either may be desirable depending on the length of the growing season.*

e. Flowers
   - to start 20-30 cm from ground level.
   - number of flowers and capsules per leaf axil: one or three.

f. Capsules
   - to start forming ca. 20-30 cm. above soil surface.
   - bicarpellate (four locules) for larger seed size.
   - long or short as desired in area, capsule length appears neutral in total yield in varieties studied (indeterminate).
   - One or three per leaf axil; number of capsules/leaf axil appears neutral in total yield in varieties studied (indeterminate)**
   - upright angle.
   - full seed-set, without aborted ovules.

g. Seed retention (see also III. below)
   - effective seed retention (nonshattering) mechanisms suitable for machine harvest or for traditional harvest methods, through better capsule indehiscence genotypes or strong placentation or still other mechanisms to be elucidated.

4. Physiological characters

- neutral daylength response and thermo-insensitivity
- more favorable reproductive to vegetative ratio
- maturity early, medium or late, according to local requirements
- higher efficiency in nutrient uptake under low and high fertility conditions
- resistance to waterlogging***, drought***, salinity*** and other environmental stresses
- potential to respond with higher seed yields to applications of fertilizers and/or irrigation, without concomitant undesirable effects (e.g. lodging).
- rapid natural dessication at physiological maturity

5. Yields

- high and stable seed yields of good quality under a wide range of environmental conditions.

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* For India Sharma (1985) and Thangavelu et al. (1985) recommended plant types having 2-3 branches with uniform and synchronized capsules' maturity.

** In India Sharma (1985) advocated plants with "each axil having a multicapsule and multilocule nature".

*** Particularly important under low-input conditions.

6. Resistance to diseases (the scientific names follow Kolte, 1985) and insect pests

a. Foliage diseases

- *Phytophthora* blight -- *Phytophthora parasitica* (Dastur) var. *sesami* Prasad, 1st priority. Widespread, destructive, several pathogenic races known; sources of resistance or tolerance are known in accessions from Africa and India and in the species *S. radiatum*. (Kolte, 1985; Lee and Choi, 1985b; Mazzani, 1983). Two independent mutations for resistance were induced recently in Sri Lanka (Pathirana-personal communication).

- white spot -- *Cercospora sesami* Zimmerman, 1st priority. Widespread, more severe under humid and warm conditions, sources of resistance are known (Kolte, 1985).

- *Alternaria* leaf spot -- *Alternaria sesami* (Kawamura) Mohanty and Behera, 1st priority. Widespread from tropical to temperate growing areas, sources of resistance or tolerance are known in India and in *S. radiatum* (Kolte, 1985; Mazzani, 1983; Verma, 1985).

b. Soil-borne diseases

- charcoal rot -- *Macrophomina phaseolina* (Tassi) Goid ssp. *sesamica*, 1st priority. Widespread, destructive; sources of resistance or tolerance to the pathogen are known (Kolte, 1985; Mazzani, 1983).

- *Fusarium* wilt -- *Fusarium oxysporum* (Schelt.) f. *Sesami* Jacz., 1st priority. Widespread and destructive, more common under dry conditions. Sources of resistance known e.g. cultivars Aceitera, Delco, Baco, some varieties in India and *S. radiatum* (Kolte, 1985; Mazzani, 1983; Verma, 1985).

c. Bacterial leaf diseases

- bacterial leaf spot -- *Pseudomonas syringae* Van Hall pv. *sesami* (Malkoff) Young, Dye & Wilkie, 1st priority. Widespread, can be destructive especially in warm (not hot) humid conditions; several pathogenic races are known. Genetic variation in reaction to the disease is known (Kolte, 1985; Mazzani, 1983).

- bacterial blight -- *Xanthomonas campestris* (Pamel) Dowson pv. *sesami* (Sabet and Dowson) Dye, 1st priority. Less common that *Pseudomonas*, can be destructive, pathogenic races are known, genetic variation in reaction to the disease is known (Kolte, 1985; Lee and Choi, 1985b).

d. Mycoplasma disease

- phyllody, caused by a mycoplasma-like organism (MLO) which is transmitted by leafhoppers (*Orosius albicinctus* Distant), 1st priority. Widespread, can be destructive in certain seasons and regions. Differential varietal reactions are known (Kolte, 1985). Screening is very difficult since it depends on field conditions, vector population build-up and MLO-infestation levels. Therefore, the development of methods for inoculation and rapid molecular disease identification and screening approaches is required urgently.

e. Virus diseases

- leaf curl, 2nd priority. Widespread but usually not severe; transmitted by the white fly, *Bemisia tabaci* Genn. Sources of resistance are known (Kolte, 1985).

f. Insect pests

- webworm -- *Antigastra catalaunalis*, 1st priority, widespread, can be destructive. Genetic differences between cultivars in tolerance to the insect have been noted (Ashri, Unpublished) and *S. prostratum* was reported to be resistant (Mazzani, 1983).

- sphingid moth - *Acherontia styx*, 2nd priority. Differences between varieties in degree of damage were noted.

- aphids, can be a problem. Genetic variation in tolerance was reported (Mazzani, 1983).

The Need For Varieties With Good Seed Retention

A good source of indehiscence, facilitating the development of varieties which retain their seeds, is very important in expanding the area of sesame and sometimes even in maintaining it. In countries where labour costs are high the growing areas decreased because combine-harvest without considerable seed loss is not feasible. Even in countries where labour costs are not high, it is difficult at times to get enough workers for a short peak season to cut or uproot the plants, stack them and thresh them by hand. Therefore, it is important to develop varieties with good seed retention which can be combined and threshed also by hand-operated machines or small mechanized threshers.

Good sources of indehiscence or other means of seed retention are not available. The indehiscent plants of the *id/id* genotype give lower yields of lower quality seeds, are more susceptible to disease and are very difficult to thresh. The best available nonshattering *id/id* lines developed by Yermanos (UCS, NS lines) yield less than the better shattering cultivars. Also, the capsules of *id/id* plants are so difficult to thresh that often yield losses and damaged seeds result.

Therefore, although this allele has been known since 1943 it has not been incorporated in any commercial sesame variety. The stronger placentation type now available is suitable for dry conditions but is not effective under conditions of repeated wetting and drying. In the semi-dehiscent cultivars now available, considerable amounts of seeds are still lost. These plants show better seed retention in dry areas, but if they mature in wet or humid conditions they shatter the seeds.

Breeding Approaches

Sesame is now at an early stage in its improvement where rapid advances can be expected from the application of proven plant breeding principles and procedures. The potential of sesame breeding is amply demonstrated (Table 3) by the achievements in tropical Venezuela (Mazzani, 1983), in temperate Korea (Lee and Choi, 1985b) and in its traditional areas in India (Desai and Goyal, 1981; Sharma, 1985; Thangavelu *et al*. 1985).

Table 3. Number of improved sesame cultivars developed by different breeding methods in India, R.of Korea and Venezuela.

Country	Direct Intro-duction	Selection from Intro-duction	Selection from Local material	Hybridization Pedigree	Hybridization BC	Induced mutation	Total	Source
India	-	-	18	6	-	1	25	Sharma 1985
Korea	1	1	3	6	-	1	12	Lee&Choi,1985b
Venezuela	-	5	-	5	2	-	12	Mazzani, 1983

* Period covered: India - not specified, Korea 1955-1984, Venezuela 1940-1983. The origin of 12 additional varieties listed for India is not specified.

Germplasm collection and evaluation

Sesame is rich in genetic variability. There are still many landraces in the growing areas which often are mixtures. Bedigian (1984) and Bedigian and Harlan (1986) studied the origin of sesame and its genetic variability and identified eight major groups of landraces within the species. The germplasm variability for oil was examined by Yermanos et al. (1972) and by Lee and Choi (1985a) for oil and other traits. Three FAO Expert Consultations (Anon. 1981b, Anon. 1985a, and Ashri, 1987) and the IDRC Workshop in 1985 (Anon. 1985b) recommended that sesame germplasm collection, evaluation and exchange will be enhanced. A sesame descriptor list published by the IBPGR (Anon. 1981b) will aid in this effort. The IBPGR and FAO have recently acted on these recommendations and gave A.Ashri a two-year grant to assemble the germplasm collection of cultivated sesame and of the wild species. The cooperation of all sesame researchers is solicited and samples of representative types and of wild Sesamum species will be much appreciated. The assembled collection which now has about 1500 entries will be planted out and studied in the summer of 1988 in Rehovot. The attainment of many of the breeding objectives described above depends on the identification of suitable sources of the desired genes in the germplasm resources and their utilization.

It should be noted that the first germplasm collection in India was established in 1925 (Brar and Ahuja 1979; Joshi, 1961) and shortly after, a large world collection was assembled in the USSR (Weiss, 1971). The sesame germplasm collections in India were described recently by Thangavelu et al. (1985) and by Paroda et al. (1987).

Introduction

Introduction, sometimes accompanied by mass - or single-plant selection proved successful in various locations (Table 3). Thus, the improved Venezuelan cultivar "Morada" selected from an introduction from Congo (now Zaire) proved very successful in Tanzania (Mazzani, 1983). Also the American cultivar "Early Russian" proved successful as is in the Republic of Korea and was released to the farmers in 1955 (Lee and Choi, 1985b). The five improved varieties of Venezuela which were selected from introductions (Table 3) originated in China, Congo, Cuba, Dominican Republic and Ethiopia. Outcrossing in sesame can vary from about 5% to 60% (Ashri, 1985b; Brar and Ahuja, 1979; Joshi, 1961; Mazzani, 1983; Yermanos, 1980) and therefore, chance crosses often lead to variable populations.

Selection

Selection, conscious or unconscious, within local germplasm pools has been traditionally practiced by the villagers who maintained, and still maintain, their own seeds. Single plant - or mass-selection were important in developing improved cultivars from both local and introduced materials (Table 3). Mass selection can be very useful in many regions since the local landraces are often very heterogeneous, containing productive as well as unproductive genotypes. Single plant selection has also produced successful varieties. There is much scope for this approach in varietal improvement especially if new variability is created by controlled crosses. The FAO Expert Consultations (Anon. 1981b, Anon. 1985 and Ashri, 1987) recommended that selection be utilized wherever possible.

Hybridization

It has been suggested by several authors (e.g. Ashri, 1985a; Kinman and Martin, 1954; Rajan, 1981) that since selection within local materials has been ongoing for a long time, often in low input conditions, the genetic variability for yield within the regions has been exhausted and breakthroughs in productivity will have to come from controlled crosses designed to create new and increased variability. Yermanos (1980) described the hybridization procedures in detail. Pedigree breeding and selection, composite crosses with bulk populations and selection, population improvement, with or without male sterility and high rates of outcrossing, have been recommended (Ashri, 1985a; Kinman and Martin, 1954; Lee and Choi, 1985b; Mazzani, 1983; Rajan, 1981; Weiss, 1971; Anon. 1981b; Anon. 1985a).

As shown in Table 3, the pedigree method has been used successfully and widely. In the USA composite crosses have been used to produce desirable variability that resulted in improved cultivars (Kinman and Martin, 1954).

The backcross method to date has had a limited impact (Table 3). It has been used to transfer desirable traits such as indehiscence into adapted varieties. Its use will no doubt expand as better and more productive varieties are developed and additional sources of specific and useful loci are identified.

Mutation breeding

Induced mutations have been employed successfully in sesame (Ashri, 1982; Ashri, 1985a; Brar and Ahuja, 1979; Kobayashi, 1981; Lee and Choi, 1985b; Murty *et al*. 1985; Weiss, 1971). Mutation breeding has so far produced at least two known commercial varieties: Kalika in India (dwarf, compact, higher yields) by EMS treatment of Vinayak (Sharma, 1985 and Micke-personal communication) and Ahnsanggae in R.of Korea (disease resistant) by x-ray treatment of Early Russian (Lee and Choi, 1985b).

The FAO Expert Consultations (Anon. 1981b, Anon. 1985 and Ashri, 1987) recommended that it should be used to obtain certain desired characters that are not available in the natural germplasm pools. The characters sought should be those that are easily screened from large populations such as nonshattering, modified plant architecture, modified growing period and resistance to diseases and pests. Sesame seeds are quite resistant to gamma rays and ethyl methane sulfonate, therefore higher dose levels should be utilized (Ashri, 1981 and 1982).

Determinate mutant

In the late 1970's Ashri (working on an IDRC grant in Israel) induced a determinate mutation by treating dry seeds of the local cultivar No. 45 with 50 Krad of gamma rays (Ashri, 1981). This mutation with its determinate habit and novel plant architecture is unique and was not known before in the entire germplasm of sesame. It is monogenic, recessive and stable in a wide range of environments. The mutant line is much shorter than the source variety. The main stem and the branches terminate with a cluster of 5-7 capsules, and the upper internodes are telescoped. Very often, but not always, the apical flower in each branch has 6 fused corolla lobes instead of the normal 5 found in the other flowers on the same plant and 6 stamens instead of the normal 4 or 4+1 found in the other flowers. The apical flowers have a bell-shaped corolla which is symmetrical (no lip). The upper clustered flowers and later on the capsules point upwards. In the apical flowers in each branch the capsules are often quadricarpellate while all other flowers in the plant (and the flowers of the source variety) are bicarpellate. The seeds are large and plump and the seed set is good. In the M_3 and M_4 some of the seeds germinated while still in the maturing capsules (vivipary). Apparently this was related to high moisture availability in the soil at maturation. In subsequent generations and in offspring from many hybrid combinations this phenomenon was not encountered or was as rare as in other cultivars.

A large scale breeding program with the mutant has been undertaken by Ashri in Rehovot with funding first by GIFRID and later by the USAID-CDR program in Israel and Thailand (with Dr. V.Benjasil). The objective is to transfer the determinate mutant into many and different sesame cultivars from various regions and to obtain adapted, high yielding, early, determinate, good quality cultivars. The scale of the program is shown in Tables 4-8.

Table 4. Biparental F_2 rows grown in Field I, Rehovot, 1987 (rows 896-987).

Combination*		No. of rows			
	No. of		From which selections were made**		
Type	varieties	Total	B	S	B+S
Det.xothers	8	27	0	1	0
Indet.x "	21	65	0	0	1
Total	-	92	0	1	1

* A nonshattering cultivar was not included among these varieties.

** B=Harvested in bulk; S=Selected plants harvested singly.

Table 5. F_3 rows from four-way crosses grown in Field I, Rehovot, 1987 (rows 561-788, 798).

Combination		No. of rows			
	No. of		From which selections were made**		
Type	varieties	Total	B	S	B+S
Det.one of parents	32	226	0	37	10
All parents indet.	4	1	0	0	0
Total	-	227	0	37	10

Table 6. Biparental F_3 rows grown in Field I, Rehovot, 1987 (rows 221-560, 801-895).

Combination		No. of rows			
			From which selections were made		
Type	varieties	Total	B	S	B+S
Det.xNonshat.	10	32	0	8	0
Det.xCola de Borrego	1	168	0	1	1
Det.xOthers	46	114	0	9	2
Indet.xNonshat.	7	17	0	6	2
Indet.xOthers	39	104	0	10	3
Total	-	435	0	34	8

Table 7. Biparental F_4 rows grown in Field I, Rehovot, 1987 (rows 1-220).

Combination		No. of rows			
	No. of		From which selections were made		
Type	varieties	Total	B	S	B+S
Det.xNonshat.	4	33	8	6	0
Det.xCola de Borrego	1	6	0	0	0
Det.xOthers	37	146	23	4	5
Indet.xNonshat.	1	1	1	0	0
Indet.xOthers	6	34	2	0	0
Total	-	220	34	10	5

Table 8. F_2 rows from backcrosses (BC) and three-way crosses grown in Field II Rehovot, 1987 (rows 2001-2603).

Combinations		No. of rows			
Type	No. of varieties	Total	B	S	B+S
(Det.xOther) x some other (C)	33	514	0	186	0
(Det.xOther)x third var.	7	34	0	2	1
(Indet.xOther x some other (BC)	5	55	0	10	0
(Indet.xOther)x third var.	0	-	-	-	-
Total	-	603	0	198	1

The most advanced materials are now in F_8 and a wide range of determinate breeding lines is now available; e.g. uniculm, moderately branched and profusely branched; large vs. small capsules; 3 capsules vs. 1 capsule/leaf axil; tall vs. short plants.

It appears that shorter determinate plants with 2-4 side branches with terminal capsules and capsules also in 2-3 nodes below the apex will give the desired short maturation period of 15 days or so advocated by Yermanos (see Riley, 1984) and by Sharma (1985) and Thangavelu <u>et al</u>. (1985). Seeds of such lines are available for distribution and cooperation with researchers in other countries is sought. Determinate plants which are profusely branched do terminate their flowering but the blooming and capsule maturation periods are too prolonged.

Additional determinate and indeterminate breeding materials are available from F_1 to F_4, as well as bulk seeds of the F_3 and F_4 selections (mostly determinate) grown in 1987. For some of the lines sufficient seeds are available for distribution to interested researchers. Also, seeds of the bulk can be obtained.

<u>Hybrid varieties</u>

F_1 hybrid cultivars could potentially be used in sesame. Some of the necessary conditions have been met. High levels of heterosis have been demonstrated in certain hybrid combinations (Brar and Ahuja, 1979; Mazzani 1983; Osman, 1985; Sharma, 1985; Thangavelu <u>et al</u>. 1985). With the discovery of a source of stable genic male sterility described by Osman and Yermanos (1982) the research in this area has intensified. In recent studies in Venezuela various hybrid combinations were produced through natural crosses with a male sterile line and significant yield incremnents were obtained (Mazzani, 1985). Cross-pollination using insects presents no problem, and each female plant can produce thousands of seeds.

Still, it is the author's opinion that F_1 hybrid cultivars will not come into widespread use for some time to come for several reasons. Successful combinations with good general and specific combining abilities may be rare, as shown by Krishnaswami <u>et al</u>. (1985) in India. In most of the major traditional sesame growing areas the seed production, certification and distribution systems are limited or nonexistent. Further, it has not been clearly demonstrated that under low input situations hybrid varieties will yield sufficiently better than conventional cultivars to justify the higher cost of hybrid seed. On the other hand, in the high input areas a cytoplasmic male sterility (CMS) genetic restorer system will be needed to eliminate the roguing necessary with the presently available <u>ms</u> locus. Even then, in such areas truly nonshattering varieties will be needed to make the cultivar attractive.

<u>Wide crosses</u>

The wild species in the genus <u>Sesamum</u> contain desirable traits such as resistance to pests and diseases and to drought (Brar and Ahuja, 1979; Joshi, 1961; Kolte, 1985; Mazzani, 1983; Nayar and Mehra, 1970; Uzo and Adedzwa, 1985; Weiss, 1971). However, the cytogenetics of the genus and the interspecific relations are poorly known. The FAO Expert Consultations (Anon. 1981b, Anon. 1985a and Ashri, 1987) recommended that the collection and investigation of the wild species be intensified.

Concluding Remarks

The improvement of sesame has lagged behind other food crops for various reasons. It is important to develop cultivars with higher and stable yields under low input and/or high input conditions. This is necessary not only because of the high quality oil of sesame and its other attributes, but also to counter the danagerous worldwide trend in which humanity depends on fewer crops and on fewer cultivars within them.

Enhanced regional and interregional cooperation and exchange of breeding materials will lead to more effective efforts and to quicker results. With research cooperation and some crucial international support sesame performances can be significantly improved.

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DISCUSSION - SESSION IV

- Dr. Ashri mentioned how IDRC support had helped generate several useful sesame mutants. He sees merging of the FAO sesame initiative and IDRC Network being better than the sum of the parts. Dr. Ashri has assembled 1500 lines on behalf of IBPGR. He requested other countries who have not contributed yet to do so. Wild species are especially lacking. Also a place to store the collection is needed. Hybridization of distant sources can lead to greatest improvement, as there is great potential to obtain genetic variability.

- The Network: it was pointed out that many countries have not supplied seed for the called-for common nursery. India mentioned that, in fact, 29 varieties of Brassica had been sent to the national program in Ethiopia. The Network Advisor will add this material to the collected germplasm and send out the nursery to the participating countries as soon as possible (by summer of 1988).

- The Network is not just a collection of IDRC projects but rather of national institutions. There are links that can further be built. Discussion concentrated on getting better understanding of problems and developing effective approaches to solve them. Brassica sub-network can be used as a model. Each country has to identify their constraints and prioritize them. A step-by-step collaborative program (s) with a lead centre is to be adopted to identify who is to do what.

- Eventhough it is difficult for Uganda to continue oilcrops research on sunflower and sesame, Uganda nevertheless wishes to continue as an oilcrops member. About 20-30% of domestic requirements come from cotton. Sunflower is being pushed to make up the difference. Uganda would like to emphasize sunflower. A sunflower project in east of Uganda is constrained by lack of good sunflower varieties. Uganda does not want to bring in hybrids. So, an appeal made to send germplasm.

SESSION V

COUNTRY PRESENTATIONS - SOUTH ASIA

Chairman: H.Belayneh **Rapporteurs: J.Chambi**
A.Mbiza

OILSEEDS PRODUCTION IN INDIA - A STATUS REPORT

M.Rai and P.S. Bhatnagar

The theme of the present paper is in two parts. An overview of the oilcrops scenario and specific research requirements of linseed, sunflower and sesame having a direct bearing on the Fourth Oilcrops Network Workshop are presented in the respective parts.

Indian Oilcrops Scenario

India, with about 19 million hectares under nine annual oilseeds occupying area-based ranks as groundnut, rapeseed-mustard, sesame, linseed, soybean, safflower, castor, sunflower and niger, Table 1, attained a record production of 12.95 million tonnes during 1984-85. It was the highest in terms of area, production and productivity in the last 35 years. However, production increase was mainly due to increase in area as productivity increased from 481 kg/ha in 1950-51 to 684 kg/ha in 1984-85, Table 2. Since 1950-51, groundnut alone continue to constitute 50% or more of the total oilseeds production of the country, Table 3. Nevertheless, progress in case of sunflower and soybean which are in fact new introductions is the most impressive.

Table 1. Distribution of area and production of various oilseeds in India (average for the period 1982-83 to 1984-85).

Crop	Area	Production
Groundnut	40.2	53.8
Rapeseed-Mustard	21.5	21.7
Sesame	11.6	4.7
Linseed	7.8	3.4
Soybean	4.9	5.6
Safflower	4.4	3.8
Castor	3.4	3.4
Sunflower	3.2	2.4
Niger	3.0	1.2
Total	100.0	100.0
	(18,768.9)	(11,969.3)

NOTE: Figures in parenthesis are absolute figures of area and production in thousand hectares and thousand tonnes, respectively.

With almost nil oilseeds acreage under irrigation in 1950-51, percentage irrigated area steadily increased over years and reached a level of over 16% in 1983-84, Table 3. Nevertheless, the fact remains that oil crop production continued to be substantially influenced by fluctuations or aberrations of the monsoon. After a record production in 1984-85, oil crop production has shown a downward trend due to poor precipitation and varying rainfall pattern, the worst being the 1987. Coupled with the vagaries of the monsoon, cultivation of energy rich oilcrops under energy-starved conditions of moisture, nutrients and plants protection measures are the major impediments adversely affecting production. Non-availability of high yielding and stable varieties with in-built resistance/tolerance to various biotic and abiotic stresses, quality seed and improved farm implements, absence of incentive price and inadequate market support, under utilization/non-utilization of the exploitable plant produce due

Table 2. All-India production of none oilseeds.

Oilseeds	1950-51	1960-61	1970-71	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
Groundnut	3.481	4.812	8.111	5.005	7.223	5.282	7.085	6.436	5.547
Castor	0.103	0.107	0.136	0.204	0.310	0.344	0.405	0.470	0.305
Sesame	0.445	0.318	0.562	0.446	0.590	0.552	0.559	0.520	0.496
Rapeseed-Mustard	0.762	1.347	1.976	2.304	2.381	2.207	2.608	3.073	2.639
Linseed	0.367	0.398	0.474	0.423	0.483	0.375	0.444	0.389	0.373
Niger	-	-	0.128	0.146	0.160	0.118	0.176	0.148	0.190
Safflower	-	-	0.154	0.335	0.422	0.396	0.501	0.515	0.321
Sunflower	-	-	0.076	0.067	0.159	0.230	0.300	0.440	0.301
Soybean	-	-	0.014	0.442	0.352	0.491	0.614	0.955	0.982

Table 3. All-India area, production and yield of oilseeds and area under irrigation.

Year	Area (million ha.)	Production (million tonnes)	Yield (kg/ha)	% coverage under irrigation
1950-51	10.73	5.16	481	-
1960-61	13.77	6.98	507	3.2
1970-71	18.64	9.63	579	7.4
1980-81	17.60	9.37	532	14.3
1981-82	18.91	12.08	639	15.2
1982-83	17.76	10.00	563	15.3
1983-84	18.69	12.59	679	16.7
1984-85	18.92	12.95	684	NA
1985-86	18.87	11.15	591	NA

to poor industrial back-up and limited usages resulting in low returns to the growers and inadequate extension of the farm-worthy crop production and protection technologies are some of the reasons for low productivity of oilseeds in India as compared to the world, Table 4.

Table 4 India's position in the world's oilseeds scenerio.

Crop	*Area ('000 ha)			*Production ('000 tonnes)		
	India	World	% of India to world	India	World	% of India to world
Groundnut	7,368	18,898	39	6,308	19,652	32
Rapeseed-Mustard	4,127	13,058	32	2,498	15,165	16
Sesame	2,324	6,350	37	541	2,099	26
Sunflower	444	13,137	3	218	16,147	1
Soybean	772	51,402	2	560	90,922	1
Castor	589	1,586	37	347	972	36
Linseed	1,582	4,958	32	424	2,448	17
Safflower**	701	1,276	55	346	872	40

* Based on the average of 1981-85, ** Based on the average of 1978-82.

Among the oilseed crops, the compound growth rate of safflower (7.6%) and castor (5.51%) was quite impressive during 1965-66 to 1985-86, Table 5. However, among the new crops, soybean exhibited considerable gains in productivity whereas sunflower exhibited a downward trend. The compound growth rate of seven oilseeds having a long history of cultivation in the country showed considerable growth during 1965-66 to 1985-86 as compared to that of the preceding fifteen years. The production of groundnut, sesame, rapeseed-mustard, linseed, castor, niger and safflower recorded annual growth rate of 2.05%. This was contributed by growth in area @1.04% and in productivity @0.81% per annum. During this period, the growth rate of oil crops was equal to the growth rate of cereals excluding wheat. However, during 1980-85, the growth rate of oil crops was 4.89%, more than that of wheat (4.3%).

Table 5. Trends in the productivity levels of different annual crops since 1965-66 (Base yield).

Crop	Yield levels in kg/ha			Compound growth rate (%)
	1965-66	1975-76	1984-85	
Groundnut	554	902	779	0.85
Rapeseed-mustard	446	580	771	1.40
Sesame	169	221	246	1.72
Linseed	192	282	279	1.19
Castor	199	381	700	5.51
Niger	173	245	251	1.64
Safflower	149	345	561	7.61
Sunflower	-	-	527	-2.24
Soybean	-	-	768	4.32
First seven oilseeds				
**	-	-	-	0.13
***	-	-	-	1.43

* Base year: 1979-80
** From 1949-50 to 1964-65
*** From 1965-66 to 1985-86

In India, different regions/states have differential concentration of crops, (Table 6). Nevertheless, rabi/spring/summer groundnut and sesame are moving very fast in non-conventional areas. Similarly, soybean, rapeseed-mustard and sunflower are gaining grounds in non-traditional seasons and regions where disease and pest problems are minimal with maximum exploitation of production potentials.

Production of both edible, Fig.1 and non-edible, Fig 2, oils is increasing steadily. The growth in population and oilseeds has been almost at par (about 2%). However, oil consumption being income elastic is going up @ 4.7% per annum leading to a vast gap between demand and supply, Fig.3. To bridge this gap, India is importing edible oils. During 1986-87, imports rose to 1.6 million tonnes and thus became the biggest importer of edible oils in the eighties. The gap is likely to widen further, unless effective measures are adopted to achieve a targeted production of 18 and 26 million tonnes of oilseeds by 1990 and 2000 A.D. to make India self-reliant in oilseeds.

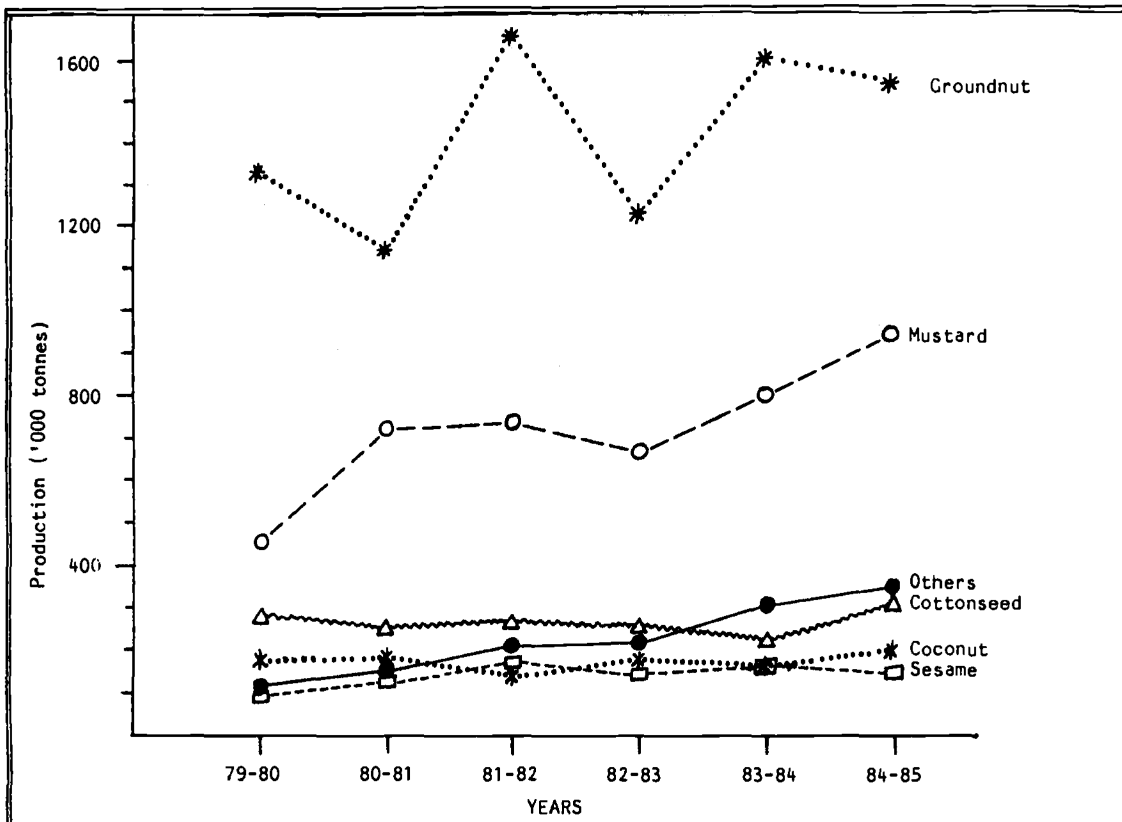

Figure 1. Production of Vegetable Oils in India, Edible Oils.

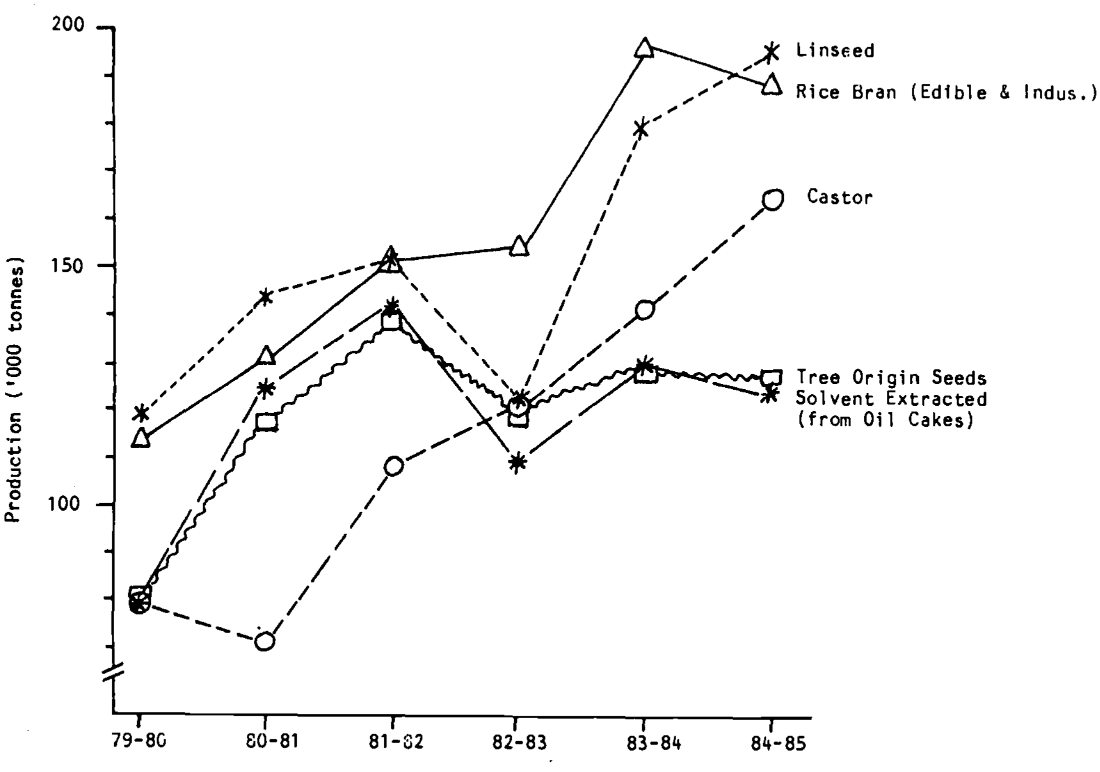

Figure 2. Production of Vegetable Oils in India, Non-edible Oils.

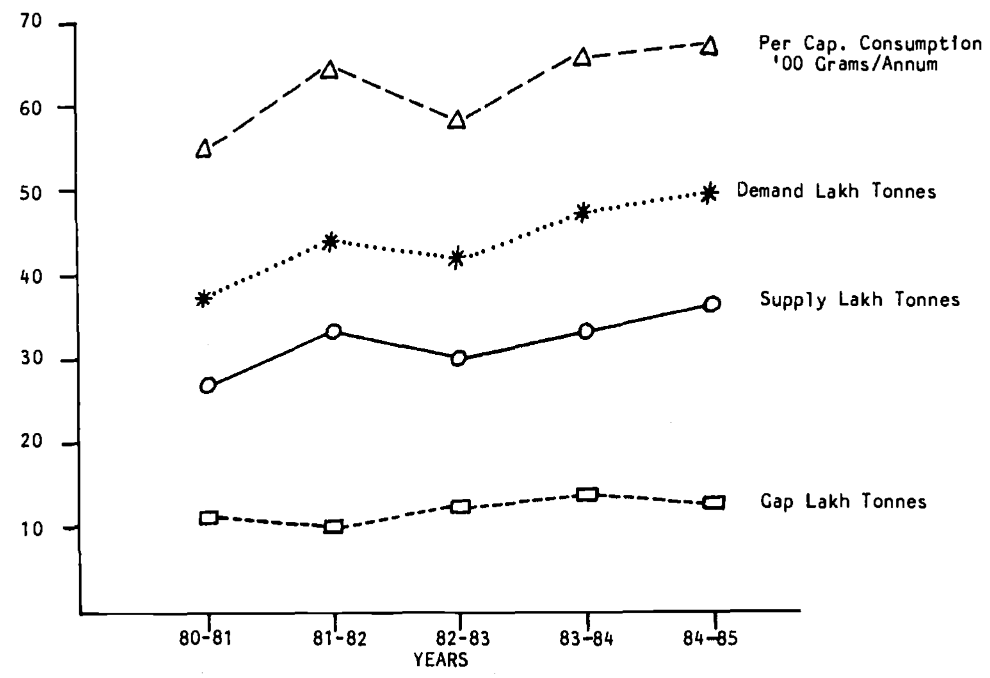

Figure 3. Demand Supply and Gap in Edible Oils During Sixth Plan.

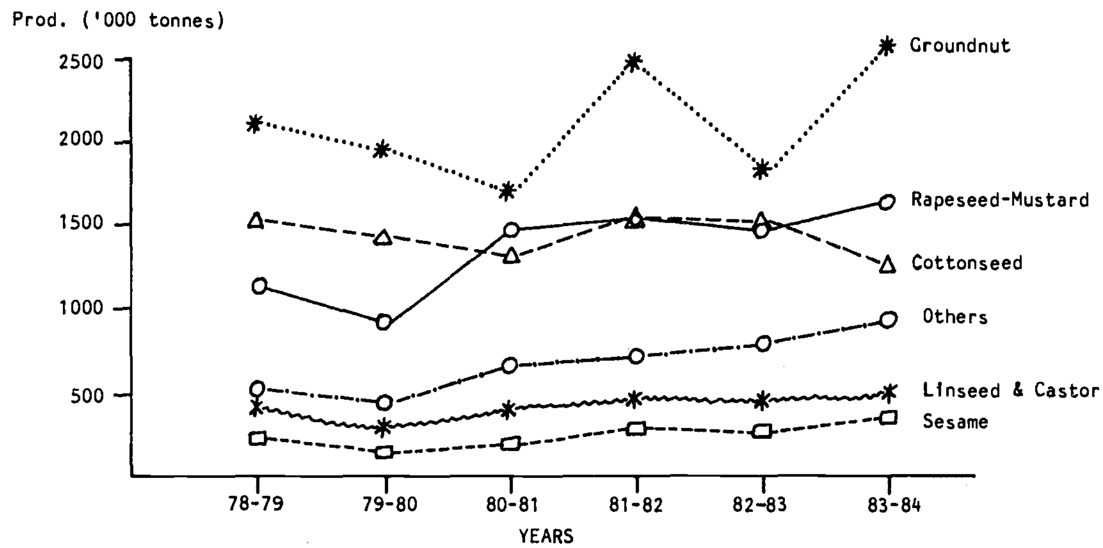

Figure 4. Production of Oilcakes in India.

Table 6. State rank in terms of area under each oilcrop (1984-85).

	Total	K	R	Rapeseed-mustard	Soy-bean	Sesame	Niger	Saf-flower	Sun-flower	Castor	Lin-seed
Gujarat	1	1	5	7		6				2	
Andhra Pradesh	2	2	1				4	3	4	1	
Tamil Nadu	3	3	2			7			3	5	
Maharashtra	4	5	6			5	3	1	1		3
Karnataka	5	4	3					2	2	4	5
Orissa	7		4			4	2			3	
Madhya Pradesh	6	6		5	1	3	1				1
Rajasthan				2	3	1				6	4
Uttar Pradesh		7		1	2	2					
Haryana				4							
Assam				3							
West Bengal				6							
Bihar										7	
Punjab							5				

K = Kharif, R = Rabi

The protein rich cakes of various oilseeds, Fig.4, are not properly utilized and many a times going as waste due to the lack of diversified usages as value added products. Also, substantial cake produced contains as much as 8% oil due to poor extraction facilities. All these add to the poor return to the oilseeds growers.

Three hundred eighteen promising varieties/hybrids evolved during the last 20 years in various oilseeds viz., groundnut (66), brown sarson (6), yellow sarson (11), Indian mustard (25), toria (17), taramira (2), sesame (45), soybean (33), safflower (13), sunflower (18), castor (40), linseed (29) and niger (13) and improved agro-production and protection technologies generated through coordinated oilseeds research network have unfolded vast short and long term opportunities for both horizontal and vertical growth of oilseeds in different agro-ecological regions and crop growing situations and systems. A number of options are now available for better monetary returns per unit area, time and input.

Short term opportunities

1. Diversification of part of the area presently occupied by less efficient crops in rainfed and irrigated areas in favor of more productive and profitable oilcrops wherever feasible as for example; Safflower and Sunflower in place of desi cotton in Karnataka; Safflower in place of chickpea, wheat in drylands of Deccan rabi; mustard in place of wheat in areas with limited irrigation in the indogangetic alluvium; sunflower in place of minor cereals in hilly areas of Maharashtra, Bihar, Andhra Pradesh and other millets growing areas in plains; sunflower and soybean in place of upland paddy in Tamil Nadu, Bihar, Andhra Pradesh, Orissa; safflower in place of barley, rainfed wheat in south-eastern Rajasthan; and in paddy fallows of Andhra Pradesh, Tamil Nadu, Karnataka, Orissa; sunflower in place of rainfed groundnut or as an intercrop with it in Saurashtra regions of Gujrat and drought prone areas of Andhra Pradesh, Karnataka etc.

2. Introduction of oilseed crops as intercrop in cereals, millets, legumes and various other crops for capitalising in terms of returns and minimizing the risk involved in different rainfed situations viz., groundnut + sunflower, groundnut + castor in all major groundnut growing areas; cotton + soybean in Maharashtra, Gujrat and Karnataka; ragi + sunflower in Karnataka; sorghum + soybean, maize + soybean in all sorghum/maize growing areas; chickpea + safflower, coriander + safflower, wheat + safflower, linseed + safflower in potential safflower belt; autumn sugarcane + mustard, wheat + mustard, wheat + chickpea in the principal rapeseed-mustard belt and potato + linseed, chickpea + linseed, lentil + linseed, autumn sugarcane + linseed in linseed belts.

3. Popularization of oilseeds as catch/sequence/relay crops before/after harvest of short durationcereals/legumes/
oilseeds in all potential two-cropped dryland areas in the country either on sustained (assured rainfall areas) or contingent (low rainfall areas) basis taking advantage of feasible and viable cereal/legume/oilseed based crop sequences identified for different situations/regions.

4. Extension of oilseeds as sole/sequence/relay/intercrop to limited irrigated areas in all potential oil crop growing areas in the country in place of those crops which require liberal and too frequent irrigations as for example rapeseed-mustard in place of wheat, rabi/summer groundnut/ sesame/sunflower in place of rice.

5. Extension of sunflower, sesame, groundnut in spring/summer after potato and sugarcane in the states of Punjab, Haryana, Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar and West Bengal where such a preposition is possible and viable.

6. Cultivation of rabi/summer groundnut and sunflower on more and more areas in Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, Maharashtra and Gujarat for higher and stable yields.

7. Extension of toria cultivation as a catch crop and rapeseed-mustard as a potential alternate crop in non-traditional areas where it is almost free from various insect pests and diseases which are in fact major problems crippling rapeseed mustard production in traditional areas.

8. Popularization of soybean as rabi crop in potential areas of the southern states where its yields are almost double than the kharif crop.

9. Exploitation of available improved production and protecting technologies involving various monetary and nonmonetary inputs to double or triple the prevailing per hectare yields of different annual oilseed crops and thereby reduce yield gaps on the farmers' fields realized with traditional technology and those attained under similar situations with the adoption of improved agro-production and protection technologies.

The long-term strategies

1. Minimize instabilities in the productivity levels of oil crops and associated risks with their cultivation in drylands through development of appropriate genotypes, crop choice and production technologies.

2. Breeding high yielding varieties/hybrids/populations with in-built resistance/tolerance to various biotic (pests and diseases) and abiotic (drought, frost, salinity, alkalinity etc.) stresses.

3. Evolving high oil-bearing varieties/hybrids/populations possessing better oil and meal quality with high biological efficiency.

4. Commercial exploitation of hybrid vigour in castor, safflower, rapeseed-mustard, and sunflower through identification/development of sources of genetic-cytoplasmic male sterility, restorers etc.
5. Breeding varieties/hybrids devoid of mycotoxins and anti-nutritional factors in seeds/extractions of crops like groundnut, soybean, rapeseed-mustard etc.

6. Evolving integrated pest and disease management systems with emphasis on low cost practices.

7. Devise, developments and popularization of farm implements and upgrading of post-harvest technologies.

8. Development of appropriate agro-production practices and cropping systems for maximizing and stablizing yields of various oilseeds under diverse agro-ecological and crop growing situations.

Specific Research Requirements of Linseed, Sunflower and Sesame

Linseed

Linseed is grown on marginal and sub-marginal rainfed soils as pure crop, mixed crop, inter-crop and paira or utera crop (broadcasted in standing paddy fields at the dough stage of paddy). The area under the crop during 1950-51 to 1984-85 has been fluctuating below 2 million hectares with an average yield at the low ebb of less than 3 q/ha, Fig.5. Madhya Pradesh, Uttar Pradesh, Maharashtra and Bihar are the major linseed growing states, having about 85% of the total linseed area of the country. The year-wise area, production and yield during eighties are presented in Fig.6. Under well managed ideal irrigated conditions, yields to the tune of 31 q/ha are realised where as average yield under paira or utera conditions are only 90 kg/ha. As about 5 lakh hectares are under utera system of cultivation, this brings down the national average yields considerably.

The following aspects need immediate attention:

(i) intensive collection and effective evaluation of germplasm for grain yield, fibre yield, various components of yield, components of seed, fatty acid profile, iodine value, resistance/tolerance to alternaria blight, linseed bud fly, cut worm, wire worm, salinity, alkalinity, moisture stresses, etc.

(ii) development of edible and technical grade varieties, separately.

(iii) breeding varieties resistant/tolerant to alternaria blight, wilt and linseed bud fly.

(iv) development of double purpose linseed varieties having fibre and seed yields at par to both best flax (fibre) and seed type varieties by genetically restructuring and reorienting branching at the top of the stem.

(v) as cytoplasmic male sterile lines are reported to be available, hybrid linseed production merits consideration.

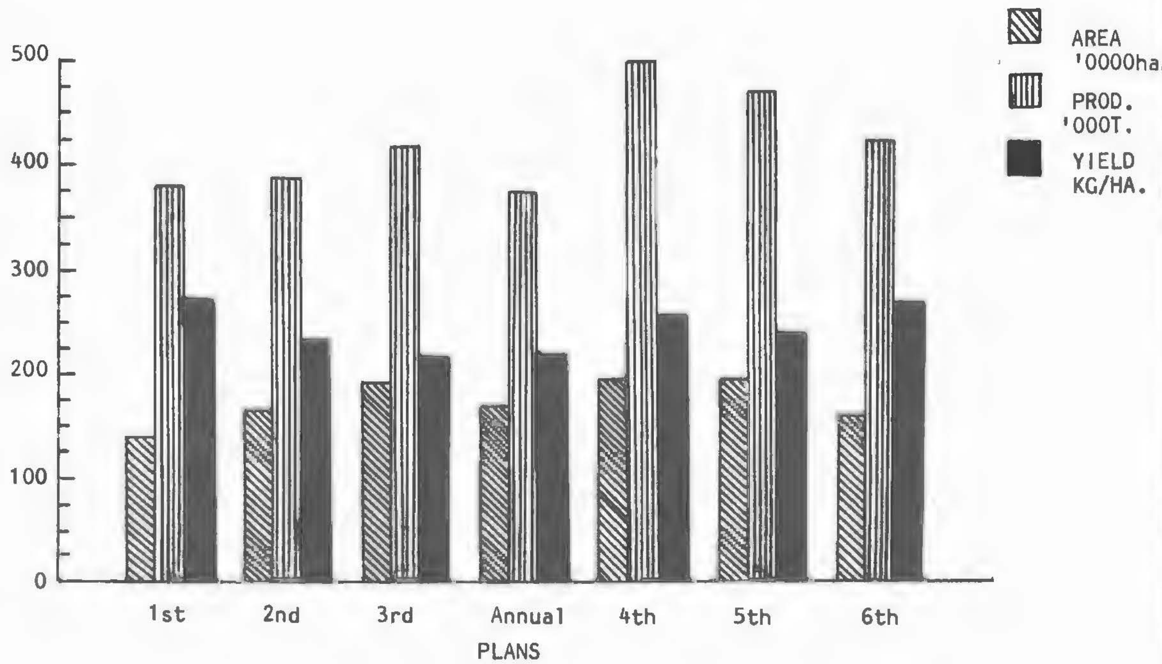

Figure 5. Area, Production and Yield -All India Plan Wise for Linseed.

(Plans: 1st=51-55, 2nd=56-60, 3rd=61-65, Annual=66-69, 4th=70-74, 5th=75-79, 6th=80-84)

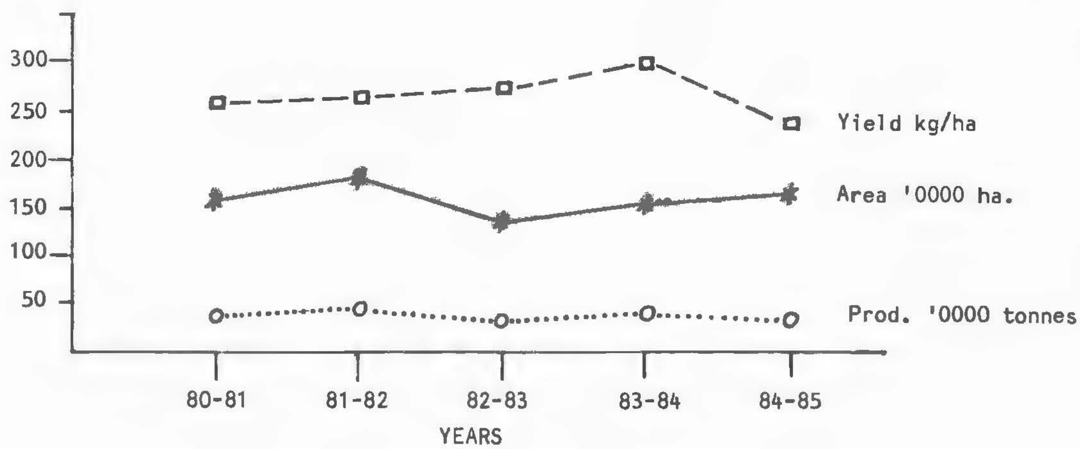

Figure 6. Area, Production and Yield of Oilseeds for Linseed.

(vi) for adverse growing situations, widely adoptable varietal blends and multiline constellations need consideration.

(vii) keeping prevailing and potential pure cropping, intercropping, relay cropping and <u>paira</u> or <u>utera</u> cropping systems in view, varieties for input intensive and input starvation conditions, need to be evolved.

(viii) matching agronomy and efficient plant protection covers for different regions and crop growing situations are to be worked out to enhance net monetary returns per unit area, time and input.

<u>Sunflower</u>

Sunflower - a new introduction during 70's has made rapid strides in terms of area and production, Fig.7. Area during 1980 to 1985 has increased to about 7 lakh/ha, Fig.8, and in fact touching one million mark in the ongoing year. The yield/ha which was going up steadily during 80's has starting showing a decline after 1985. As this crop is well suited to different regions, seasons, situations and systems, it is showing a sign of success in almost all the regions of the country. Failures are being encountered only where sunflower is being attempted in isolated pockets resulting in serious bird damage. The major research requirements of this new crop are:

(i) development of high-yielding hybrids/populations which can be had through isolation and exploitation of new CMS and restorer lines.

(ii) constellation of widely adaptable populations as replacement of seed at a very high rate is a problem in Indian agriculture.

(iii) varietal renovation and continuous upgrading of oil content in the seed.

(iv) development of early maturing hybrids/populations of about 90 to 95 days for the popularization of sunflower as a catch/relay crop.

(v) researches to enhance seed filling through the improvement of hybrids/populations and matching agronomic managements.

(vi) breeding resistant/tolerant varieties to downy mildew, alternaria blight, wilt and rust diseases which have started crippling sunflower production in recent years.

(vii) development of efficient pure cropping, intercropping and relay-cropping systems and crop geometry in different potential pockets.

<u>Sesame</u>

Although sesame occupies 3rd position in terms of acreage on the oilseeds map of the country, the productivity of the crop is one of the lowest. However, during <u>rabi</u>/summer season where crop is grown under assured irrigation conditions, the yield per ha are about 3 times more than the one realized in regular <u>kharif</u> season. The area and production has been more or less steady. But, the average has shown a few drastic drops during 1950-51 to 1984-85, Fig.9. However, average yields during 80's have increased considerably primarily due to more and more area coming into <u>rabi</u>/summer sesame, Fig.10. The research projects on priority list are:

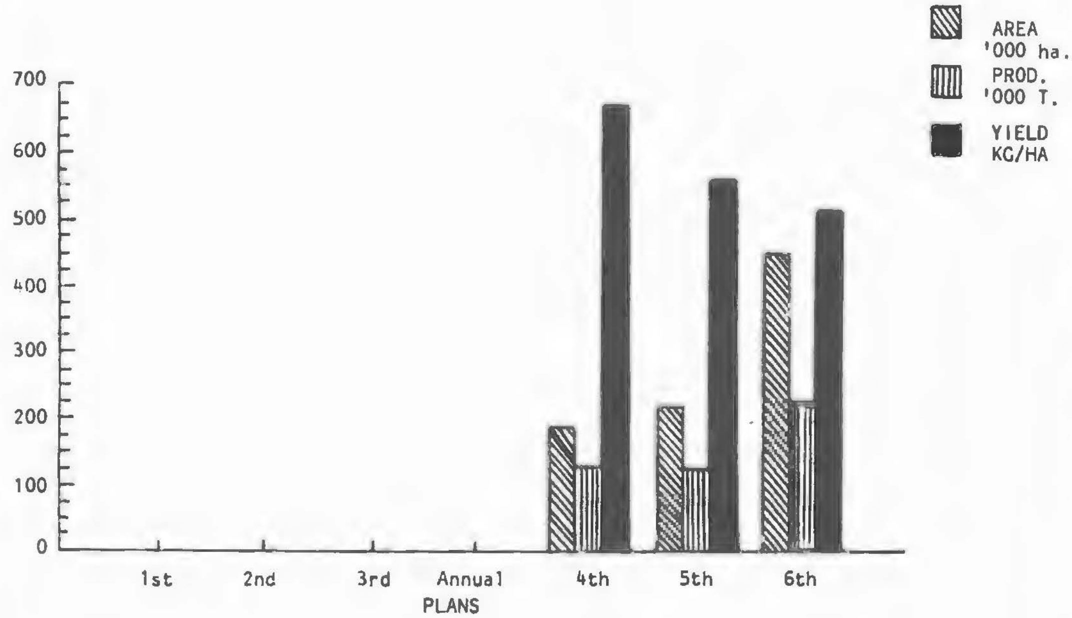

Figure 7. Area, Production and Yield -All India Plan Wise for Sunflower.
(Plans: 1st=51-55, 2nd=56-60, 3rd=61-65, Annual=66-69, 4th=70-74, 5th=75-79, 6th=80-84)

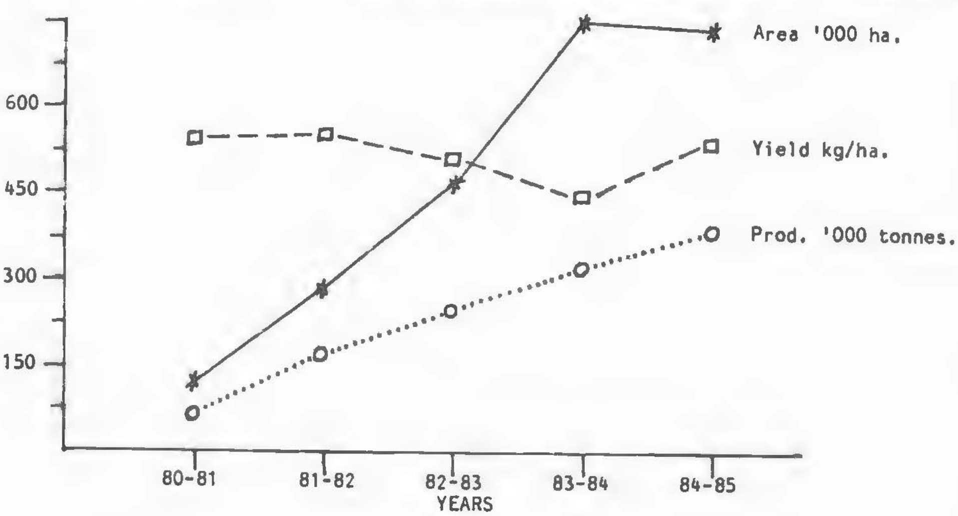

Figure 8. Area, Production and Yield of Oilseeds for Sunflower.

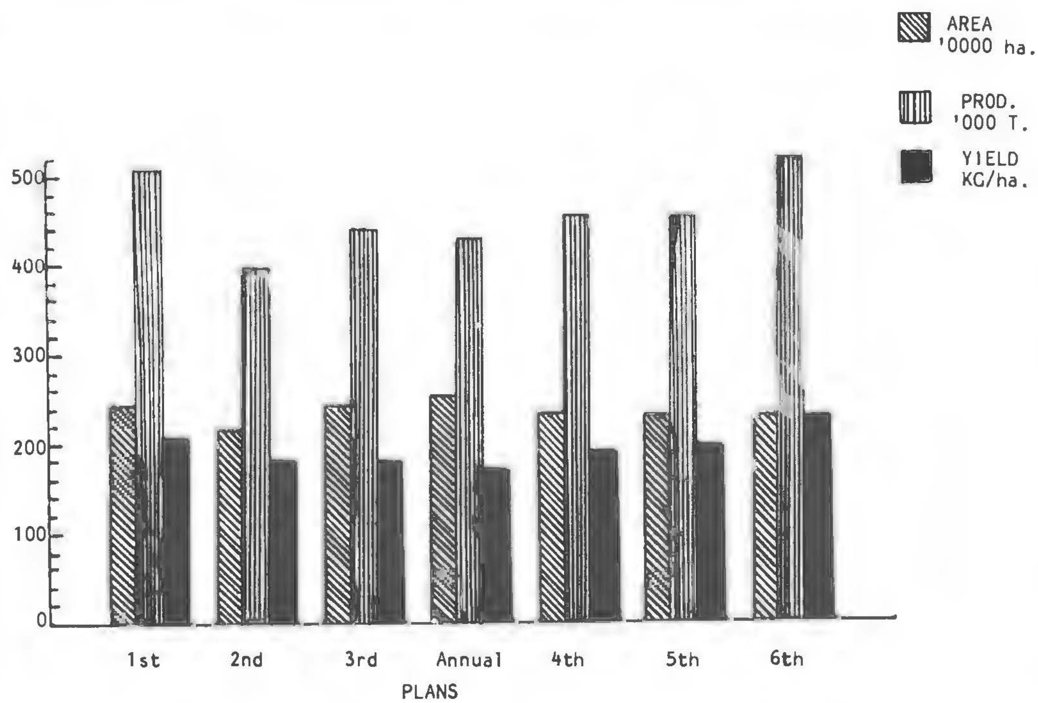

Figure 9. Area, Production and Yield -All India Plan Wise for Sesame.
(Plans: 1st=51-55, 2nd=56-60, 3rd=61-65, Annual=66-69, 4th=70-74, 5th=75-79, 6th=80-84)

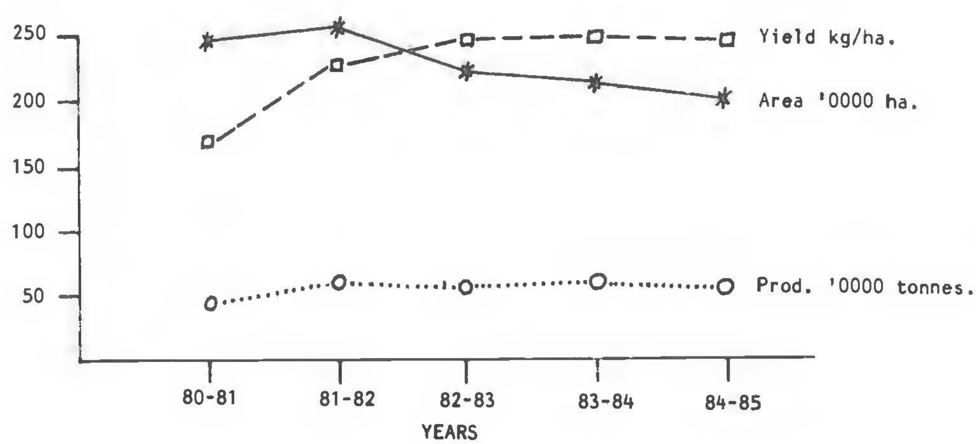

Figure 10. Production and Yield of Oilseeds for Sesame.

(i) breeding for resistance/tolerance to phyllody, phytopthora blight, cercospora leaf spot, Alternaria leaf spot and powdery mildew diseases and leaf roller, shoot borer and gall midge pests.

(ii) evolving shattering resistant varieties to realize real yield potential of varieties.

(iii) development of cold tolerant varieties to bring more and more area under non-conventional sesame tracts during winter and spring seasons.

(iv) for the popularization of sesame as a catch crop/relay crop through the development of 65-70 days varieties.

(v) development of high-yielding sesame varieties with 50 to 55% oil content in the seed.

CORRELATION STUDIES IN SESAME

S.Thangavelu and C.S. Sridharan

Abstract

The correlation studies conducted with 444 sesame genotypes representing different geographic regions of the world during two kharif, two Rabi and one Summer seasons revealed the environmental influence on the associations and the stability of few associations during Kharif or Rabi or both, or Kharif or Rabi and Summer seasons. The plant height, number of capsules on branches, number of capsules on main stem - number of capsules on branches, number of capsules on branches - yield, number of primaries- number of capsules on branches and plant height-number of primaries were found to be stable across the seasons, hence identified as reliable to be relied upon in selection program for improvement of sesame.

Introduction

Sesame is one of the important oilseed crops grown in the world as well as in India. Inspite of intensive efforts to increase the productivity of this crop, the total production remains more or less static for the last decade. The prime reason is the lack of suitable high yielding varieties. Again, yield is a complex polygenic character greatly influenced by environment. Hence, selection of superior genotypes based on yield is not likely to be effective. So, informations on the variability and character associations are absolutely necessary to formulate an effective breeding strategy. Even the study of character association for only one season might not be very useful as the sesame crop is very sensitive to the influence of environment. Further, sesame is being widely cultivated in different seasons throughout the world, and hence, study of association of important characters with yield over a number of seasons assumes special significance in deciding the basis for identifying the high yielding genotypes. An attempt was made in the present study to assess the stability of character association over the seasons during which sesame is grown in Tamil Nadu.

Materials and Methods

A total number of 444 genotypes of sesame (Sesamum indicum) representing the diverse geographic regions of the world collected at Regional Research Station, Vriddhachalam, India under IDRC assisted sesame project was raised in a single row of three meter length with a spacing of 30 cm between rows and 15 cm between plants within the row during the following five seasons:

1. 1980 Summer - irrigated
2. 1980 Kharif-rainy
3. 1980 Rabi - post-rainy
4. 1981 Rabi - post-rainy
5. 1984 Kharif - rainy

The data for the following six important economic characters were collected on five randomly selected plants in each genotype and the mean of the five plants was considered for statistical analysis.

1. Plant height at maturity
2. Days to 50% flowering
3. Number of primary branches at maturity
4. Number of capsules on main stem
5. Number of capsules on branches
6. Seed yield per plant

The correlation coefficients were calculated as indicated below using the method given by Fisher, 1932.

1. For individual season
2. For Kharif seasons pooled
3. For Rabi seasons pooled
4. For all seasons pooled

So, eight estimates are available for discussion.

Results and Discussion

The correlation coefficients for individual seasons, pooled kharif seasons, pooled Rabi seasons and pooled all seasons are furnished in Tables 1-8. A consolidated statement for the significant correlations for the different character pair associations for at least one summer or Kharif or Rabi season, one Kharif + pooled Kharif, one Rabi + pooled Rabi and all pooled is presented in Table 9.

Table 1. Correlation between different characters in sesame correlation coefficients - 1980 - Summer.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	0.1494*	0.2227**	0.5639**	0.1394	0.2756**
(2) Days to 50% flowering		0.3360**	0.615	0.3464*	0.3591**
(3) Number of primaries			0.0964	0.6396**	0.5485**
(4) Number of capsules on main stem				0.0830	0.2350**
(5) Number of capsules on branches					0.8522**
(6) Yield					--

Table 2. coorelation coefficients - 1980 - Kharif.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	0.3584**	0.2984**	0.1849**	0.2482**	0.0428
(2) Days to 50% flowering		0.2523	-0.2392**	-0.0034	0.1202
(3) Number of primaries			-0.2362**	0.3959**	0.0808
(4) Number of capsules on main stem				0.2066**	0.1449
(5) Number of capsules on branches					0.1809*
(6) Yield					--

Table 3. Correlation coefficients - 1984 - Kharif.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	0.0029	0.0654	0.0668	0.2321**	0.0849**
(2) Days to 50% flowering		0.0540	-0.1332	-0.0606	0.0285**
(3) Number of primaries			0.0205	0.0902	0.0442**
(4) Number of capsules on main stem				0.2391**	0.0074
(5) Number of capsules on branches					-0.0179
(6) Yield					--

* and ** significant at .05 and .01 levels.

Table 4. Correlation coefficients - Kharif - Pooled.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	0.2505**	0.1482*	0.2995*	0.3368**	0.2458**
(2) Days to 50% flowering		0.1455	-0.0984	0.0137	0.0614
(3) Number of primaries			-0.0371	0.2107**	0.0395
(4) Number of capsules on main stem				0.3017**	0.2434
(5) Number of capsules on branches					0.2210**
(6) Yield					--

Table 5. Correlation coefficients - 1980 - Rabi.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	0.1856**	0.4042**	0.0978	0.3047**	0.2910**
(2) Days to 50% flowering		0.0915	0.0986	0.0421	0.2401**
(3) Number of primaries			0.1034	0.5022**	0.2769**
(4) Number of capsules on main stem				0.4279**	0.2252**
(5) Number of capsules on branches					0.3975**
(6) Yield					--

Table 6. Correlation coefficients - 1981 - Rabi.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	0.1939**	0.2192**	0.5066**	0.3614**	0.3526**
(2) Days to 50% flowering		0.1043	0.1358	0.2528**	0.0062
(3) Number of primaries			0.0635	0.2725**	0.1773
(4) Number of capsules on main stem				0.3453	0.3703**
(5) Number of capsules on branches					0.5421**
(6) Yield					--

Table 7. Correlation coefficients - Rabi - pooled.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	0.2786**	0.2164**	0.4558**	0.4567**	0.2440**
(2) Days to 50% flowering		0.0961	0.1940**	0.2083**	0.1357
(3) Number of primaries			0.0651	0.3187**	0.1958**
(4) Number of capsules on main stem				0.4863**	0.2384**
(5) Number of capsules on branches					0.4186**
(6) Yield					--

* and ** significant at .05 and .01 levels.

Table 8. Correlation coefficients - all seasons - pooled.

Characters	(2)	(3)	(4)	(5)	(6)
(1) Plant height	-0.0404	0.2016**	0.4467**	0.1797**	0.2691**
(2) Days to 50% flowering		0.1012	-0.0399	0.1999**	0.2684**
(3) Number of primaries			0.0559	0.2751**	0.0992
(4) Number of capsules on main stem				0.2286**	0.0399
(5) Number of capsules on branches					0.3245**
(6) Yield					--

* and ** significant at .05 and .01 levels.

Table 9. Significant correlation coefficients between different pairs of characters - different seasons and pooled.

Character association*	At-least one K**	Both K	Pooled K	One K Pooled K	Both K Pooled K	Grade K	At-least one R	Both R	Pooled R	One R Pooled R	Both R Pooled R	Grade R	At-least one S	All pooled	Grade all
1-2	/	X	/	/	X	3	/	/	/	/	/	5	/	X	9
1-3	/	X	/	/	X	3	/	/	/	/	/	5	/	/	10
1-4	/	X	/	/	X	3	X	X	/	X	X	1	/	/	6
1-5	/	/	/	/	/	5	/	/	/	/	/	5	X	/	11
2-3	/	X	X	X	X	1	X	X	X	X	X	-	/	X	2
2-4	X	X	X	X	X	-	X	X	/	X	X	1	X	X	1
2-5	X	X	X	X	X	-	X	X	X	X	X	1	/	/	3
3-4	X	X	X	X	X	-	X	X	X	X	X	-	X	X	-
3-5	/	X	/	/	X	3	/	/	/	/	/	5	/	/	10
4-5	/	/	/	/	/	5	/	/	/	/	/	5	X	/	11
1-6	X	X	/	X	X	1	/	/	/	/	/	5	/	X	7
2-6	X	X	X	X	X	-	/	X	X	X	X	1	/	/	3
3-6	X	X	X	X	X	-	/	X	/	/	X	3	/	X	4
4-6	X	X	/	X	X	1	/	/	/	/	/	5	/	X	7
5-6	/	X	/	/	X	3	/	/	/	/	/	5	/	/	10

* 1 - Plant height; 2 - Days to 50% flowering; 3 - Number of primaries; 4 - Number of capsules on mainstem; 5 - Number of capsules on branches; 6 - Yield

** K - Kharif R = Rabi S - Summer /=correlated, X=not correlated.

During summer, all the five characters viz, plant height, days to 50% flowering, number of primaries, number of capsules on main stem and number of capsules on branches were significantly and positively associated with yield. The plant height was also found to be significantly related to days to 50% flowering, number of primaries and number of capsules on main stem, while days to 50% flowering was found to be correlated with number of primaries, and number of capsules on branches. The number of primaries was also found to exhibit significant positive association with number of capsules on branches.

Considering at least one Kharif, the following pairs of characters were found to be significantly associated: 1 with 2,3,4, and 5; 2 with 3; 3 with 5; 4 with 5; 5 with 6.

In the association for both the Kharif seasons were considered only two pairs of characters viz, plant height, number of capsules on branches and number of capsules on main stem - number of capsules on branches were significantly correlated. However, in the Kharif pooled analysis eight pairs of characters as given below showed significant relationships: 1 with 2,3,4,5, and 6; 3 with 5; 4 with 5 and 6; 5 with 6.

The character association at least for one Kharif and pooled Kharif indicated that seven pairs exhibited significant coefficient while for both Kharif and pooled Kharif only two pairs of characters showed significant associations. It is interesting to note that the following pairs which did not show any significant association at least in one Kharif season, exhibited significant associations:

- plant height and yield
- number of capsules on main stem and yield

This might probably be due to not much fluctuations between seasons. Considering the significant relationships between 15 pairs of characters for at least one Kharif, both Kharif, pooled Kharif and one Kharif + pooled Kharif, the associations between two pairs of characters viz, plant height - number of capsules on branches and number of capsules on main stem - number of capsules on branches were found to be highly stable for Kharif season.

If the correlation at least for one Kharif and pooled Kharif were considered, the following five additional associations would take the next rank: 1 with 2,3 and 4; 3 with 5; 5 with 6.

So, these correlations between five pairs of characters could be safely considered as stable for selection purposes. The relative contributions to yield (Table 10) by the number of capsules on main stem and the number of capsules on branches were found to be significant at least in one Kharif and pooled Kharif while significant contribution of plant height was observed in the pooled Kharif analysis.

Table 10. Relative contribution of five characters to seed yield in sesme in different seasons.

Character	Summer 1980	Kharif 1980	Kharif 1984	Kharif pooled	Rabi 1980	Rabi 1981	Rabi pooled	All seasons pooled
R^2 =	0.7655**	0.0594**	0.0093	0.1125**	0.2315**	0.3654**	0.1845**	0.2698**
Plant height	0.0145**	0.0011	-0.0042	0.0171**	0.0349**	0.0210**	0.0070	-0.0498**
Days to 50% flowering	0.0321**	-0.0392**	-0.0290	-0.0389**	0.1018**	-0.0496**	0.0138	0.0944**
Number of primaries	-0.0883	0.1672	-0.0206	0.0093	0.1443	0.0295	0.1191*	0.1417**
Number of capsules on main stem	0.0616**	0.0494*	-0.0007	0.0392**	0.0296	0.0825**	0.0161	0.0699**
Number of capsules on branches	0.0943**	0.0244*	0.0004	0.0196**	0.0770**	0.0910**	0.0769**	0.0628**

** = Significant at 1 percent level.
* = Significant at 5 percent level.

As the yield was associated with the number of capsules on branches which in turn are related to number of primaries and plant height, these characters could be relied upon for selection.

Krishnadoss and Kadambavanasundaram (1986 reported that plant height, number of branches per plant and number of capsules per plant were positively correlated with yield and also with each other. The number of capsules on main stem showed positive and significant correlation with yield according to Reddy et al. (1984). According to Joel (1987), plant height exhibited significant positive correlation with number of primaries, number of capsules on main stem and number of capsules per plant - during Kharif while number of capsules on main stem was associated with yield.

In the Rabi season, the expression of association between characters was found to be higher in magnitude, in general, and significant for number of pairs. The following eight pairs of characters exhibited significant positive associations at least in one Rabi, both Rabi, pooled Rabi and one Rabi + pooled Rabi thereby indicating their stability during Rabi season and reliability of the association for selection: 1 with 2,3,5 and 6; 3 with 5; 4 with 5 and 6; 5 with 6.

The relative contribution made by number of capsules on branches to yield was also stable over both Rabi and pooled Rabi followed by plant height and number of capsules on main stem. So, these two characters and plant height could be considered as main traits for selection in yield improvement for Rabi season.

An association of yield with plant height, number of capsules on branches, number of capsules on main stem showed stability during Rabi seasons and as these characters were inter-related among themselves, these characters as well as the association of these characters could be relied upon for selection in yield improvement.

Thangavelu and Rajasekaran (1983) observed high positive inter-correlations among plant height, number of branches per plant, number of capsules on main stem during Rabi season. Reddy (1986) reported in his Rabi season studies high positive inter-correlation among plant height, number of primaries, capsules on main stem and capsules on branches. The yield was also associated with plant height, number of primaries, capsules on main stem and capsules on branches. Pathak and Dixit (1986) also reported that the significant association of plant height with yield.

If the association between different pairs of characters were considered for both Kharif and Rabi seasons, two correlations viz, plant height - number of capsules on branches and number of capsules on main stem - number of capsules on branches were found to be highly stable followed by number of capsules on branches yield, number of primaries - number of capsules on branches and plant height - number of primaries. The contributions made by plant height, number of capsules on main stem and number of capsules on branches to yield during the seasons were relatively high and significant. Hence, these three characters might serve as selection indices of selection for yield improvement in sesame. It is interesting to note that the number of primaries did not show any significant association with number of capsules on main stem during any season or in pooled analysis thereby revealing their independence and the possibility of making selection for them individually. If the performance during summer had also been considered, the same criteria would have been good.

Sikka and Gupta (1949) in their studies with three genotypes for two years reported that the correlations of plant height with yield, number of capsules with yield, plant height with number of capsules and number of branches with number of capsules were not very much influenced by seasonal fluctuations. In the pooled analysis of two years data, all the correlations among plant height, number of branches, number of capsules and yield except the association of plant height with number of capsules in one genotype were found to be significant. The study of relative contribution made by each character indicated that number of capsules ranked first followed by number of branches.

In conclusion, the correlation studies made during Kharif, Rabi and summer seasons revealed the influence of environment on association of characters in sesame and the stability of certain correlations during a particular season, across the seasons and the reliable characters to serve as key character for yield improvement, as follows:

Associations stable for Kharif: 1 with 2,3,4 and 5; 3 with 5; 4 with 5; 5 with 6.

Associations stable for Rabi season: 1 with 2,3,5 and 6; 3 with 5; 4 with 6; 5 with 6.

Associations stable across all the seasons: 1 with 3 and 5; 3 with 5; 4 with 5; 5 with 6.

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PRESENT STATUS OF SESAME IN INDIA

S.Thangavelu

Abstract

Sesame is one of the major oilseed crops grown in India in an area of 2.24 million hectares with annual production of 495500 t. India ranks first in area and production of sesame in the world. The area under sesame was reduced drastically during the early sixties, however, the total production was maintained due to improved technologies. Because of the wide agro-climatic variations prevailing in the country, a number of improved varieties and technologies suitable for different regions have been evolved and recommended. The technology mission on oilseeds has been formulated and implemented starting from 1986 with the objective of achieving self-sufficiency in edible oils by 1990. Targets have been prescribed for covering all aspects of oilseed production like research priorities, technology transfer, post-harvest technology, marketing, institutional finance etc. to achieve the goal of self-sufficiency.

Sesame is one of the major oilseed crops grown in India, the other oilseed crops being groundnut, niger, sunflower, safflower, and castor. This crop is being cultivated in India from ancient times. Eventhough India ranks first in area for groundnut and sesame and third in rapeseed and castor, the production is not sufficient to meet the demand and hence a total quantity of 16 lakhs (1 lakh = 100,000) tonnes of edible oil costing 476.92 million dollars was imported last year. As per the latest figures available for 1985-86, an area of 2.24 million hectares with a total production of 495,500 t was raised under sesame. This area and production of sesame in India represents 34% and 21% of the world respectively. The average productivity in India is 221 kg/ha as compared to the world average of 353 kg/ha. Hence, there is wide gap in productivity.

The major sesame growing states in India are Rajasthan, Uttar Pradesh, Madhya Pradesh, Orissa, Maharashtra, Gujarat, Tamil Nadu, Andhra Pradesh and Karnataka although some considerable area is being grown in other states also, Table 1. About 80% of the total area under sesame is traditionally under rainfed cultivation. During 1950-51 the area of 5.6 million hectares, under sesame cultivation was drastically reduced to 2.3 million hectares during 1963-64 because of the substitution by other food and commercial crops and also the conversion of the rainfed area to irrigated area by the construction of large dams. The area under sesame during 1985-86 was estimated to be 2.24 million hectares. However, the production level was maintained more or less at the same level of 1950-51 or a little more. The total production during 1950-51 was 453,000 t as compared to 495,500 t during 1985-86. This stable production was achieved inspite of the reduction in area by about 60% as the productivity increased from 80 kg/ha to 221 kg/ha, the increment in yield being 176%. Taking into account the total period (nearly 36 years) during which this increase in productivity was achieved, the enhancement in yield cannot be considered as high. Of course, a high productivity of 283 kg/ha was obtained because of favourable seasonal conditions during 1983-84.

Table 1 Area, production and yield in kg/ha - India (1985-86)

States	Area ('000 ha)	Production ('000 tonnes)	Yield kg/ha
Andhra Pradesh	145.2	28.8	198
Assam	15.1	7.4	490
Bihar	18.5	6.8	368
Gujarat	126.8	19.6	155
Haryana	5.9	2.7	458
Himachal Pradesh	6.3	1.5	238
Jammu and Kashmir	8.3	4.9	590
Karnataka	113.5	30.1	265
Kerala	14.1	3.5	248
Madhya Pradesh	259.4	51.1	197
Maharashtra	227.2	49.9	220
Manipur	1.1	0.6	545
Nagaland	0.8	0.5	625
Meghalaya	0.8	0.4	500
Orissa	278.3	144.5	519
Punjab	13.9	5.6	403
Rajasthan	520.0	27.0	52
Tamil Nadu	126.6	43.6	344
Uttar Pradesh	277.9	17.1	62
Tripura	2.7	1.0	370
West Bengal	75.6	46.9	620
Mizoram	3.7	1.3	351
Arunachal Pradesh	0.4	0.3	750
Pondicherry	0.7	0.4	571
All India	2242.8	495.5	221

Source: Agricultural situation in India, November, 1986.

In India, being a vast country, wide fluctuations in area and production are observed because of the occurrence of drought in one or another part of the country almost every year. The area was very much reduced during the last two years because of the continuous drought which affected the production drastically. The productivity also ranged from 52 kg/ha to 750 kg/ha in different states within India, Table 2. The planting time and the varieties raised also differ widely according to the seasonal conditions as indicated in Table 3. The planting may start as early as May during rainy season and in the post-rainy season in October. Similarly, summer planting is also done under assured irrigated conditions. Hence, sesame crop is being cultivated almost throughout the year in one or another part of the country and this is more applicable to Tamil Nadu where planting is done during three seasons.

The agricultural universities in India, given the mandate of research responsibility for technology development in different crops to improve the productivity and production, have undertaken a number of research programs to cater to the needs of the different states and have released a number of location specific varieties, Table 3. A total of 35 varieties is now available in different states of India for cultivation in different regions.

Table 2. Planting time in different states of India.

States	Season	Month of planting
Rajasthan	Rainy	June - July
Uttar Pradesh	Rainy	July
Madhya Pradesh	Rainy	July
	Postrainy	Late August and early September
Maharashtra	Rainy	June - July
	Postrainy	Late August and early September
Andhra Pradesh	Rainy	May - July
	Summer	January (second fortnight)
Orissa	Rainy	June - July
	Postrainy	September - October
	Summer	February - March
Gujarat	Rainy	June
	Postrainy	September
	Summer	January - February
Tamil Nadu	Rainy	June - July
	Postrainy	October - November
	Summer	January - March
Karnataka	Rainy	April - May June - July

Table 3. Improved varieties recommended for different states.

States	Varieties recommended
Uttar Pradesh	T4, T12, T13
Rajasthan	Pratab (C-50), TC-25, T-13
Punjab	Til-1, TC-25, TC-289
Haryana	Til-1
Madhya Pradesh	N-32, Jt.7
Andhra Pradesh	Gauri, Madhavi, T-85
Orissa	Vinayak, Kanak, Kalika
Maharashtra	Phule, No.138, Tapi
Gujarat	Gujarat Til-1, Mrug, Purva, Patan-64
Tamil Nadu	TMV 3, TMV 4, TMV 5, TMV 6, CO1
Kerala	Kayamkulam-1, Kayamkulam-2, ACV1, ACV-2
Bihar	Krishna

However, all these attempts were not sufficient to meet the increasing requiremants for edible oil of the ever growing population in India. Eventhough technologies are abailable to increase the productivity, there is a large gap in yield levels at different stages as indicated below:

Research stations (potential yield) kg/ha	Demonstrations in farmer's field (realizable yield) kg/ha	Average yield kg/ha
600	400	221

Hence, attempts are made to bridge the gaps at different levels by formulating appropriate strategies like technology transfer projects, operation research project, on-farm demonstrations, lab-to-land projects etc., involving the scientists.

In India, with the objective of increasing the oilseed production to 18 million tonnes during 1989-90 and produce 5.6 million tonnes of oil from the present production of about 13.5 million tonnes, a technology mission on oilseeds has been conceived from 1986 and is under operation now. This mission takes into account all aspects of production as indicated below and is monitored directly by Prime Minister's Secretariat.

1.	Technical	Research priorities
2.	Transfer of technology	Production and inputs
3.	Post-harvest technology	Storage, processing, modernization of machinary
4.	Institutional finance	Marketing, pricing, etc.

The feasibility of increasing the production of non-conventional oils from rice bran, cotton, maize, soybean, as well as non-edible oils to arrest the diversion of edible oil for non-edible industrial purposes is also being explored under this mission.

The following strategies are being adopted to increase the production in sesame:

1. Bringing the fallow marginal lands under sesame.
2. Planting sesame as first or second crop by increasing the crop intensity where mono-cropping with long duration crops/varieties is being practised.
3. Increasing the productivity by improved technologies.

Targets have been assigned to be achieved under research programs for sesame so as to increase the oilseed production, Table 4. By adopting all these strategies, it is sincerely hoped that India will achieve self-sufficiency in the production of edible oils.

Table 4. Targets assigned to increase oilseed production.

Project	Present situation	Target	Time
1. High yielding varieties	700 kg/ha	1000 kg/ha	6 years
2. Earliness	90 days	70-75 days	5 years
3. High oil content	40-45 %	52%	6 years
4. Resistance to fungal and bacterial diseases	S	R	7 years
5. Pest-resistance (leaf roller)	S	R	8 years
6. Resistance to phyllody	S	R	7 years
7. Shattering resistance	S	R	8 years
8. Germplasm no.	3830	(Collection, evaluation and cataloguing)	
9. Fertilizer management	-	-	2 years

S = Susceptible, R = Resistant.

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GENETIC ANALYSIS OF SESAME AND BREEDING STUDIES FOR ITS IMPROVEMENT

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Introduction

The average yield of sesame in Sri Lanka is rather low with a seasonal variation from 378 kg/ha to 740 kg/ha. However, there is much higher potential in this crop as some varieties have record of over 1450 kg/ha in Sri Lanka. Low yield and its fluctuation are due to many problems faced by the farmer. These include indeterminate growth habit coupled with the shattering of capsules which result in the loss of yield in the field, narrow adaptation of cultivars and land races, pest and disease attack and low yield potential of the genotypes.

Sesame has been traditionally grown in the shifting cultivation systems, after burning the shrub jungle in the semi-arid zone of the country. Large-scale irrigation projects have been implemented in these areas recently and therefore the cropping systems have become more intensive. As a result of poor net returns, sesame is being displaced by cash crops, improved grain legumes and cereals in these newly emerging intensive cropping systems. Therefore, the improvment of yield potential of sesame through disease resistance of cultivars, change of their growth habit from indeterminate to determinate, adaptability to a wider range of environments, good response to added fertilizer and good seed retention at maturity will help to boost the production of this valuable oil crop.

Aim and Objectives of the Breeding Program

The overall aim of the sesame breeding program at the University of Ruhuna is to provide a broad genetic base for substantially increasing and stabilizing the yield and production of sesame by breeding genotypes that can be included in the newly emerging intensive cropping systems in Sri Lanka.

The specific objectives are:

a) The collection, maintenance, evaluation and utilization of the dwindling germplasm resources of sesame in Sri Lanka and elsewhere.

b) The use of varierties with neutral or low reaction to day length and disease resistant genotypes in a hybridization program with semi-dehiscent and indehiscent genotypes and with the determinate mutant (Ashri, 1982; 1985) to create a wide range of segregating populations to breed adapted cultivars with increased yield potential and good seed retention.

c) The use of mutation breeding and invitro techniques so as to create additional variability in the locally adapted germplasm.

d) The utilization of high degree of heterosis observed in sesame (Murthy, 1975; Brar and Ahuja, 1979; Godawat and Gupta, 1985; Krishnaswamy et al., 1985) in a hybrid seed production program.

In addition to the breeding program, researches in sesame agronomy, pathology and entomology are also in progress.

This sesame research program at the University of Ruhuna was started in 1986 with the financial support from US Agency for International Development. A brief review of the progress is given in this paper.

Results and Discussion

Germplasm collection and evaluation

About 200 foreign and local germplasm lines have been collected and evaluated for their morphological, physiological and yield characteristics during two growing seasons. The characterization of the collection was made according to the FAO sesame descriptors (Anon., 1981). The range of variation was found to be high for many characters studied (Tables 1 and 2). The analysis of the collection for seed oil and protein is in progress. This has been completed in 40 cultivars and the oil content ranged from 39-53% and the protein content from 22-28%. The genotypic correlation coefficient for oil and protein for the 40 samples was r = -0.203.

Table 1. Estimates of range, mean, standard error, variance, genotypic and phenotypic variability and heritability.

Plant characters	Range	Population mean	Standard error	Phenotypic variance	Genotypic variance	Phenotypic coefficient of variability %	Genotypic coefficient of variability %	Heritability %
Plant height (cm)	22.34-70.05	42.69	1.49	93.19	62.99	22.61	18.59	65.59
Height to first capsule(cm)	10.65-42.80	23.86	0.99	42.69	26.41	27.37	21.53	61.87
No. of nodes on plant	7-45	17.09	1.18	75.61	42.83	50.88	38.29	56.65
Height at flowering (cm)	15.5-47.7	26.55	0.99	42.79	30.02	24.63	20.63	70.15
Height to first flowering node (cm)	11.65-45.50	24.93	1.05	53.53	37.99	29.34	24.72	70.97
Time to flowering (days)	27.10-42.40	32.30	0.50	13.52	9.57	11.38	9.57	70.80
Plant dry weight (g)	1.47-9.35	3.84	0.25	2.79	0.69	45.53	21.62	24.67
Length of capsule (cm)	1.84-3.15	2.23	0.04	0.07	0.06	12.16	10.89	80.16
Number of capsules/plant	4.4-22	9.63	0.52	9.53	3.45	32.05	19.29	36.20
No. of nodes on stem	7-23.8	12.80	0.60	19.50	12.54	34.48	27.65	64.30
Seed yield per plant	0.1-3.51	1.41	0.10	0.42	0.90	45.68	21.20	21.53
1000 seed weight (g)	2.33-3.77	3.15	0.04	0.10	0.07	10.07	8.31	68.22
Time to maturity (days)	58-95	78.53	1.35	100.	76.49	12.78	11.21	75.86

Heritabilities (in broad sense) estimated for the different characters over two years showed remarkable consistency except for the length of capsule. Thus, the heritability was high for plant height, height to first flowering node, time to flowering, number of nodes on stem and for seed size (1000 seed weight), Tables 1 and 2. Similar high heritability values were obtained by Pathak and Dixit (1986).

Low heritability values were recorded for seed yield per plant, number of capsules per plant, number of seeds per capsule and plant dry weight. In experiments carried out with nine varieties Kandaswamy (1985) reported high heritabilities of number of seeds per capsule and yield.

Table 2. Estimates of population mean; phenotypic variance; genotypic variance, genotypic and phenotypic variability and heritability.

Plant character	Population mean	Phenotypic variance ($\sigma^2 p$)	Genotypic variance (σ^2_g)	Phenotypic coefficient of variability %	Genotypic coefficient of variability %	Heritability %
No. of capsules on main stem	25.68	196.40	56.28	55.32	29.38	28.65
Total number of capsules/plant	40.99	410.64	104.63	49.43	21.95	25.47
Plant height at flowering	43.92	198.63	128.80	32.03	25.79	64.84
Height to first flowering node	35.25	163.37	108.15	36.25	29.50	66.19
Number of nodes to fiest flower	04.88	1.95	01.21	28.74	22.66	62.05
Time to flowering	37.66	26.93	17.31	13.72	11.04	64.27
Capsule length	2.38	0.19	0.06	18.64	10.41	31.57
Number of seeds/capsule	64.08	111.08	40.50	16.41	09.91	36.46
Number of nodes/plant	33.76	432.77	174.10	61.62	39.08	40.22
Number of nodes on main stem	18.12	35.71	20.93	32.99	25.26	58.61
Number of branches	3.03	04.10	01.84	67.10	45.02	44.87
Internode length, cm	7.40	02.57	0.58	21.63	10.31	22.56
Seed yield/plant, g	5.96	14.56	06.18	61.78	41.73	45.57
Plant height, cm						

Using the same data, a correlation and path coefficient analysis (Wright, 1921; 1923) were made for the more important characters contributing to yield. The results indicated a high degree of genotypic correlation of the number of capsules, nodes, branches and the height at flowering with seed yield. When these correlations were partitioned into their direct and indirect effects by path analysis, it was found out that the correlations of the number of nodes, branches and the height at flowering with seed yield had low direct effects on seed yield. The high correlations of these characters were mainly due to indirect effects via the number of capsules (Table 3 and Fig.1). The other characters had low indirect effects on the correlation of the number of capsules with seed yield. Thus, in spite of the low heritability of the number of capsules, it's direct relation to yield needs the attention of plant breeders. Unlike in many other crops, most of the direct yield components of sesame such as thousand seed weight, capsule length and the number of seeds per capsule did not show significant positive correlation with yield.

Table 3. Genotypic correlation, direct and indirect effect on the yield in sesame.

Type of relationship	No. of capsules per plant	No. of nodes per plant	No. of branches	Height at flowering
Correlation coefficient (r)	0.852	0.760	0.540	0.473
Direct effect (P)	0.669	0.311	-0.106	0.085
Indirect effect via				
No. of capsules/plant	-	0.474	0.405	0.259
No. of nodes/plant	0.220	-	0.199	0.19
No. of branches	-0.063	-0.068	-	-0.056
Height at flowering	0.033	0.052	0.046	-

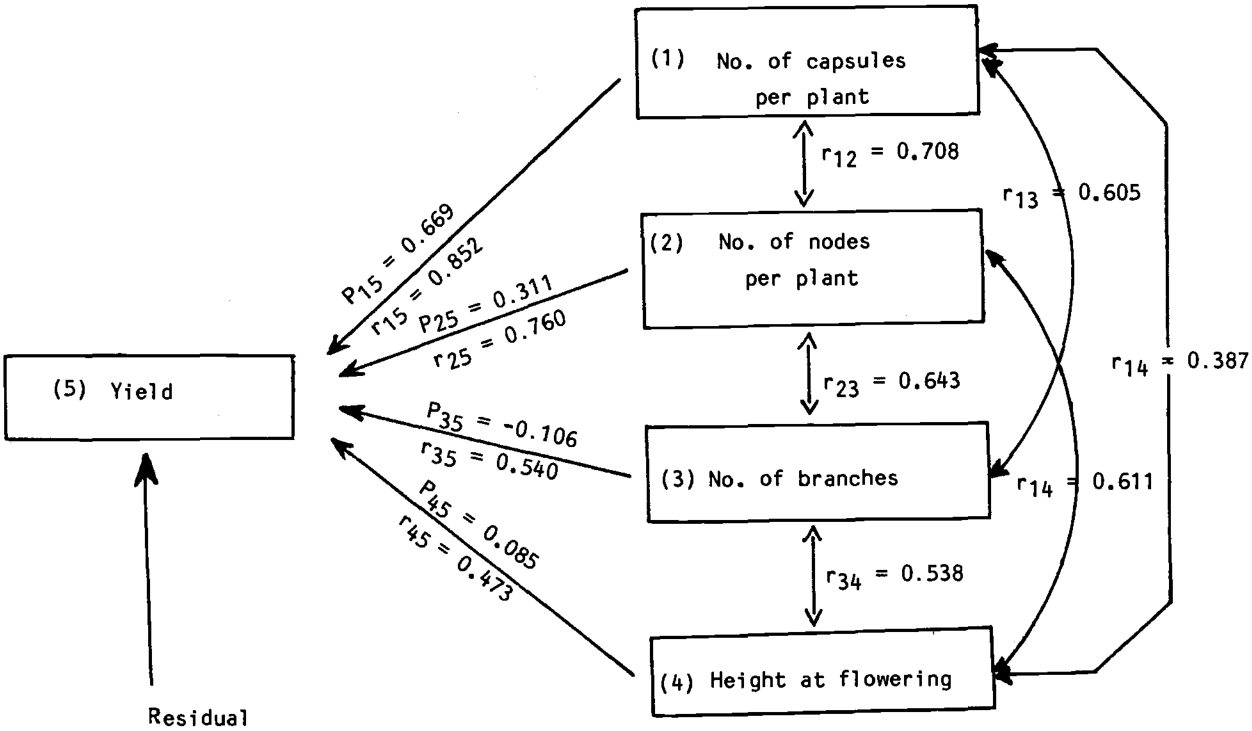

Figure 1. Path analysis in sesame.

The results of the evaluation of the varieties are maintained in the form of a varietal catalogue using a computer data base.

Hybridization

So far, about 230 crosses have been produced. The varieties widely used in the hybridization program include the improved local cultivars MI 2 and MI 3, local land races and other promising material from Sri Lanka and abroad. Phytophthora tolerant mutants induced recently (Pathirana, 1984a), determinate mutant (Ashri, 1982; 1985), Australian introduction with low reaction to change in day length (Pathirana, 1984b) and early maturity cultivars such as Bjal Sadovski and Suweon 21 are also widely used in the crossing program. F_2 seeds from another 150 crosses were harvested recently and a selection of desirable genotypes will be carried out in the coming seasons.

Induced mutations

Pilot experiments carried out have shown that sesame seeds can be irradiated with gamma rays upto 100 krads without much physiological damage. Seeds of local variety MI 2 and a promising line from a cross (TMV 3 x T 65) were treated with different doses of gamma rays, diethyl sulphate and ethyl methane sulphonate in 1986 and 1987. The M_1 plants were harvested individually and the M_2 generation was raised on an M_1 plant to M_2 progeny basis.

In the M_2 several promising variants were selected. These included early maturity, short internode, three capsules per leaf axil in MI 2 which is a BAN type; increased carpel number, small leaf etc. Some of these selections have been already confirmed in M_3 as stable mutations.

High yielding and normal looking plants were also selected in M_2 for progeny testing.

Another mutant with completely split corolla was sterile and hence pollen from parent plant is being used to pollinate these flowers and to maintain this sterile type. In 1947, D.G. Langham has reported a type with completely split corolla. This character was found to be controlled by two recessive genes (Brar and Ahuja, 1979).

Reaction to day length and combining ability

All possible F_1 crosses involving seven contrasting varieties viz MI 2, Australian Introduction, Oro tall, Bjal Sadovski, Determinate, Criolla de falcon and Suweon 21 and the parent varieties were tested for the reaction to two day lengths in a factorial strip plot design with two replications. The two day lengths given were the normal southwest monsoon period day length (12 hrs. 30 min) and artificially shortened day (11 hrs. 30 min.).

Out of the many characters studied on a 10-plants-per plot-basis the time taken to flowering exhibited significant differences for the day length treatments, genotypes and their interaction. The differences in time taken to flowering under the two day lengths were least in the Australian Introduction, which confirmed our earlier results with this variety (Pathirana, 1984b). Even the early flowering varieties like Bjal Sadovski and Suweon 21 reacted more to the change in day length than the Australian Introduction (Table 4).

Table 4. Performance of seven sesame cultivars under two day lengths.

Character / Variety	Time taken to flowering (days)		Plant height at flowering (cm)		Number of leaves at flowering		Plant height (cm)		Capsules per plant		Seed yield per plant (g)	
	T_1*	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Australian Introduction	48	51	46	42	52	48	77	72	35	28	3.7	3.2
Bjal Sodovski	30	39	23	25	14	31	48	43	10	12	0.9	1.5
MI-2	52	66	52	55	96	106	97	81	71	65	8.7	8.0
Ore Short	41	45	29	31	41	39	45	53	15	13	1.4	1.3
Criolla de Falcon	68	76	81	95	147	207	107	117	34	49	3.3	4.2
Determinate	42	45	14	23	16	24	44	38	22	19	2.0	1.7
Suweon 21	38	48	25	28	37	35	42	37	21	8	2.2	1.0

* T_1 = Reduced day length - 11 hrs 30 min. T_2 = 12 hrs 30 min.

For the other characters studied including the capsule number and seed weight per plant, the differences in the two day length treatments were not significant. The genotypic differences and the interaction of light period with genotypes were significant for all the characters. The additive effects were more important than the dominance effects.

For the varieties MI 2 and Criolla de Falcon, a high general combining ability for yield and number of capsules was recorded. The crosses with high specific combining ability for yield characters are Criolla de Falcon x Determinate, MI 2 x Determinate and Determinate x Suweon 21. The estimated GCA and SCA effects of the varieties and crosses are presented in Table 5.

Table 5. Estimated SCA and GCA (underlined) effects for number of capsules per plant.

Cultivar*	162	48	152	32	76	67	51
162	-<u>0.263</u>	6.42	-2.44	-4.9	2.05	10.93	8.69
48		-<u>5.518</u>	2.814	3.35	7.49	-4.71	0.11
152			<u>12.592</u>	-6.38	7.55	-20.51	0.7536
32				-<u>8.447</u>	-0.914	1.6397	7.019
76					<u>12.25</u>	17.542	-15.903
67						-<u>1.4038</u>	12.455
51							-<u>9.2083</u>

* 162 = Australian Introduction; 48 = Bjal Sadovski
152 = MI 2; 32 = Oro short
76 = Criolla de Falcon; 67 = Determinate
51 = Suweon 21
SE (gi - gi) = 2.95012; SE = (sij - sik) = 8.3442
SE (sij - sik) = 7.8053; CD = 5.78225

<u>Varietal response to soil moisture levels</u>

Four contrasting sesame cultivars were grown in plastic pots specially designed to control the soil moisture level. Nine soil moisture levels, as shown below, were given by changing them at the vegetative and flowering periods.

Treatment number	Vegetative phase	Flowering and maturity
1	Irrigation at wilting	Irrigation at wilting
2	- do -	60% of field capacity
3	- do -	80% of field capacity
4	60% of field capacity	Irrigation at wilting
5	- do -	60% of field capacity
6	- do -	80% of field capacity
7	80% of field capacity	Irrigation at wilting
8	- do -	60% of field capacity
9	- do -	80% of field capacity

The cultivars tested were MI 2, MI 3 (two morphologically contrasting, locally released cultivars), UCR - 82 - 203 NS (an introduced cultivar with indehiscent capsules) and Instituto 71 (an introduced cultivar with three capsules per leaf axil). The experiment was carried out in a factorial, randomized complete block design in a rain protected device.

The varietal response was most marked in the treatments where the soil moisture levels were different at the flowering phase. The highest evapotranspiration rate during the vegetative and flowering phases was recorded for the variety Instituto 71 (9.7 mm/day and 12 mm/day respectively). The total water consumption in this variety was significantly different from the other three varieties studied. Although the total water consumption in MI 2, MI 3 and UCR - 82 - 203 NS was not significantly different, the water use efficiency was higher in MI 2 and MI 3 because of their higher yield.

The number of capsules and yield were reduced by 27-50% in different varieties when the soil moisture level was reduced from 80% of field capacity to irrigation at wilting (Fig. 2). Results clearly indicate that sesame is more susceptible to moisture stress at flowering than at vegetative growth phase.

Acknowledgement

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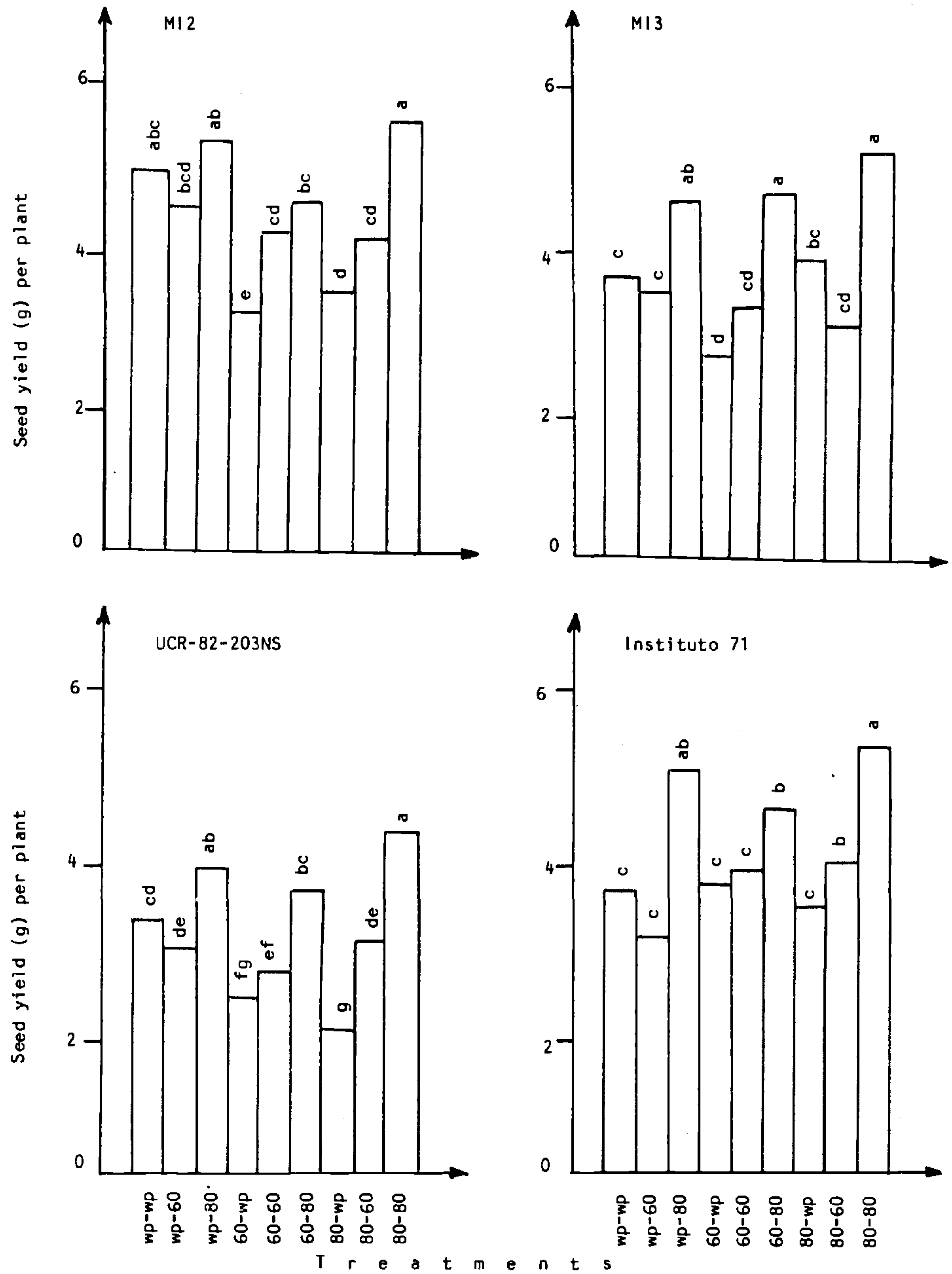

Figure 2. Effect of soil moisture level on seed yield of sesame cultivars.

SESAME IMPROVEMENT IN SRI LANKA

L.A. Weerasena

Abstract

Sesame (Sesamum indicum L) is a priority and traditional oil crop grown in Sri Lanka and its cultivation is confined to dry and intermediate zones. The average yield fluctuates around 500 kg/ha. The main objectives of the sesame improvement program are increasing yield, developing disease/pest resistance and ideotypes, and identifying the varieties specific to one season or non-sensitive to both seasons. Genetic stock is being maintained and evaluated for various morphological attributes. The main characters observed were: branching type, plant height, number of capsules/plant, height to first bearing capsule, number of locules/pod, number of capsules/axile pod length, maturity, seed colour and seed weight. Induction of genetic variability through physical and chemical mutagens has been made to evolve a resistant variety for phytophthora blight disease. Attempts are also being made to enhance yield and incorporate other desirable attributes through hybridization and selection procedures. Field tolerant lines to phytophthora blight have been evolved.

Introduction

The oilseed improvement program of Sri Lanka was initiated in 1981 by the support of IDRC (Canada) with the objectives of developing the traditional annual oilseed crops such as sesame, groundnuts, mustard and castor and to undertake feasibility studies with other oilseed crops such as sunflower, safflower and niger. The project headquarters is located at the Regional Research Cenre, Angunukolapelessa, in the southern dry zone of Sri Lanka.

In Sri Lanka, sesame is mainly used in the confectionary industry and as a source of edible oil particularly in the northern and eastern areas. In addition, it was found that sesame stubble has a good potential for the production of high quality papers.

The two main growing seasons in Sri Lanka are Maha or periods of major rains (Oct. to Jan.) and Yala or periods of minor rains (April to July). Based on the amount of rainfall the country is divided into three major moisture zones: wet (>2000 mm) intermediate (1000-2000 mm) and dry (<1000 mm). These zones are further subdivided into different agro-ecological regions on the basis of rainfall distribution.

The majority of the dry zone is at a relatively low elevation and much of this land occupies major sesame growing areas. In the intermediate zones sesame is grown as an intercrop under coconut palm. About 84% of the cultivation is done during the Yala season while about 16% of the crop is sown in Maha in the driest areas such as Hambantota and Thanamalwila due to eratic and insufficient rainfall, Table 1. Almost all sesame farmers establish their crop as broadcasted mono or as a mixed crop with finger millet.

Table 1. Cultivation extent and production of sesame during the period from 1981 to 1986.

Year	Extent (Ha) Maha	Yala	Average yield (kg/ha) Maha	Yala	National average (kg/ha)
1981/82	7295	27660	574	515	545
1982/83	6324	29841	655	523	589
....					...
1984/85	5074	31716	654	394	524
1985/86	4410	27775	645	345	495
Percentage	16%	84%	22%	78%	

Source: Agricultural implementation program, Ministry of Agriculture and Research, Sri Lanka.

During the normal years the average yields vary from 450 to 580 kg/ha. The yields of Maha cultivation are higher than the Yala season, Table 1. Increased production in some years can be attributed only to the increased cropping area.

The recommended varieties are black-seeded types MI-1 and MI-2 and white seeded MI-3. However, the majority of subsistant level farmers used locally adapted cultivars which are location and season specific. White-seeded varieties are preferred for the export market.

Sesame improvement program has been carried out at the Regional Research Centres, Angunukolapelessa and Mahailluppalama in the sourthern and north central dry zones of Sri Lanka respectively.

Breeding Objectives

At the inception of the project many objectives were identified for the breeding program but phytophthora blight prevalent in the area was a strong barrier as it destroyed the experimental plots on many occasions. Except for the phytophthora blight resistance, the main objectives identified in the sesame breeding program at Angunukolapelessa are as follows:

1. Improving the yield potential of the existing varieties and stablizing production.
2. Developing white seeded varieties particularly for the export market.
3. Developing resistance to major pests (Antigastra catalaunalis).
4. Developing resistance to diseases (Phyllody, mildew).
5. Developing varieties suitable for different seasons and locations.
6. Evolving varieties suitable for all seasons and locations.
7. Developing ideotypes for different farming systems.
8. Breeding varieties responsive to high inputs.

Breeding Strategies

The prime importance of any breeding program is placed to enlarge the existing genetic stocks through collection of local cultivars and foreign introductions. After evaluation and screening of the germplasm, desirable cultivars for parental purposes with desired traits can be isolated. Thus, since 1981 our sesame germplasm collections were increased both by introductions and local cultivars.

As phytophthora blight is an economically important disease in sesame in the southern dry zone, a mutation induction program was initiated to evolve resistant cultivars. However, the introductions or local cultivars did not show any resistance to the disease. Gamma rays and chemical mutagents (EMS and dES) were used to induce resistance or tolerance variability in different genetic backgrounds. Thus, induced variants were screened under field conditions and tested for field and other performances.

A crossing program was also initiated using such tolerant mutant lines as parents to high yielding adapted varieties. In addition, a back crossing program was also initiated very recently to incorporate white colour seed coat into tolerant mutant lines.

Results

Desirable cultivars having various desired attributes have been identified by field screening and evaluation of breeding materials and germplasm. Some of the characteristics observed were branching habit, number of branches, maturity, plant height, length of capsule bearing portion, height to first capsule from the soil, leaf characteristics, pod length, number of locules, number of pods per plant, seed colour, pest and disease resistance. In general, local cultivars consisted of very tall plants having larger unbearing portions from the soil, and branching habit. The majority of the local cultivars were also photoperiod sensitive. Exotic cultivars were normally short in stature with higher number of capsules per leaf axile.

A number of mutant lines have been identified for phytophthora blight tolerance under field conditions, Table 2 & 3. Advanced breeding lines are in the national level yield testing Table 4.

Table 2. Performances of mutant lines tested at R.R.S. Angunukolapelessa 1983/84 Maha.

Line	Days to mature	Plant height (cm)	No of branches	Capsules /plant	Survival %	Yield kg/ha
180/52	92	94	4.9	80	67	747
182/3	88	94	3.7	50	54	611
182/15	92	104	5.2	74	65	847
MI-3	85	112	0	72	7	106

Table 3. Preliminary yield evaluation and other characteristics of phytophthora tolerant mutant lines of sesame, RRS A'pelessa, 1986/87 Maha season.

Mutant line	Seed Colour	Branching habit and No. branches	Number of pods/leaf axile	Number of locules/ pod	Number of pods/plant	Yield kg/ha	% check
183 - 2	Black	Br. (3.3)	1.0	4	27.4	494	60.9
180 - 36	Black	Br. (2.4)	1.0	4	42.8	607	97.7
182 - 5	Black	Non.bran.(0)	1.5	6-8	23.5	276	-10.1
180 - 43	Light brown	Br. (3.8)	1.0	4	27.1	475	54.7
182 - 23	Black	Br. (3.9)	1.0	4	70.0	689	124.4
182 - 30	Black	Br. (3.6)	1.0	4	35.3	685	123.1
182 - 25	Black	Br. (3.5)	1.0	4	41.9	443	44.2
180 - 28	Black	Br. (3.4)	1.0	4	35.1	689	124.4
182 - 11	Black	Br. (4.2)	1.0	4	45.9	554	80.5
182 - 15	Black	Br. (2.8)	1.0	4	43.4	402	30.9
182 - 32	Black	Br. (2.0)	1.0	4	26.4	575	87.3
182 - 2	Black	Br. (3.4)	1.0	4	38.9	523	70.4
180 - 35	Brown	Br. (3.2)	1.0	4-6	28.6	474	54.4
Mi-3 check	White	Non br. (0.0)	2.5	4	19.8	307	0.0

CV% = 34.7

Table 4. Yield (kg/ha) performances of advanced lines of sesame tested at different agro-climatic regions, 1986/87.

Variety	Site: A'pelessa Yield	A'pelessa Rank	Site: Monaragala Yield	Monaragala Rank
Taivan white	710	9	1423	3
T40 x Paloma (Sel)	754	7	1398	4
TMV3 x T65	852	3	1051	9
182/3	794	4	1593	1
P37 x Margo Sel	858	2	1318	5
MI-3 x A.I. (tall)	768	6	1582	2
MI-3 x A.I. (short)	778	5	1214	8
Sudu thala 102	722	8	1233	7
Margo x MI-3 Sel	979	1	1267	6
MI-3 (check)	713		1417	
Location mean	793		1350	
CV%	23.5		22.3	
F	NS		NS	

SUNFLOWER, SESAME AND LINSEED IN PAKISTAN - A COUNTRY REPORT

Masood A. Rana and M. Munir

Edible Oil Position

Edible oil deficit problem stands first among the food problems of the country. More than 75% of the total foreign exchange spent on the import of foodstuff is used for the import of edible oils. Its deficit is increasing at a rate of (+)8.4% every year. On the average of the last 10 years, import bill is increasing by Rs.604 million annually and during 1985-86 it has reached upto 7520 million rupees i.e., US$470 million, Table 1.

Table 1. Share of domestic production and import in the total availability of edible oil in Pakistan and value of imported oil.

Year	Domestic production	Import	Total availa-bility	% of total availability	Value* Million dollar	Value* Million rupee
	(000 tonne					
1975-76	184	270	454	59.5	105.3	1047
1976-77	175	285	460	62.0	149.3	1478
1977-78	212	298	510	58.4	156.9	1553
1978-79	183	361	544	66.4	298.0	2953
1979-80	228	439	667	65.8	231.8	2295
1980-81	226	471	697	67.6	265.2	2625
1981-82	236	624	860	72.6	336.6	3450
1982-83	249	657	906	72.5	319.1	3670
1983-84	176	730	906	80.5	460.6	6516
1984-85	256	684	940	72.8	432.3	6954
1985-86e	276	746	1022	73.0	470.0	7520

e = Estimated.
* = Value of imported edible oil.
Source: Agricultural Statistics of Pakistan (many issues).

Pakistan has been making impressive progress in agricultural sector over the last several years. But it remained chronically deficient in edible oil production. This increasing deficit in the country is attributed mainly to the growing population, the increase in per capita consumption and the stagnant local production of oilseeds. The annual per capita consumption has increased from 4.9 kg to 9.12 kg during the last eleven years, Table 2. The expanding urbanization, increased household incomes, and the high cost and meagre availability of animal fats are responsible for the increase in per capita consumption of vegetable oil.

The local production of oilseeds meets only about 30% of the total requirements of the edible oil. The domestic production of edible oil has increased at a very low annual growth rate i.e., (+)2.7% for the last one and half decades. Most of this increase was due to more production of cottonseed. Edible oil produced in the country was 252,000 and 320,000t in 1971-72 and 1986-87 respectively. As a result the gap between production and consumption has become very large, Fig.1.

Table 2. Annual per capita consumption (kg/annum) of edible oils in Pakistan.

Year	Cooking oil	Vegetable Ghee	Total
1975-76	0.97	3.95	4.92
1976-77	1.13	4.51	5.64
1977-78	0.40	4.84	5.24
1978-79	0.80	5.51	6.31
1979-80	0.85	5.72	6.57
1980-81	1.09	6.22	7.31
1981-82	1.10	6.67	7.77
1982-83	1.12	6.97	8.09
1983-84	0.98	6.77	7.75
1984-85	1.15	7.12	8.27
1985-86e	-	-	-

e = Estimated.
Source: Agricultural Statistics of Pakistan (many Issues).

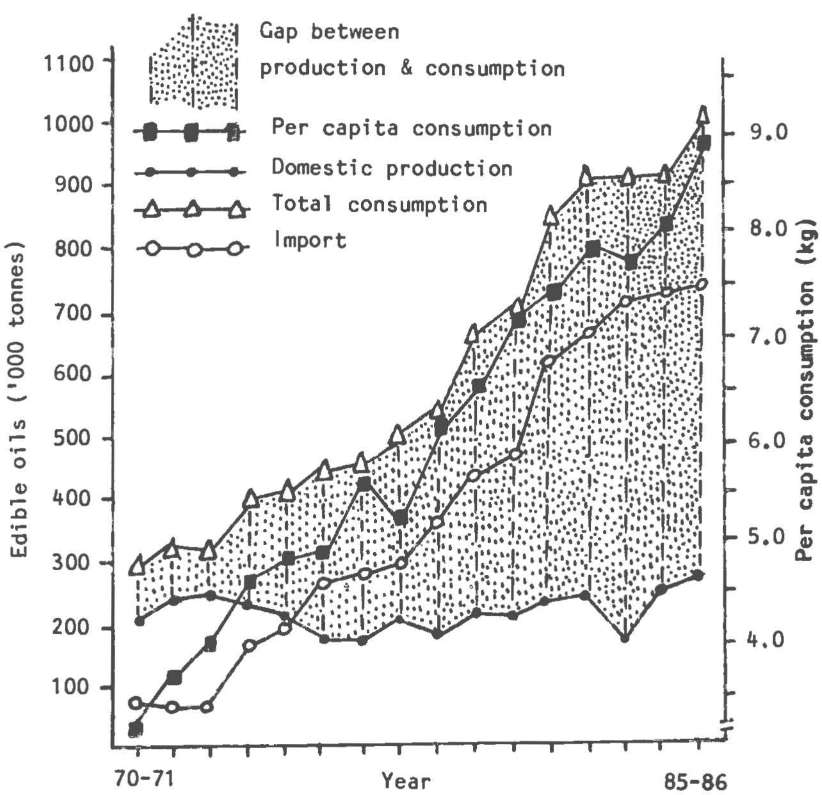

Figure 1. Domestic production, import, per capita consumption and gap between production and consumption of edible oils in Pakistan from 1970-71 to 1985-86.

Oilseed Crops in Pakistan

At present, the major portion (more than 70%) of the total production of edible oil in Pakistan comes from cottonseed which is primarily grown for its fibre and hence does not come under the general characterization of oilseed crops. Oilseed crops grown in the country are classified into two groups viz, conventional or traditional and nonconventional or new. Rapeseed, mustard, groundnut and sesame are conventional crops and have been grown in Pakistan for a long period of time. Sunflower, soybean and safflower are nonconventional crops and have been introduced in the country in the recent past.

Area, production and average yields of the oilseed crops are given in Tables 3,4 and 5 respectively. Moreover, there are some oil bearing trees such as olive and coconut which are being tried to increase the local production of edible oil. In addition to those described above, there are other oilseed crops such as linseed, castor etc. which are grown in the country and used for industrial purposes, Table 6.

Table 3. Area ('000 ha) under oilseed crops in Pakistan.

	Conventional crops				Nonconventional crops				Grand
Year	Rape*	Sesame	G.nut	Total	Soybean	Sunfl.	Saffl.	Total	total
1975-76	470	28	44	452	0.83	0.48	-	1.31	543
1976-77	519	30	45	594	1.66	0.39	-	2.05	596
1977-78	412	32	51	495	3.05	0.04	0.04	3.13	498
1978-79	433	46	37	515	3.44	0.48	0.23	4.15	520
1979-80	409	46	41	496	3.51	0.59	0.22	4.32	501
1980-81	417	44	47	508	3.16	4.68	2.38	10.22	518
1981-82	391	43	60	493	3.69	7.24	4.23	15.16	509
1982-83	386	29	69	483	4.10	8.13	4.13	16.36	500
1983-84	313	22	73	408	4.33	8.46	2.87	15.66	424
1984-85	347	34	59	440	4.54	9.59	2.88	17.01	457
1985-86	351	38	55	444	4.21	19.80	2.70	26.71	471
1986-87	362	33	63	458	6.50	48.50	3.00	58.00	516

* Rapeseed and mustard.
Source: Agricultural Statistics of Pakistan, 1986.

Rapeseed and mustard are grown over almost 400,000 ha annually and they constitute, on the average, over 21% of the indigenous production of edible oils. Groundnut, the second largest oilseed crop of the country, is used as roasted nut and no oil is extracted from it. All other crops such as sesame, sunflower, soybean and safflower constitute only about 6% of the local edible vegetable oil production, Table 7.

Average yields of all oilseed crops are very low. The gap between potential yields of oilseed crops and the national average yields is very wide, Table 8. Mostly, conventional oilseeds are grown on the marginal lands and proper inputs are not applied to them by the growers. New oilseeds are passing through the process of introduction and farmers do not yet know their production technology. Consequently, national averages of the oilseeds are very low as compared to the other developed countries.

Table 4. Production ('000 tonnes) of oilseeds in Pakistan.

Year	Conventional crops				Nonconventional crops				Grand total
	Rape*	Sesame	G.nut	Total	Soybean	Sunfl.	Saffl.	Total	
1975-76	267	11	62	339	0.40	0.23	-	0.63	340
1976-77	296	12	64	373	0.62	0.19	-	0.81	373
1977-78	236	13	72	321	1.29	0.04	0.04	1.37	322
1978-79	248	19	46	312	1.76	0.31	0.22	2.29	315
1979-80	247	19	50	317	1.33	0.36	0.24	1.93	319
1980-81	253	18	57	328	1.34	3.49	2.16	6.99	335
1981-82	239	17	72	328	1.54	5.86	4.40	11.80	339
1982-83	246	11	84	341	1.35	6.31	4.45	11.12	353
1983-84	217	9	88	314	1.45	6.80	3.09	11.34	325
1984-85	235	14	69	317	1.80	7.79	3.14	12.73	330
1985-86	244	15	63	322	1.50	17.60	2.80	22.0	349
1986-87	271	13	75	359	3.60	37.80	2.80	44.2	403

* Rapeseed and mustard.
Source: Agricultural Statistics of Pakistan, 1986.

Table 5. Average yield (kg/ha) of oilseed crops in Pakistan.

Year	Conventional crops			Nonconventional crops		
	Rape & Mustard	Sesame	Groundnut	Soybean	Sunflower	Safflower
1975-76	572	378	1411	484	472	-
1976-77	572	397	1421	370	483	-
1977-78	573	399	1228	423	946	1114
1978-79	573	409	1245	511	649	927
1979-80	604	419	1233	378	600	1090
1980-81	606	414	1234	424	746	910
1981-82	611	388	1208	416	809	1041
1982-83	638	379	1214	329	776	1077
1983-84	693	394	1213	335	804	1076
1984-85	677	397	1170	397	812	1090
1985-86	711	397	1149	356	889	1094
1986-87	750	377	1194	554	779	933

Source: Agricultural Statistics of Pakistan, 1986.

Table 6. Area, production and average yield of linseed and castor in Pakistan.

Year	Area ('000 ha)		Production ('000 t)		Av. yield (kg/ha)	
	Linseed	Castor	Linseed	Castor	Linseed	Castor
1975-76	8	11	4	8	563	750
1976-77	8	15	4	11	550	736
1977-78	10	17	6	13	547	732
1978-79	13	46	7	35	531	769
1979-80	10	23	6	18	609	775
1980-81	11	23	7	18	608	779
1981-82	10	22	6	18	602	779
1982-83	8	31	5	26	601	811
1983-84	9	30	5	24	571	817
1984-85	9	27	5	22	549	826
1985-86	11	27	6	22	545	829

Source: Agricultural Statistics of Pakistan, 1986.

Table 7. Share of different oilseed crops in the total production of edible oil in Pakistan.

Year	Production of edible oil ('000 tonnes)					Oil as % of total		
	Rape & Mustard	Cotton-seed	Total	Other*	Grand total	Cotton-seed	Rape & Mustard	Other*
1970-71	77	119	196	14	210	56.7	36.7	6.7
1971-72	76	158	234	18	252	62.7	30.2	7.1
1972-73	84	154	238	14	252	61.1	33.3	5.6
1973-74	80	140	220	16	236	59.3	33.9	6.8
1974-75	77	127	204	16	220	57.7	35.0	7.3
1975-76	70	103	173	11	184	56.0	38.0	6.0
1976-77	75	88	163	12	175	50.3	42.9	6.9
1977-78	83	116	199	13	212	54.7	39.2	6.1
1978-79	68	95	163	20	183	51.9	37.2	10.9
1979-80	69	144	213	15	228	63.2	30.3	6.6
1980-81	71	160	231	15	246	65.0	28.9	6.1
1981-82	71	169	240	20	260	65.0	27.3	7.7
1982-83	70	185	255	20	275	67.3	25.5	7.3
1983-84	69	105	174	26	200	52.5	34.5	13.0
1984-85	75	160	235	27	262	61.1	28.6	10.3
1985-86	71	242	313	27	340	71.2	20.9	7.9
1986-87 e	78	264	342	29	371	71.2	21.0	7.8

e = Estimated.

* = Sesame, sunflower, soybean and safflower.

Source: Agricultural Statistics of Pakistan (many issues).

Table 8. Gap between the national average and potential yields of different oilseeds crops.

Crop	Yield (kg/ha) National*	Yield (kg/ha) Potential**	Gap (kg/ha)
Rapeseed & Mustard	693	2750	2057
Groundnut	1213	4000	2787
Sesame	394	1200	806
Soybean	335	3500	3165
Sunflower	804	3800	2996
Cottonseed	1076	1500	424
Linseed	549	2600	2051
Castorbean	545	2800	2255

* Agricultural Statistics of Pakistan, 1986.

** Yield obtained in research plots.

To increase the domestic production of edible oils, more emphasis is being given to promote both conventional and nonconventional crops. Nonconventional crops such as sunflower and soybean are short duration crops, can be grown twice a year and can also fit in the existing cropping pattern easily as catch crops. There is also a lot of area available where these nonconventional crops can be grown without disturbing the area under main staple crops of Pakistan, Table 9.

Table 9. Estimated area available for planting sunflower and other nonconventional oilseed crops such as soybean and safflower.

Land Description	Area ('000 ha)	% area available	Area available ('000 ha)
Dobari	1900	30	570
Cotton fallow	2210	30	663
Rainfed	6000	27	1500
Riverine	4500	75	3375
Intercropping (with sugarcane)	946	25	236
TOTAL	15560	41	6344

Source: USAID, OICD estimates, 1984.

SUNFLOWER (*Helianthus annuus* L.)

Sunflower, as an oil crop, was introduced in Pakistan during early 1960s and research work was initiated in 1964-65 in Sind. Subsequently, sunflower germplasm was evaluated at different provincial research institutes. Experimental results were encouraging and they provided motivation for starting commercial cultivation in Pakistan.

Sunflower open-pollinated varieties, Noor and Shams, which were developed through selection from Peredovik and Armevirate respectively were given for commercial cultivation. Some sunflower hybrids, NK-212, Suncross-843, Hysun-33, Cargill-206, etc. are also grown on commercial scale and their seed is imported from USA and Australia.

A large number of hybrids of different origins have been tested under the hybrid testing program at the National Agricultural Research Centre (NARC), Islamabad, Table 10. Among those tested Florem-206, Florem-328, NS Condore, Adalid-8, Romsun-150, NK-212, Sunbred-280, Sunbred 265 and Do-164 were promising, Table 11.

Table 10. Sunflower germplasm tested at NARC, Islamabad during 1984-1987.

S. No.	Country	No. of varieties/ hybrids tested
1.	USA	34
2.	Romania	45
3.	Yugoslavia	22
4.	Spain	8
5.	Hungary	17
6.	West Germany	3
7.	Australia	10
8.	Canada	1
9.	Turkey	2
10.	Bulgaria	2
	Total	144

Commercial cultivation of sunflower began in 1965, but it did not increase rapidly as expected up to 1984-85 since it was grown on negligible area, Table 3. However, the area under sunflower is now increasing very rapidly. During 1986 it was grown on 10,000 ha while during spring, 1987 it increased to 48,500ha. Like all other oilseed crops, the average yield of sunflower is much lower than most of the countries.

Existing production area

Most of the area under sunflower is in Punjab and Sind. On the average of the last 5 years (1980 to 1985), 52% of the total area in Pakistan is located in Punjab, 47% in Sind and only 1% is in NWFP. The area in Punjab is almost equally distributed in Sargodha, Faisalabad, Sialkot, Gujranwala, Sheikhupura, Kasur, Okara, Sahiwal, Multan, Rahimyar Khan and Vehari districts. However, the planting of sunflower is now being concentrated in Gujranwala division, in a rice-based farming system, and in Multan and Sahiwal districts, in a cotton-based farming system. In Sind, sunflower is grown mostly in Badin district (61%). Other important sunflower areas in Sind are Nawabshah, Hyderabad, Thatta, Tharparkar, Sanghar, Badin and Sukku.

Table 11. Performance of some promising sunflower hybrids grown at NARC, Islamabad during autumn (A) and spring (S) of 1985-87.

Variety	Origin	Yield (kg/ha)				Plant height (cm)				Days to mature			
		85A	86S	86A	87S	85A	86S	86A	87S	85A	86S	86A	87S
NK-212	USA	1783	3242	1332	1904	158	179	145	154	78	127	110	118
Sunbred-254	USA	-	2725	1973	2023	-	177	134	129	-	131	103	123
Sunbred-262	USA	1025	3159	2194	2283	115	187	145	143	77	131	106	123
Sunbred-265	USA	-	3041	2060	2148	-	137	116	129	-	128	100	119
Sunbred-280	USA	1359	2900	2127	1697	121	160	125	120	78	126	106	118
Sunbred-2012	USA	1283	3052	1796	1974	106	162	131	170	76	132	-	124
Do-164	USA	-	-	2204	2064	-	-	144	129	-	-	104	114
Do-704	USA	-	-	1995	2743	-	-	133	149	-	-	103	116
Do-855	USA	-	-	2187	2145	-	-	125	132	-	-	103	116
Florem-206	USA/ROM	1575	3495	-	1739	121	164	-	133	76	126	-	117
Florem-328	USA/ROM	1750	3201	-	1785	101	178	-	150	81	128	-	121
Florem-412	USA/ROM	1076	3243	-	1698	108	195	-	146	80	128	-	121
Romsun-150	ROMANIA	1972	3476	2091	2049	118	188	138	145	78	132	110	120
Romsun-155	ROMANIA	-	3008	2102	2455	-	170	112	146	-	131	108	119
Adalid-8	YUGOSLAV	1560	3591	-	-			-	-			-	-
NS Condor	YUGOSLAV	2038	3573	-	-	147	187	-	-	82	124	-	-
NS Helios	YUGOSLAV	1683	3013	-	-	134	181	-	-	81	123	-	-
NS Shine	YUGOSLAV	1401	3522	-	-	123	177	-	-	82	127	-	-
IH-51	YUGOSLAV	1793	2813	-	-	100	144	-	-	78	116	-	-
IH-173	YUGOSLAV	1882	2981	-	-	93	170	-	-	76	127	-	-
Suncross-140	AUSTRALIA	-	-	2533	2870	-	-	121	140	-	-	102	117
Suncross-24	AUSTRALIA	-	-	2494	2227	-	-	118	112	-	-	106	117

Potential production area

In addition to the above production areas, there are many places where sunflower can be grown successfully such as Lasbela, Naseerabad, Kachhi, Khairpur, Larkana, Rajanpur, D.G. Khan, Layyah, Jhang, Gujrat and D.I. Khan.

Scope of sunflower

Research work at the provincial research institutes and NARC, Islamabad as well as trials conducted at the farmers' fields have indicated that sunflower is adaptive to many agro-ecological regions and can give high yields. Thus it has a potential to bridge the gap in the country. The following are the advantages of sunflower growing:

a. It has high yield potential (up to 3.8 t/ha).
b. It is a short duration crop (matures in 90-110 days) and can easily be grown twice a year.
c. Being tolerant to drought, it can be successfully grown in rainfed areas.
d. It is a cash and catch crop.

e. Being a short duration crop, it can fit in the existing cropping system without clashing with the major crops such as wheat, cotton and rice.
f. It has a potential to produce the highest oil yield per hectare.
g. Oil can be extracted from it with extraction equipment already present in Pakistan.

Organizational setup

It has been shown that with the increase in the area under sunflower, more diseases, insects, and production problems are encountered and they are expected to increase further in the future. To counter these problems, a feedback system of research on sunflower has been established using the existing facilities at the following research organizations in Pakistan:

1. National Agricultural Research Centre (NARC), Islamabad which is a part of the Pakistan Agricultural Research Council (PARC) at national level under Agricultural Research Division of the Ministry of Food and Agriculture. PARC coordinates the research activities and planning with various concerned agencies at national and provincial levels.

2. Agricultural research and extension departments under the provincial ministries of agriculture.
3. Ghee Corporation of Pakistan under the Ministry of Industries. It is responsible for the procurement and promotional activities for the new oilseed crops.

Production Technology

Planting time

(1)	Punjab:	(a)	Spring crop:	February to 10th March
		(b)	Autumn crop:	July to 10th August
(2)	Sind:	(a)	Spring crop:	January to end of February
		(b)	Autumn crop:	July to end of August
(3)	NWFP:	(a)	Spring crop:	15th February to 20th March
		(b)	Autumn crop:	July only
(4)	Baluchistan:	(a)	Spring crop:	March to 25th April

Plant population

(1) 40,000 - 50,000 plants/ha for rainfed lands.
(2) 45,000 - 60,000 plants/ha for irrigated lands.

Planting method

Row planting with distance of 60 to 75 cm between rows and 25 to 30 cm between plants.

Fertilizer application

(1) Irrigated: 120:60:25 NPK kg/ha
(2) Rainfed: 75:50:00 NPK kg/ha

Irrigation

Twenty to 35 mm of water is required during growth period and 3-4 irrigations are enough for satisfactory yields. However, at high tempratures one additional irrigation is required. The last irrigation should be applied two weeks after the start of flowering.

Major insect pests

(1) Hairy caterpillars	(Diacrisia obliqua)
	(Euproctis spp.)
(2) Armyworm	(Cirphis unipuncta)
(3) Gram Caterpillar	(Heliothis spp.)
(4) Cabbage Semilooper	(Plusia orichalcea)

Diseases

(1) Charcoal rot	(Macrophomina phaseolina)
(2) Alternaria blight	(Alternaria helianthi)
(3) Wilt	(Verticillium dehliae)
(4) Stalk and head rot	(Sclerotinia sclerotiorum)

Constraints

(1) Lack of improved and high yielding varieties for different regions and for different seasons.
(2) High cost of imported seed and lack of assured supply.
(3) Unawareness of farmers about the crop and its production technology.
(4) High bird damage at the maturity stage.
(5) Nonexistance of private or government agencies which would produce sunflower hybrid seed locally (some private agencies interested in this field have recently come on the scene).
(6) Failure of sufficient seed setting in open-pollinated biotypes in hotter regions of the country.
(7) Nonexistance of planting and threshing equipments.
(8) Defective and inefficient procurement system of farmers' produce.

Proposed future strategy

(1) Strengthening the research capabilities on sunflower crop.
(2) Producing local hybrids.
(3) Increasing the area under sunflower.
(4) Improving in the marketing system.

SESAME (Sesamum indicum)

Sesame is the most ancient oilseed crop known to man. Charred sesame seeds as old as 3500 B.C. have been found from excavations at Harappa, Pakistan. Sesame oil is regarded as one of the best oils for its high quality and stability. In Pakistan it is mostly used for confectionery purposes and as an ingredient for cakes, cookies and bread. The oil, the seed and even the leaves have also had several medicinal and other desirable properties.

Sesame is cultivated on a limited area and is considered a minor oilseed crop. Like other traditional oilseed crops in Pakistan, the area under sesame has remained almost stagnant. It was grown on 30,600 ha in 1970-71 and remained almost static until 1977-78. The area under sesame increased by about 15,000 ha from 1978 to 1981 when, on an average of four years, it was planted on over 44,800 ha.

During 1982-83, the area suddenly dropped once again to 28,500 ha and was reduced to 22,400 ha during the following year. Over an average of 15 years the area under sesame increased with an annual growth rate of (+)0.66% from 1971-72 to 1986-87. Total production of sesame in Pakistan was 13,000t during 1986-87, Table 4. The highest production of 19,300t was recorded during 1979-80.

Average yield

Sesame, in general, is a low yielding crop. Its highest yield potential reported in the literature is 2200 kg/ha which was exploited in the experimental plots in Egypt. In Pakistan, its average yield is only 390 kg/ha, which is obviously very low as compared to the yields realized in Egypt, USA and Mexico. The average yield of sesame has increased in the last 15 years from 341 to 397 kg/ha, which indicates an annual growth rate of (+)0.76%.

Constraints of low yield

Although it is an established crop in Pakistan and has been grown there since ancient times, it has never received much importance as an oil crop. The main causes for its present low average yield are:

(1) Shattering losses due to high susceptibility to capsule splitting at maturity.
(2) Uneven maturity of pods on one plant.
(3) Lack of improved varieties.
(4) The use of indigenous cultural practices.
(5) The use of inferior quality sed because certified seed is not available.
(6) Cultivation on marginal lands.
(7) Nonavailability of proper marketing and potential buyers for the produce.
(8) Damage by diseases and insect pests due to the lack of resistant varieties and plant protection measures.

Prospects of sesame

Due to the above critical shortcomings, it can be predicted that sesame will likely remain a minor oilseed crop in Pakistan for some time. However, the present situation is not completely hopeless, since there are countries where high yields of oil from sesame are being obtained (El Salvador, Guatemala, Honduras and Afghanistan). The same may be possible in Pakistan as well if proper attention is paid to the development of this crop. More emphasis should be given to the work on this crop. If such efforts are launched for the improvement of sesame as have been done for major crops such as cereals, a high yield potential can be obtained at least like those of the other oilseed crops.

Proposed future strategy

Strengthening research program: Sesame needs some important genetic improvement through plant breeding work. Even if one character such as development of nondehiscent-type capsules is sought, it will be a great breakthrough in research and will increase sesame yields considerably. A strong research program should be started for sesame crop to accomplish the following objectives:

(1) Nondehiscent-type capsules. These may be possible through mutation breeding.
(2) Plant type on which capsules mature uniformly.
(3) Plants with a large number of capsules.
(4) Varieties resistant to diseases and insect pests.
(5) Development of production technology suitable for different areas.

LINSEED (*Linum usitatissimum*)

In Pakistan, linseed is mainly grown for its seed which has industrial and medicinal uses. Linseed oil is a drying oil and is used in varnishes and paints. The residue after oil extraction is a valuable high protein cattle feed called linseed cake.

Area and production

Linseed is mainly grown in Sind and Punjab provinces. In Punjab, it occupies about 68% of the total area in Pakistan. In Sind, the crop is generally grown without irrigation on the residual moisture in the rice fields. It is also grown as an intercrop with field peas, rapeseed and mustard etc. The area under linseed was 11,000 ha during 1985-86 which produced 6,000t of seed. The crop is generally affected by wilt disease in Punjab but is mostly free in Sind.

Varieties

The approved variety of linseed in Sind is L-1 and in Punjab, it is T-5. There is little activity on the breeding of linseed in both provinces. However, there are few more promising lines which have been developed and will be released in the future for general cultivation.

Constraints

Major constraints hindering production in linseed are:

(1) Lack of major linseed research program in the country.
(2) Absence of seed multiplication programs.
(3) Low inputs and poor management conditions.
(4) Absence of assured floor prices.

Possibility of Establishment of an IDRC Supported International Oilcrops Centre in Pakistan

The IDRC oilcrops network for East Africa and South Asia is planning to establish an international oilcrops unit in a country of East Africa or South Asia. This information was conveyed by Dr. Abbas Omran, Technical Adviser, Oilcrops Network, during his visit with the project Director BARD, SSO Oilseed Program NARC, Director General NARC, Member (Crop Sci.) PARC and Chairman PARC at Islamabad. Dr. Omran indicated that they have not taken final decision on the location of the proposed new centre and that they have been thinking for setting it up in Ethiopia or Sri Lanka. It was proposed to him that the centre can also be established in Pakistan, but he expressed that negotiations are taking place with Ethiopia and that the decision will be taken during discussions at this workshop. He suggested that Dr. M.Munir, SSO BARD, who will attend this meeting may propose the idea to the workshop forum.

The following factors go in favour of this proposal of establishing an international oil crops center in Pakistan.

1. Oilseeds - a critical agricultural problem

Pakistan is chronically deficient in edible oil production and the deficit has attained a magnitude of menace to the country's economy. During 1985-86, the annual import bill reached upto Rs.7520 million (equivallent to US$ 470 million). The bill has been increasing @Rs 604 million annually for the last 10 years. The edible oil import bill constitutes more than 75% of the total foreign exchange spent on foodstuff. It is realized that there is a pressing need to solve this problem.

2. Oilseeds production - a major thrust of the government

Due to high magnitude of the problem, a high priority is given to it by the Government of Pakistan. GOP will welcome any suggestion, effort or program regarding the increasing oilseed production in the country. So the environment to start such a project is very conducive and favourable in Pakistan.

3. Senior management endorse the idea

During his visit to Pakistan, Dr. Omran met with the high officials of Pakistan government - Chairman, PARC; Secretary, Agricultural Research Division; Oilseed Commissioner (Ministry of Agriculture); Member (Crop Sci.) PARC and Project Director BARD. They all endorsed and supported the idea of hosting such an international research centre in Pakistan.

4. All oilcrops grow in the country

Almost all oilseed crops; namely, brassica (more than five species), sesame, groundnut, linseed, sunflower, safflower, soybean and castor etc. are grown in the country at various locations and in diverse cropping situations. Any new technology such as variety, production technology, marketing and processing can therefore be tested within the country.

5. Basic infrastructure available

The basic infrastructure of agricultural institutes i.e., good pool of scientists is present from which talent can be drawn to work on various oilseed crops whenever such need arises. A CIDA-and PARC-funded agricultural research and development project, BARD, is in progress which will be terminated by June 1991. BARD's present management agrees fully with the idea and has offered its assistance to start up such a new centre.

6. On-going breeding programs on oilseed crops

Major breeding programs are already underway on rapeseed, mustard, sunflower, safflower, linseed, castor etc., at NARC and provincial research institutes.

7. Adequate physical facilities at research institutes

Physical facilities at agricultural research stations are fairly good especially at NARC, and are superior to many research facilities in developing countries.

8. Facilities for comfortable living

All the facilities for comfortable living of expatriate scientists are available in the cities near the research institutes.

9. Commodities available

Almost all commodities are available in Pakistan.

10. Easy access in the area

NARC and other research institutes are situated within easy access to air terminals and daily connections to major world centres.

11. Free movement of scientists

Movement of scientists in and out of the country is not restricted.

12. Transportation around the area available

There are good transport services around the area for movement of the scientists, especially air and rail services which are really good.

13. Location

The location of such an international institute established in Pakistan will be central to most of the African and Asian countries.

14. No other international research institute

There is no other international agricultural research institute present in Pakistan. This is an additional reason why Pakistan should be strongly considered for the establishment of an International Research Centre on Oilcrops.

15. Capable of hosting international conferences

There will be a need to hold international meetings and conferences at this centre. We, at NARC, have demonstrated the capability of hosting international conferences.

SESAME, LINSEED AND SUNFLOWER IN NEPAL

M.L. Jayaswal

Introduction

Oilseeds occupy about 124,000 ha of land with a production of about 83,000 metric tonnes. Although the major contribution in the area and production of oilseed is from rapeseed-mustard (Brassica campestris var. toria), some other oilseed crops such as groundnut (Arachis hypogaea), sesame (Sesamum indicum), linseed (Linum usitatissimum), niger (Guizotia abyssinica), safflower (carthamus tinctorius) and castor (Ricinus communis) have also been grown in Nepal for a long time in the past. Chiuri (madhuca butyracea) has been grown in the hills of Nepal for centuries for its seed from which oil is extracted for human consumption. Separate statistics of area and production of various oilcrops are not yet available.

Sesame

Sesame has been grown in different parts of Nepal for years, although on small-scale, for farmers domestic use. In spite of its various industrial uses, it has been mainly used in Nepal for worshiping, confectionaries, pickle preparations and as illuminating oil. In recent years, it's cultivation has shown an increasing trend. In Chitwan, a very potential district for agricultural production, the cultivation of sesame in the last few years has increased to a great extent replacing some maize areas as the sesame price went up to NRs.22.00/kg (almost doubled) while maize price and production has been steady.

The major cropping patterns for sesame are:

a. Paddy nursery-sesame-fallow
b. Sesame-fallow
c. Sesame-rapeseed/mustard (recent).

In the map, it is shown that sesame cultivation is scattered throughout "tarai" and "midhills" although its concentration is more in tarai, Figure 1.

A varietal evaluation with sixteen entries (received from FAO) conducted at Nawalpur during 1987/88 on acidic soil (pH=6.0) showed that varieties Instituto-81, Ciano-16, No.450 Katy and No.449 Kostantsa were earlier in maturity than the local cultivar.

The introduced varieties matured between 70 and 80 days while local cultivars took 94 days to mature. The seed yields were not very high i.e. mean yield obtained from Ciano - 16, No. 449 Kostantsa, Instituto-81, No. 450 Katy and local check were 459 kg/ha, 450 kg/ha, 434 kg/ha, 425 kg/ha and 411 kg/ha respectively.

Major insect pests of sesame

1. Jute hairy caterpillar - Spilosoma obligua (WiK)
2. Leaf and pod caterpillar - Antigastra catalaunalis (Dup)
3. Til hawk moth - Acherontia stynx (West)

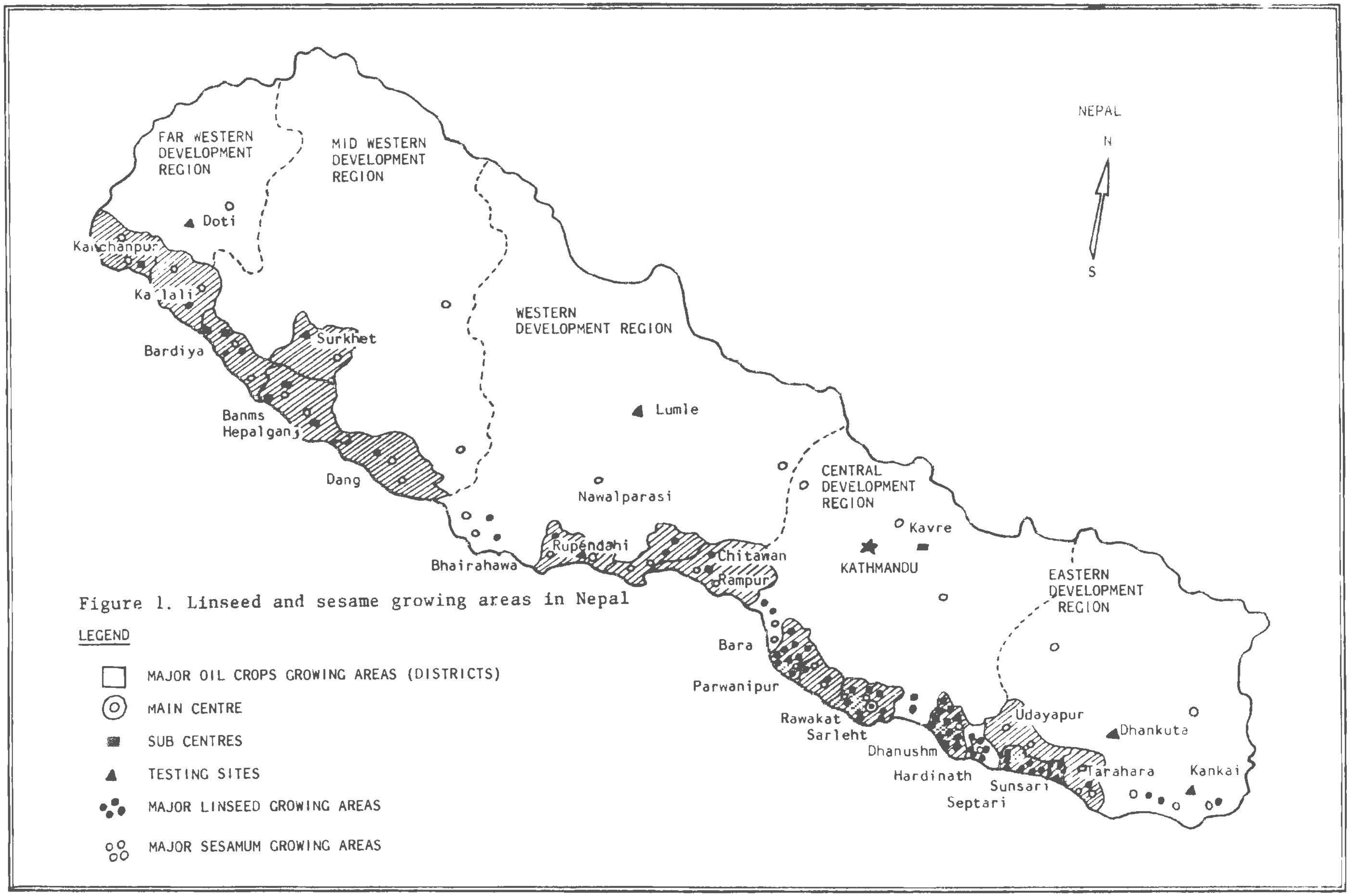

Figure 1. Linseed and sesame growing areas in Nepal

Major diseases of sesame

1. Phyllody - virus transmitted by insect orosius sp.
2. Leaf spots - Cercospora sesami Zimm
3. Stem rot - Macrophomina phaseoli Maubl.

Linseed

Linseed has been grown in Nepal for years but on marginal lands of tarai and inner tarai regions. The yield of linseed in Nepal is estimated to be 200-300 kg/ha. This crop is grown on marginal land with minimum tillage and inputs. Prevalant cropping patterns for linseed are:

a. Rice/linseed - Linseed is broadcasted as relay crop in standing rice without any fertilizer.
b. Rice - linseed
c. Rice - linseed + Lentil and/or chickpea + rapeseed.

Much of the linseed production in the country is exported. The export data available is only up to 1978. Besides India, 3,517, 1,522 and 1,668 metric tonnes of linseed were exported during 1975/76, 1976/77 and 1977/78 respectively.

In the map it can be noted that the cultivation of linseed has been mainly in the tarai with greater concentration in the central region, Figure 1.

There seems to be enough scope for yield improvement of this crop by introducing improved varieties and better management. A fertilizer experiment with local cultivar conducted at Nawalpur showed that the seed yield of linseed could be doubled by some fertilizer application. In the experiment, three doses of nitrogen (60, 40, 20 kg/ha) two doses of phosphorus (40, 20 kg/ha) with constant dose of potash (20 kg/ha) were studied. It was found out that N:P:K: @20:40:20 kg/ha gave significantly higher seed yield (625 kg/ha) as against control (336 kg/ha). It was also observed that in the plots with higher nitrogen level (60 kg/ha) the incidence of powdery mildew was more.

Major insects/pests of linseed

1. Linseed Gallfly - Dasyneura lini (Barnes)
2. Linseed Caterpillar - Laphygma exigua (Hb)

Major diseases of linseed

1. Rust - Melampsora lini
2. Fusarium wilt - Fusarium oxysporum

Sunflower

Sunflower (Helianthus annus) was grown in the past as garden flower only. After the establishment of the National Oilseed Development Program (NODP) in 1977/78, some oil type sunflowers were introduced from USSR Variety Perodovik was found to be comparatively better. Some farmers are growing this variety on small-scale either as monocrop or intercroped with maize. Very little work has been done on this crop in Nepal. However, it can be an additional commercial oil crop of the nation in the future if the disease problems are overcome. Yield potentials of introductions from other places could not be fully assessed because severe foliar diseases did not allow the crop to have full head development and seed setting.

Major insect/pests of sunflower

1. Jute hairy caterpillar - Spilosome obliqua (Wlk)
2. Cutworm - Agrotis ipsilon (Hfn)
3. Tobacco caterpillar - Spodoptera litura (F)

Major diseases of sunflower

1. Leaf spots - Alternaria helianthi
2. Stem rot - Sclerotium rolfsii
3. Leaf blight - Cladesporium cladisporioides

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COUNTRY PAPER ON OILCROPS IN BANGLADESH WITH REFERENCES TO SUNFLOWER, LINSEED AND SESAME[1]

M.A. Khaleque

Introduction

Geography

Bangladesh is a humid tropical country with its typical monsoon climate. It is located in between the latitudes 20.34N and 26.38N and longitudes 88.08E and 92.41E. Its typical summer is hot and humid with rainfall ranging from 1250 mm to 5000 mm from May to September. It faces a short period of dry winter for 3 months (December-February) following rainy summer and a very short spring following winter. The mean annual temperatures hovars around 25°C. The January mean temperature ranges between 17°C in the north and 19°C in the south. The summer temperature varies from 32°C to 35°C which occurs usually in April.

Soil and crops

Edaphically it is a newly formed delta with new alluvium soils created by the great rivers: Ganges, Jamuna, Padma and Meghna. It is mainly a plain land with a small hilly area on the north-eastern borders. The soil and the climate have made Bangladesh a country of abundant vegetation. In agriculture, the crop subsector predominates with 78% of total agricultural output. The major crops are rice, wheat and jute. In 1980-81, these crops accounted for 78.0%, 4.8% and 4.5% respectively of the total cropped area, 13.2 m.ha (Bangladesh Yearbook, 1983). Oilseed crops as a group stands fourth after the above noted three major crops with a total area of 294,000 ha and a total production of 263,000 tons (Statistical Year Book of Bangladesh, 1984-85). The oilseed crops in Bangladesh comprise rape/mustard, sesame and groundnut as per area among the major oilseeds, Table 1. In addition, sunflower, niger, safflower, linseed, cotton and castor are the minor oilseeds grown in the country. Rape and mustard alone covered 74% of the oilseed area and 71% of the local production.

Production and requirement of oil

Bangladesh has been suffering from the acute shortage of edible oil since the 1960s. It has been producing only one third of its requirement and the remaining two thirds are met by import every year. The local production has considerably increased during the last one decade. In fact, it has almost been doubled from 1975 to 1985. The oil production in 1972-73 was only 51,000 tons Table 2. This went up to 58,000 tons in 1981-82 and further increased to 90,000 tons in 1984-85. But still the deficiency remained more or less tha same during the last few years. The requirement for a population of 100m. @ 7.0 g/h/d amounts to 250 thousand tons of oil, but the local production can meet only about

100,000 tons and the deficiency remains to be 150,000 tons. This shortage amounts to 60-65% which remained more or less static during the last several years in spite of the favourable increase in local production. The increased requirement arising out of increasing population is responsible for this standing deficiency. The edible oilseeds and the status of sesame and sunflower among the edible oilseeds, and linseed in the non-edible group in Bangladesh are described below.

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[1] Paper received but not presented as the author could not attend.

Table 1. Different sources of oil.

English name	Local name	Scientific name
A. Field Crops		
1. Rape & Mustard	Sarisha	1. *Brassica campestris*
		2. *Brassica juncea* Cass
		3. *Brassica napus* Linn.
2. Groundnut	Cheenabadam	*Arachis hypogaea* Linn.
3. Sesame	Teel	*Sesamum indicum* Linn.
4. Niger	Garzon Tell	*Guizotia abyssinica* Cass.
5. Safflower	Kusumful	*Carthamus tinctorius* Linn.
6. Sunflower	Surjomukhi/ Surjophul	*Helienthus annus* Linn.
7. Soybean	Soybean	*Glycine max* (L.) Merril
8. Castor	Bheranda	*Ricinus communis* Linn.
9. Linseed	Tishi	*Linum usitatissimum* Linn.
10. Corn	Bhutta	*Zea mays* Linn.
11. Cotton seed	Tulabeej	*Gossypium* hirsutum Linn.
12. Rice bran	Kura	*Oryza sativa* Linn.
B. Oil Bearing Trees		
1. Coconut	Narikel	*Cocos nucifera* Linn.
2. Oilpalm	Telpam	*Elaes guineensi* Jack
3. -	Bazna	*Zanthoxylum rhetsa* D.C.
4. Mango Kernel	Amer Ati	*Mangifera indica* Linn.
5. -	Sal beej	*Sherea rebusta* Gaertn
6. -	Royna/Pitraj	*Amoora rohituka* Wight and Arnott.
7. -	Mahua	*Basia Latifolia* Roxb.

Table 2. Area, production of oilseeds from 1972-73 to 1984-85.

Year	Area '000 ha	Production '000 tons	Equivalent oil '000 tons	Source
1972-73	262.2	165	51	Accelerated winter oilseed improvement and development program.
1981-82 (Ave. of 5 years ending 1981-82)	272.4	176	58	Bangladesh Bureau of Statistics.
1984-85	284.1	271	90	Bangladesh Bureau of Statistics.
1984-85 (Mustard)	375.6	275	92	Department of Agriculture Extension.

Sesame

Sesame is the second oil crop in area among the oilseeds after rape and mustard. It is the most important oil crop, for summer season in Bangladesh, usually grown from March to June and locally known as "Kharif til". It is also grown on a small-scale in winter, Table 3 and Fig. 1. Sole crop is usually produced, but mixed crop with foxtail millet locally known as "Kaon" is a popular practice in localized areas e.g. Pabna, Faridpur, Natore, Tangail and Camilla districts, Table 4. Its growing area is concentrated to western and southern districts of Pabna, Faridpur, Khulna, Barisal, Jessore and also in the central region of Dhaka and Comilla, Fig.2.

Table 3. Area, production and yield per hectare of summer and winter sesame.

	Area (ha)	Production (mt)	Yield (kg/ha)
Summer	27,045	13,045	482
Winter	6,050	3,525	583

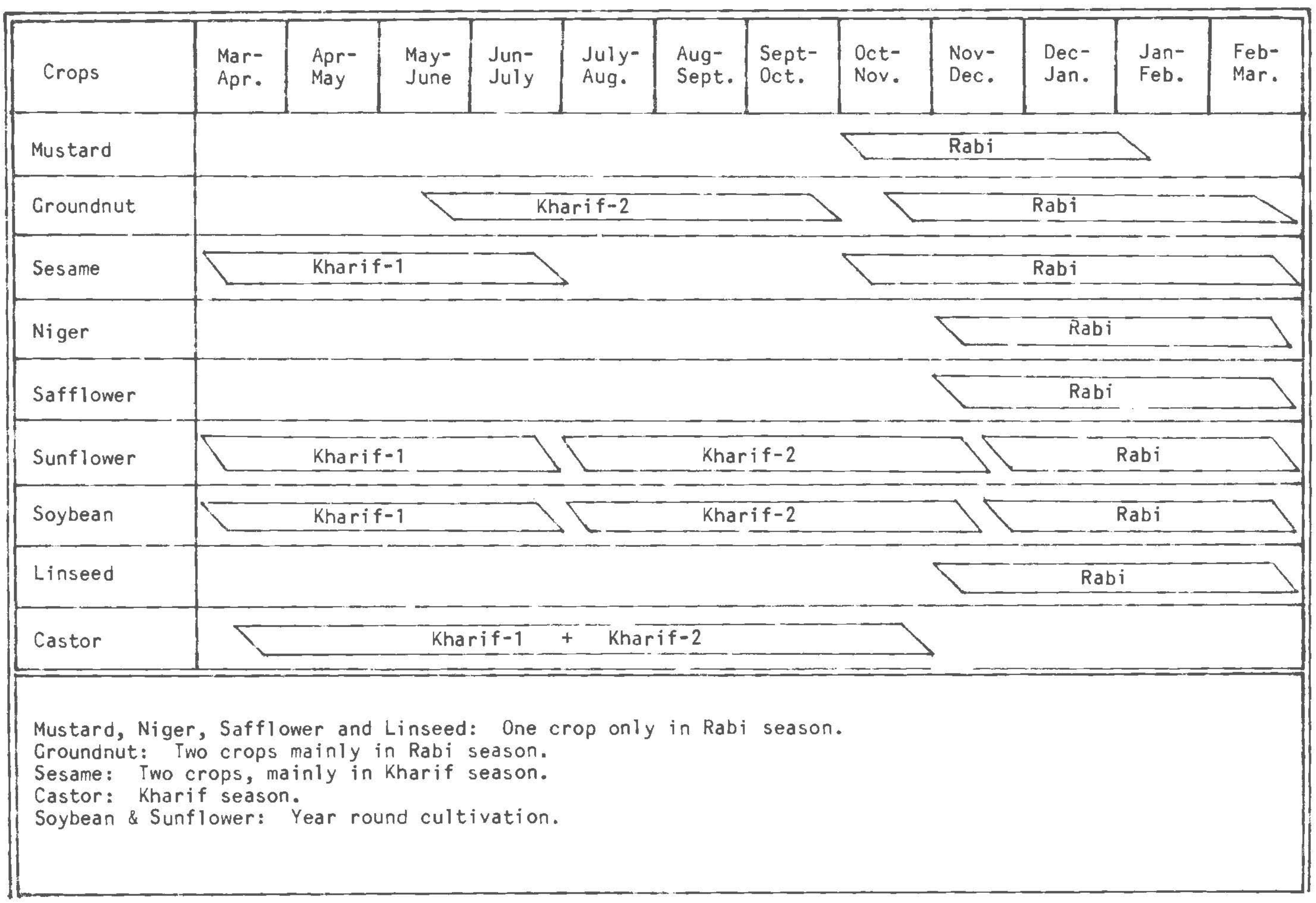

Figure 1. Oilcrop Calender.

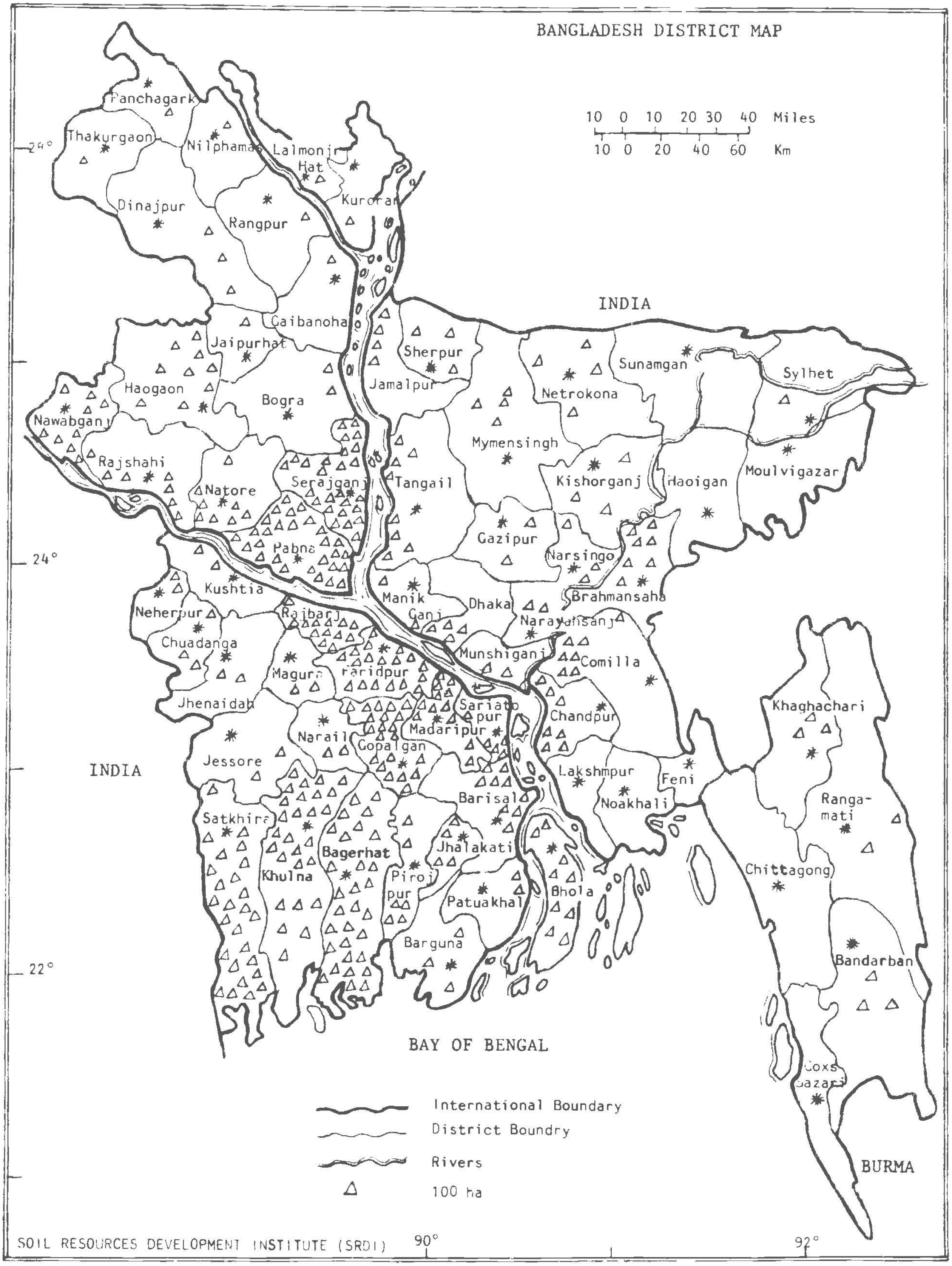

Fig.2. Sesame growing areas in Bangladesh district map, 1982-83.

Table 4. Crop sequence with sesame.

Spring (Kharif-I)	Autumn (Kharif-II)	Winter (Rabi)	Regions
Sole crop:			
1. Sesame	T.Aman rice	Lentil/Chickpea	Faridpur, Barisal, Khulna
Mixed crop:			
1. Aus rice+Sesame	T.Aman rice	Late mustard/ Khesari	Pabna
2. Kaon+Sesame	T.Aman rice	Mustard/Pulse	Pubna, Tangail, Comilla, Faridpur
Intercrop:			
1. Sugarcane/sesame	Sugarcane continued		Northern districts

Varieties

A local variety; namely, T-6 is cultivated througnout the country. It has very small black seeds as the 1000 seed weight is 2.82g only. The plant grows 60-90 cm in height of an average crop, but in a better crop it rises upto 120 cm. It produces only 4-5 branches and bears pods in every leaf axil alternately. T-6 matures in 80-95 days. This variety has a high shattering habit and therefore is harvested when 80% of the pods are mature. In some locality few more types with brown and white seeds are also cultivated, but with almost the same habit and characters.

Two selections (UCR-9 and UCR-7) of American origin have been made recently with opposite and multiple bearing habits which are promising for future recommendation, Table 5 and Fig.3. Breeding for quality oil/oil meal is not done for sesame in Bangladesh. Sesame oil is considered a good quality oil, Table 6. It contains 45% lenoleic acid (18:2).

Diseases and insects

Sesame varieties of Bangladesh including T-6 are highly susceptible to stem rot (Macrophomina phaseolina) and therefore suffer from water logging during rainy season. Early sowing during March has been found to be suitable for succcessful crop production and to avoid stem rot. In Bangladesh sesame is attacked by hairy caterpillar (Diacricia obliqua) and sesame hawk moth (Acherotia styx). Resistant materials are not yet available. Research emphasis in this respect is highly essential.

Extraction and uses of oil

Local sesame contains about 43-44% oil in seeds, Table 6, but the produce is mostly consumed directly as different food items in the form of palatable recipes and also used in the confectionery. It is very easy to extract its oil by the bullock-driven press locally known as "Ghani". Its oil is used for cooking and also as hair oil. Sesame oilcake is largely used in this country as cattle feed specially for milk cows. The oilmeal is also used as manure and sesame straw is used as fuel.

Table 5. Plant characters of different selected lines of sesame, BARI, 1986.

Characters	T-6 (check)	UCR-9	UCR-7-1
01. Plant height	Tall	Medium	Medium
02. Branching habit	Branching	Less branching	Branching
03. Lodging habit	Lodging	Semilodging	Lodging
04. Pod bearing habit	Alternate onw pos/node	Opposite bearing 2 pods/node	Multiple bearing 4 pods/node
05. Pod length	Medium	Long	Short
06. Pod size	Narrow	Medium	Broad
07. No. of chamber per pod	4	4	8
08. No. of seeds/plant	44	48	54
09. Seed colour	Black	Light brown	Deep brown
10. No. of seeds/pods	46	50	67
11. Maturity period	80-85 days	75-80 days	80-85 days
12. Oil content (%)	42-44	44-45	44-46
13. Disease reaction (Stem rot)	Susceptible	Less	Less
14. 1000 seed weight	2.82 gm	2.80 gm	1.9 gm
15. Yield per plant	5.66 gm	6.72 gm	6.87 gm

Source: Oilseed Research Project, BARI.

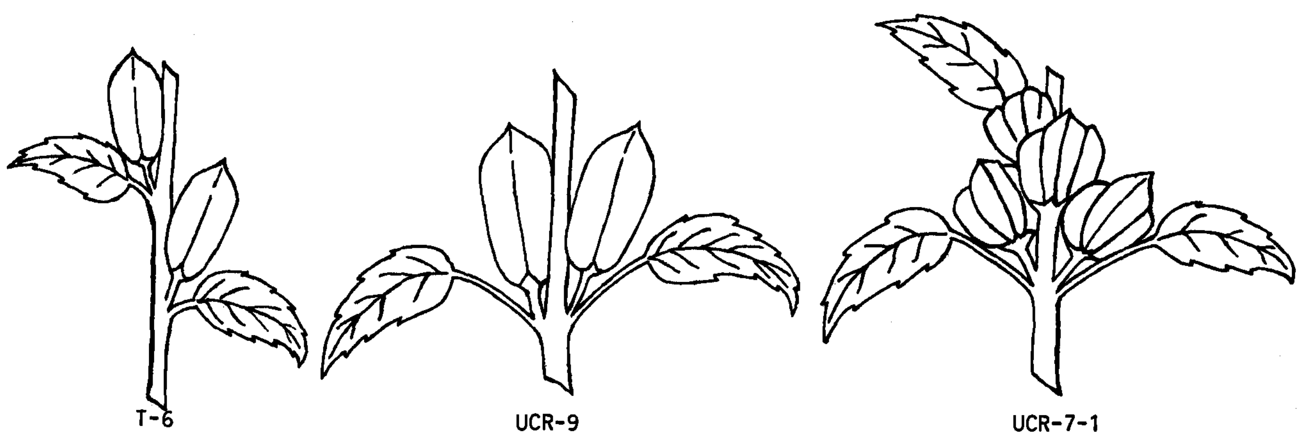

Figure 3. Position of capsules for 3 sesame varieties.

Table 6. Some important constituents of oilseeds (%).

Crop	Variety	Oil	Protein	Oleic acid (18:1)	Leno-leic* acid (18:2)	Leno-lenic* acid (18:3)	Erucic acid** (22:1)
Rape & Mustard	Tori-7	40.2	21.5	15.0	13.4	9.3	50.1
	Rai-5	39.5	22.0	11.0	16.0	11.0	48.2
	TS-72	42.7	24.0	13.7	12.0	9.4	55.1
	SS-75	44.5	25.6	14.2	14.1	8.5	55.5
Groundnut	DA-1	48.2	22.7	44.9	34.3	2.8	Nil
	DG-2	48.0	22.3	48.2	32.3	2.5	Nil
Sesame	T-6	44.0	19.7	44.4	45.2	Trace	Nil
Sunflower	DS-1	41.3	27.5	37.0	55.4	Trace	Nil
Safflower		40.0	23.0	9.7	81.0	-	Nil
Niger		39.7	23.9	-	-	-	Nil
Soybean		20.1	43.2	24.6	52.0	8.0	Nil

*Essential fatty acid, ** Undesirable fatty acid
Source: Oilseed Project, BARI.

Marketing

Farmers sell out their produce after harvest at low price. Due to subsistence farming, farmers cannot keep their seeds for a better market price. Rather, during sowing time, they buy seeds from the agents or the middleman at a higher price. The middleman gets the benefit of the hard labour of farmers.

Sunflower

Sunflower is a new crop in Bangladesh. There is scope for growing sunflower after the harvest of transplanted Amon rice in some northern districts of the country. The crop is currently cultivated in the districts of Rajshahi, Pabna, Tangail, Gazipur, Comilla, Natore, Barisal, Dinajpur etc. Of couse, it is still under demonstration and popularization. In the demonstration trials conducted in farmers' field since 1984, 1100-1200 kg/ha yield was obtained Table 7. In Rajshahi region the yield was as high as 2.0 t/ha. Sunflower can be cultivated throughout the year, particularly in spring (Kharif-1) and winter (Rabi) seasons successfully, Fig.1. So, it is likely to play a vital role in reducing the chronic shortage of edible oil prevailing in the country.

Variety

A cultivar of sunflower; namely, DS-1 (Kironi) has been released in 1981. This has been developed from the variety "Alkopolski" of Poland. Under improved management practices the yield ranges between 1400 and 1500 kg/ha. It grows upto 1.5m under normal growing condition. In the autumn crop the plant grows too high and sometimes lodges due to heavy rain and wind. At the same time some sterility

Table 7. Results of demonstration trial of sunflower in farmers' field.

Districts	Years 1980-82	1984-85	1985-86	1986-87	Average
Gazipur	1200	960	-	1500	1200
Rajshahi	1500	962	1339	1340	1360
Tangail	-	-	1081	-	1081
Ishurdi	1450	850	1100	850	1062
Average	-	-	-	-	1181

problem has been observed. Study on this problem has been taken up recently. As sunflower is a new crop in this country and the oil is already of superior quality, breeding work has not been taken up to further improve the quality, Table 6.

Disease and insects

The variety DS-1 is not usually affected by any serious disease and insect pest. But hairy caterpillar (*Diacricia obliqua*) is sometimes observed to attack the crop.

Extraction and uses of sunflower

The seed contains 40-44% oil, but when crushed in "ghani" only 25% oil is extracted. This goes upto 33% if extrcted by expeller. The oil is used as cooking medium for different food preparation particularly for fried foods. It is considered as superior to mustard oil and is, therefore, more liked by the literate families. Its demand is gradually increasing. The oilmeal is used as cattle feed and manure and the straw is treated as valuable fuel.

Marketing

As a new crop sunflower oil is not commercially available in the market and few farmers who grow sunflower consume their product themselves. However, its marketing is not likely to be difficult.

Linseed

Linseed is both oil and fibre crop. But it is produced in Bangladesh for the purpose of oil only. In some locality of Bangladesh, particularly in Pabna area, it is known as "Maishna" in Bengali in place of "Tishi". In terms of area under oilseeds, linseed stands fourth after rape/mustard, sesame and groundnut. In 1981-82 its area was 15,134 ha with production of 7,865t @ 533 kg/ha. Linseed is cultivated extensively in the greater districts of the northern region, namely, Faridpur, Pabna, Jessore, Rajshahi, Kushtia and Tangail, Fig.1.

Variety

There is no recommended variety of linseed in Bangladesh. Different varieties are grown in different regions. Recently one local line; namely, Lin-1 has been selected and recommended by the evaluation team of the National Seed Board of Bangladesh (NSB). This is likely to be released as variety in the near future. The yield of this selection ranges between 1000 and 1100 kg/ha and matures in 100-110 days. It is a dwarf variety with blue flowers and contains 8-10 major branches with many small branches. The second selection of Pakistan origin is P-14-25, which is also prominent, but matures in 125-130 days with higher yield potential. Quality work on linseed is not done in Bangladesh as it is not considered suitable as edible oil.

Crop sequence

Linseed is cultivated both as sole crop and mixed crop. In the greater districts of Jessore, Pabna and Tangail it is grown as mixed crop with mustard, chickpea, chilli and coriander. Cropping patterns followed for linseed with other crops are shown in Table 8.

Table 8. Cropping pattern of linseed.

Cropping pattern	Summer (Kharif-1)	Autumn (Kharif-II)	Winter (Rabi)
1. Sole crop	Aus rice/Jute	T.Amon rice	Late Linseed
2. Sole crop	Aus rice/Jute	Fallow	Early Linseed
3. Mixed crop	Aus rice/Jute	Fallow	I.Linseed+Mustard II.Linseed+Chickpea III.Linseed+Chilli+ Coriander.

Oil extraction and uses

Linseed contains 35-38% oil in the seed. About 28% of the oil may be extracted from linseed by "Ghani". From 7 to 10% of the oil is retained in the cake. Linseed oil is not suitable for consumption, but in some areas of northern districts its oil is sold in the market mixed with mustard oil and is thus consumed as edible oil. It is mainly used in the making of soap. Linseed oilmeal is considered toxic and so it is not used as feed, but only as manure.

Marketing

Linseed oil is mixed with mustard oil and marketed as mustard oil. It is also used in the soap industry. The middlemen purchase the seeds from the farmers at a low price and sell it to the industry or mix it with mustard oil as an adulterant. Even some of the farmers themselves use this as adulterant with mustard while crushing oil.

DISCUSSION - SESSION V

In this session a total of seven papers were presented and discussed.

1. Dr. Mangala Rai was asked for explanation on the cause of decline in sunflower yields while total acreage was increasing. He said that the declining yield was attributed to diseases such as downy mildew and others which are most serious. Shortage of hybrid seed was sited as the reason for using the disease susceptible varieties, Peredovik and Morden.

   To a question regarding the allowance made in farmers' yield estimates for the harvest retained by the grower for domestic use, Dr. Mangala Rai stated that the yield figures quoted are from crop cutting sampling.

2. To the two questions about the possible explanation to the constant total production with declining total hectarage under sesame, Dr. S. Thangavelu replied that it was attributed to improved production technology in this crop including high yielding cultivars.

   Dr. S.Thangavelu was also asked to elaborate on his work to find Antigastra and phyllody resistance. He explained that three Antigastra resistant germplasm lines were found after screening 2000 entries. He pointed out that *Sesamum malabaricum* and *S.alatum* have good resistance to Antigastra but they are wild species. His work also showed that there are breeding lines free of phyllody but their resistance need to be confirmed.

3. Dr. R.Pathirana was asked for explanation how the *Phytophthora* resistant lines identified in the mutation breeding program. He explained that the M_2 bulk populations were grown in a sick field and surviving plants were selected. He also added that they are now able to culture *Phytophthora* invitro and the resistance will be checked by artificial inoculation.

   Regarding the competition between perennial oil crop (coconut) and the annual oilseeds in Sri Lanka, Dr. Pathirana said that both the annual and perennial oil crops are produced mainly for export and thus there is no problem of competition.

4. Dr. M.Munir was asked if there is any point in doing oilseed research in Pakistan unless there is an efficient marketing system buying at attractive prices. In reply, he emphasized that research will provide more productive varieties which farmers will then want to grow.

   To a question about the cropping system to be followed in sunflower production, Dr. Munir explained that it is being grown as a catch crop in rice and cotton growing areas which otherwise remain fallow. He further explained that the policy of the Pakistan government is to increase the domestic production of oilseeds without disturbing the area under main staple crops of the country. Finally, the delegation from Pakistan invited the proposed Network Centre to be located in Pakistan, and he gave the advantages of the proposed location in that country.

5. In response to inquiry about the production cost of sesame in Nepal, Mr. Jayaswal stated that such data are not available, and that the production cost are low since farmers are not using fertilizer.

To a few questions about the seriousness of sunflower diseases in Nepal, Mr. Jayaswal explained that there was a downward trend in the productivity of sunflower due to diseases and pests. He pointed out that high level of fertilizer enhanced the incidence of downy mildew but the yield loss was not assessed. It was noted that Nepal is trying to introduce downy mildew resistant sunflower varieties from India in an effort to increase the production of edible oil in the country.

Mr. Jayaswal was asked whether it is a common practice to cultivate oil-bearing trees. He said that there is a program in Nepal to protect oil-bearing trees.

SESSION VI

COUNTRY PRESENTATIONS - SOUTH-EAST ASIA AND CENTRAL AMERICA

<u>Chairman</u>: J.Rutto

<u>Rapporteurs</u>: M.Mwala
H.Doggett

SUNFLOWER AND SESAME IMPROVEMENT IN THE PHILIPPINES

Nenita M.Tepora

Sunflower and sesame research in the Philippines is conducted by the Central Luzon State University (CLSU). It started with the main thrusts on varietal improvement and cultural management. Sunflower research was started in 1972 and sesame research in 1982. CLSU N-1 sunflower variety was released in 1974. Guatemala white sesame variety has been identified to be relatively high yielding and is grown by farmers in the locality.

The major constraint on the production of these crops is their low yield potential, specially in sesame, so that intensive efforts in the improvement of yield has been the main focus of Philippine's research since 1982. Other objectives are the development of early maturing varieties which could be fitted into multiple cropping schemes, and pest and/or disease as well as drought resistant varieties.

Sunflower Improvement

Germplasm collection, evaluation and maintenance

To date, a total of 150 sunflower accessions have been accumulated in our germplasm bank. Most of these were obtained through the FAO Cooperative Research Network. Maintenance is done in variety-to-row plots for observation on agronomic and seed characters. Selection is made for promising varieties which are advanced to the preliminary yield trial. Promising varieties are also used in the crossing program.

Development of early maturing, high yielding sunflower varieties

In order to encourage farmers to grow sunflower as a secondary crop, early maturing, high yielding variety(ies) should be available to fit into multiple cropping schemes, especially in rice-based farming systems. To achieve this goal, accessions in the germplasm collection identified to posses earliness and high yield potential are used extensively in the production of crosses. Crosses are produced in the screenhouse once or twice a year depending on the prevailing climatic condition. Evaluation of the different selections from the germplasm collection and from the segregating generations of crosses is usually done 1-2 times a year starting from October to April.

Uniformity in agronomic characters and high seed yield per plant are the main criteria for evaluation. Advanced lines in our selections have maturity of 76-82 days from emergence and seed yield of 35-60g per plant. These selections are now in the advanced yield trial.

In the advanced yield trial, three varieties: Cosmarema, Sigco 86 and Tuscania, were identified with yields higher than CLSU N-1. Seed production for these varieties is being done this cropping season, in preparation for pilot testing in farmers' fields outside the CLSU research station.

Improvement of existing variety

CLSU N-1, the variety grown by farmers, was observed to have become variable in plant height, maturity and head diameter as well as low in yield. Recurrent selection was used to improve this variety. Uniformity in most agronomic characters and higher yield have been achieved after four cycles of recurrent selection. The improved variety is now being used in the pilot testing project. Another cycle of recurrent selection is programmed to be made to determine if further improvement of yield could be achieved.

Development of sunflower hybrids using male sterility

Hybrids are generally higher yielding than open-pollinated varieties. With available hybrid seeds more farmers could be encouraged to plant sunflower.

Efficient and economical production of hybrid seeds is greatly facilitated with the use of male sterility and this was planned to be made in this experiment. Several inbred lines have been produced. However, stable sterile lines could not be made available although sterile plants have been observed and used in several crosses within fertile plants. No concrete evidence on the type of sterility involved has been observed.

Random mating for the production of high yielding sunflower variety

The wide genetic variability available in the CLSU sunflower germplasm collection was used to synthesize high yielding variety (ies). One hundred seeds each of 65 accessions were bulked, planted and allowed to random mate in 1982. Plants with uniform height and maturity were selected and the seeds composited for the next generation. The selections are now at the fifth cycle of random mating. Five cycles of random mating are scheduled after which selection for desirable characters will be done with emphasis on seed yield.

Evaluation of sunflower varieties and hybrids under Philippines (CLSU) condition (FAO Cooperative Research Network)

Every year CLSU receives materials (Hybrids and open-pollinated varieties) from FAO for evaluation following a prescribed standard procedure. The results are forwarded to FAO, Rome. Promising varieties are identified for further evaluation and eventual inclusion in the advanced yield trial.

Improvement of sunflower productivity through induced mutations

Recently, induced mutations have been used as supplement to our conventional breeding method. Physical and chemical mutagens are being used. Selection is focused on earliness and high seed yield. Some lines have been selected and are being tested for their breeding behavior in the advanced generation.

Sesame Improvement

Germplasm collection, evaluation and maintenance

The CLSU sesame germplasm collection has increased from 20 to 60 accessions including local and foreign varieties. The accessions are grown in variety-to-row plots for maintenance. Promising varieties identified for their desirable characters are used extensively in our crossing program.

Breeding for high yield and pest and/or disease resistance

Crosses are continuously being produced using new accessions. Selections are made for high yield, early maturity as well as for field resistance to powdery mildew which is the prevalent disease of sesame in the Philippines. Five selections are presently being evaluated in the preliminary yield trial and another five in the advanced yield trial.

Improvement of sesame productivity through induced mutations

This study was started at the same time as the sunflower mutation work in 1984. The emphasis on selection is high yield and early maturity. Some selected lines are being tested for their breeding behavior in the advanced generation.

THE PRESENT SITUATION AND MAIN ACHIEVEMENTS OF SESAME PRODUCTION IN CHINA

Zhan Yingxian

The significance of national economy of sesame production

Sesame (Sesamum indicum L.) is an important and valuable oil crop of our country. Its seed contains abundant oil with excellent quality and its protein contains methionine needed by human body and animals, as well as anticancerin matter. As a result, the consumption of sesame, especially since the 1980's is increasing rapidly every year.

Sesame is also an excellent crop with high economic effect. Because of its various economic advantages (edibility; industrial, medicinal, forage and fertilizer uses), all parts of the sesame plant are used and no waste matter left for disposal. So, our farmers like to grow it.

The secretion of its root system which remains in the soil after harvesting may promote the activity of some soil bacteria and accelerate the decomposition of organic matter. This increases the soil nutrient and fertility. and ensures the normal growth and development of the ensuing crop so as to give high and stable yield. Therefore, sesame becomes a good forecroppong of cereals in crop rotation. Our farmers always arrange it as the forecrop of wheat. Its flowering period is rather long (about two months) and its honey has excellent colour (brown or orange colour) with diaphanous texture, sweet taste and fragrant flavour. As a result sesame is the most ideal honey plant. Sesame is also our export product which increases the foreign exchange income and helps the economic construction in our modernization effort. It has important national and economic significance. This is the reason why we must develop and raise the sesame production now.

The Present Situation of Sesame Production

China is a large sesame producing country in the world. The distribution of sesame production almost covers all parts of our country because of its short growing period, little disease and pest attacks and strong capability to adapt for local conditions. The northern area of the Great Wall is spring sesame area. The sesame there is sown in spring and there is only one crop in a year. Most of the sesame varieties are of early maturity. The plain of Yellow River and Huai River, which is called Huang-Huai plain, is the main summer sesame production area in China and covers more than half of the total sesame acreage in our country. The sesame there is sown after harvesting the wheat, and has two crops in a year. The areas in lower reaches of Yangtze River and the Pearl River valley are autumn sesame areas. The sesame there is sown in autumn and there are three crops in a year. Most of the sesame varieties are black-seeded with waterlogging endurance.

According to the report of the "World Agricultural Products Statistical Yearbook" of 1940, both the total sesame sown acreage and production of China rank first in the world in the 1930s. In 1933 (the highest year in the 1930's), the total sesame area was 9,648,000 ha, its total production was 9,647,000 quintals (1q = 50 kg). From the end of the 1930's to the 1940's, the sesame production reduced enormously due to the war and man-made or natural calamities. Since the foundation of the People's Republic of China in 1949, the total sesame acreage, production and average yield per unit area have been raised upward although there were some fluctuations. The reason for this increase is the great attention paid to sesame production by the agricultural departments of the central and local governments. In 1986, according to the report of "China Agricultural Yearbook" of 1987, the total sesame area was 1,052,000 with a total production of 691,435 tons and the average yield per unit area was 660 kg/ha. When compared with 1949, the total area increased by 27.2%, the total production by 121.4% and the average yield per unit area by 78.5%. At present, the sesame acreage has not yet recovered the highest level in the history. Therefore, the Chinese sesame production still has great potentialities and has a good future.

Todate, there are some problems on sesame production. The main problem is the fluctuation and low yield of its production. The causes of low yield are problems of continuous cropping, tillage, agro-technic and quality of seeds. In addition, most of our farmers regard sesame as a land-fertilizing crop and they grow it on infertile land or land on which no fertilizer or irrigation are applied. This also causes low yield to a great extent.

However, the low yield could be improved, on the one hand by overcoming the people's neglect concerning the crop management and by breeding a high quality improved variety which is a prerequisite for good production. On the other hand, based on the three characteristics of sesame (no continuous cropping, small seed and threshing for several times), the corresponding agro-technical measures must be taken so as to solve the problems gradually.

The main achievements of sesame work

The main achievements of sesame production work in China are as follows:

1. The farmers' varieties in its production areas all over China have been collected, identified and arranged. This not only helps to understand and reserve the Chinese rich germplasm resources, but also lays solid foundations for sesame breeding. At the same time, during identification, a lot of better farmers' varieties have been found, and some of these varieties have still good effects in production.

2. The sesame breeding work has been widely launched. Although this work began in the late 1950's, 22 new varieties are improved at present. Among these 11 varieties were selected by systematic selection, 10 varieties were produced by hybridization breeding and one variety was bred by induction breeding with laser.

3. A whole set of agro-technical measures of high and stable yield of sesame crop has been probed. These measures include

   a) Changeing flat cropping to bed cropping with narrow bed and deep trenches, so as to irrigate and drain easily, avoiding waterlogging and protecting seedlings.

   b) Fertilizing with nitrogen and phosphorus combined fertilizer and spraying potassium dihydrogen phosphate or boric fertilizer as foliage dressing.

   c) Applying the improved varieties to adapt for the local conditions.

   d) Changing the sparse planting to dense planting in line, the planting density being 150,000 - 250,000 plants/ha.

e) Arranging the sesame adequately in crop rotation. The sesame crop may be sown again after two years interval.

f) Using tip pruning which may accelerate the capsule growth and the seed plump.

These measures appear more markedly in the sesame production areas with drought or excessive rain, poor soil, confused varieties and extensive farming.

4. The initial research work on various scientific fields of sesame has begun. Before the 1950's sesame research work in China was rare but since then it has increased rapidly. Many papers have also been published, among which: The investigation of biological characters of Chinese sesame varieties, Studies on the rules of inheritance in sesame, Studies on the regularities of inheritance of quantitative characters in sesame, cytogenetic studies in sesame, The estimation of correlation of main characters of sesame yield, The correlation and path analysis of main characters of sesame yield, The identifying technique of antiwater-logging characters of sesame varieties, Studies on heterosis of sesame, The high and stable yielding agro-technics of sesame, The experiment of photoperiodism of sesame, and Biological studies on fertilization of sesame etc.

Our country is too late to begin sesame research work and is short of exchange and cooperation. I hope sincerely that we may always exchange research information and help one another to raise continuously the sesame research level in relation to its production. Then we shall make more contributions to each country and to the people all over the world.

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STUDIES OF GIEMSA C-BANDING PATTERNS OF CHROMOSOME IN SESAME (*Sesamum indicum* L.)

Zhan Yingxian, Cheng Ming and Wu Aizhong

Abstract

The form of Giemsa C-banding patterns of chromosome in sesame is: 2n = 26 = CITOW type = 8C + 8CI ++ 4CT ++ 2CI ++ 20 + 2W. According to the morphological indices (relative length and centromere position) and Giemsa C-banding patterns (C,I,T,O, and W), the 13 pairs of homologous chromosomes in sesame karyotype may be separated and recognized. Among these plant chromosome techniques, the BCG method of Giemsa C-banding technique is the better one for studying the Giemsa C-banding pattern in sesame. Some problems having relation to C-banding pattern are also discussed.

Introduction

Sesame (*Sesamum indicum* L.) is one of the valuable oil crops with better-quality oil and higher oil content (45-62%). It has been grown widely in Asia, Africa and Latin-America and China is a big sesame-producing country in the world. It is only one cultivated species in the *Sesamum* genus. As its chromosomes are small in size and many in number, all these may increase the difficulty in preparing a chromosome slide. As a result, the Giemsa C-banding patterns of chromosome in sesame have not yet been reported.

The purpose of the present paper is to analyze the C-banding patterns of chromosome in sesame and to find out a better method of Giemsa C-banding technique for sesame research.

Materials and Methods

A cultivar, Ba-Wang Bian, supplied by the oil crop laboratory of BAU is used as material.

The procedures of Giemsa C-banding technique of chromosome include: 1) material culture (the same as squash method), 2) pretreatment (0.002M 8-hydroxyqinoline: 0.01% colchicine solution = 1:1, v/v, treating 1.5 hrs), 3) fixation (methanol: glacial acetic acid = 3:1, v/v, fixating 2-24 hrs), 4) dissociation (1 N HCL, 50-60 sec.), 5) normal squash (removal of cover glass from slide by refrigerated chromosome detacher; in 95%, 95%, 100% and 100% alcohol for deacidification and dehydrolysis, each time 15 min. and then air dry 24 hrs), 6) banding treatment: denaturation (5% Ba (OH) 2, 5 min.); renaturation (2 x ssc, 1 hr); Giemsa staining (1/15 phosphate buffer: Giemsa stock solution = 50:1, v/v, staining 1 hr), 7) mounting with Canada balsam, and 8) micrograph and analysis of C-banding pattern for analysis).

Results and Discussion

The research results of Giemsa C-banding patterns of chromosome are shown in Fig.1, Fig.2 and Fig.3 and may be concluded as follows:

First: the form of Giemsa C-banding patterns of chromosome by BSG method: 2n = 26 = CITOW type = 8C + 8CI ++ 4CT ++ 2CI ++ 20 + 2W. The C-banding patterns in sesame contain: 1) C = centromeric band (C band), 11 pairs in 13 pairs of homologous chromosomes, 2) I = intercalary band (I band), 5 pairs, 3) T = telomeric band (T band), 2 pairs, 4) N = nucleolar constriction band (N band) which is absent in sesame, 5) O = zero or absent band (O band), 1 pair, and 6) W = whole band (W band), 1 pair. Though the C-banding pattern in sesame has a pair of nucleolar constriction, no N band is present. It may be to demonate that the chromosome with nucleolar constriction does not always present the N band (Funaki et al, 1975). Furthermore, even if the N band is absent in C-banding patterns in sesame, the C band, I band, T band, O band and W band are all present. This is fundamentally corresponding to six C-banding patterns (C, I, T, N, O, and W) presented by BSG method (Cheng Ruiyang et al, 1979). The polymorphism of C-banding pattern shows the difference in components of hereditary substance of chromosome, and the effectiveness of the plant Giemsa banding technique for diagnosis with heterochromatin (Vosa and Marchi, 1971; Seheweizer, 1973).

Second: according to the morphological indices (relative length and centromere position) and Giemsa C-banding patterns (C, I, T, O and W), the 13 pairs of homologous chromosomes in sesame karyotype may be separated and recognized, Table 1. This evidence not only prevails in sesame, but also appears in other crops (Linde-laursen, 1978). Because of the different techniques of chromosome banding, or even in the same method, and due to different chemicals (kind, concentration and time) used and different time for taking material and treatment, the chromosome length is affected, especially in relative length and centromere position which decides the arm ratio and which shows a definite variation.

Table 1. The marker characteristics of each pair of chromosomes in sesame karyotype.

Chromosome	The marker characteristics of chromosome		
	Relative length %	Centromere position	C-banding pattern
K_1	10.97	sm	C
K_2	10.32	sm	CI+
K_3	9.88	sm	CI+
K_4	7.74	sm	C
K_5	7.74	m	CI+*
K_6	7.74	m	CI+**
K_7	7.74	m	C
K_8	7.74	sm	CT+
K_9	7.71	sm	CI+***
K_{10}	6.45	sm	CT+
K_{11}	5.81	sm	C
K_{12}	5.80	sm	O
K_{13}	5.16	sm	W

* I band in median region of long arm of chromosome.
** I band in subterminal region of long arm of chromosome.
*** I band in submedian region of long arm of chromosome.

Third: among plant chromosome techniques, the BSG method of Giemsa C-banding technique is a better one for studying the C-banding pattern in sesame. The advantage of BSG method is that it may present various C-banding patterns and has a better reproducibility in a relative constant conditions. But the disadvantage is that the procedures of BSG method are too complicated especially in the processes of denaturation and renaturation of banding treatment, the washing of material and the time and temperature required strictly. So, attention to these processes should be paid in order to obtain high resolution C-banding patterns.

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STUDIES ON SESAME DISEASES IN CHINA

Li Lili

Sesame is widely grown in our country, but mainly in the Yellow River Valley and the Middle and Lower Yangtze River Valley where there is warm climate and abundant rainfall. It is also one of the important oil crops in China. People are very interested in sesame oil as it has a very good quality.

There are many kinds of sesame diseases in China. Some of the diseases are widely distributed causing a great damage to the sesame production.

The Kinds of Sesame Diseases and Their Distribution and Damage

According to the incomplete statistics, sesame can be infected by thirty pathogens in the sesame growing areas of China, Table 1. Macrophomina phaseoli, Fusarium vasinfectum, TuMV and PMMV, Phytophthora parasitica var. sesami, and Pseudomonas solanacearum are considered as the most widespread pathogens causing the most serious damage.

Results of the Research Work on Main Diseases

A survey was initiated in 1959 to determine the presence and prevalence of the diseases on commercially cultivated sesame in China, and more research work on important diseases has been done. The results are given below.

A. Stem necrosis of sesame (Macrophomina phaseolina (Maubl) Ashby; Phoma sesami Saw)

The most important disease of sesame is probably stem necrosis. This disease is common all over the major sesame growing areas, and it can cause significant yield loss on sesame. The incidence of the disease is often from 10% to 20%, but seriously over 80% in a few years in some districts, resulting in 10% to 15% loss in seed yield and reduced oil content from 1-12%. Only a few affected plants are found in a seedling stage; it causes seed rot and seedling dies. A lot of infected plants are seen in flowering and fruiting stage.

The frist symptoms appear on root and stem basal portion. The root becomes brown with small, blackish sclerotia in the cortex. Water-soaked, yellow-brown spots appear, then become dark-brown, and lastly turn into silver color at the middle part of the spots. There are many black pycnidia and small sclerotia on the surface of the diseased stem. The leaves of the diseased plant curl and wilt from bottom to top and the severely diseased plants die.

The diseased seed, the soil and the diseased plant refuse all can spread the disease. Primary infection results from the mycelium produced on sclerotia under high soil moisture and over 25°C soil temperature. The incubation period is about 5 to 10 days. The spores from infected plants are widely distributed by wind and spattering rains so that numerous secondary infections occur. The secondary infected plants are about 46%. Sclerotia may remain alive in soil for two years.

Table 1. Sesame diseases.

Pathogen	Name of disease	Distribution	Severity degree
Alternaria sesamicola	Black spot	North China	+
Ascochyta sesami	Brown spot	North China	+
Ascochyta sesamicola	Ring spot	North China	+
Cercospora sesami	Leaf spot	Wide spread	+
Colletotrichum sp.	Anthracnose	Hubei province	+
Corticium centrifugum	Rhizoctonia rot	Three provinces	+
Corynespora sesameum	Leave necrosis	Widespread	+
Dothirella philippinensis		Two provinces	+
Erysiphe cichoracearum	Mildew	Widespread	+
Fusarium vasinfectum	Wilt	Widespread	+++
F. vasinfectum var. sesami	Wilt	Widespread	+++
Helicobasidium mompa	Purple root rot	Local area	+
Helminthosporium sesami	Leaf blight	Widespread	+
H. sesamum Sacc	Leaf blight	Widespread	+
Macrophomina phaseolina	Stem necrosis	Widespread	+++
Macrosporium sesami	Purple blotch	North China	+++
Oidium erysiphoides	Mildew	Local area	+
Phoma sesami	Stem necrosis	Local area	+
Phytophthora nicotianae var. sesami	Blight	Central China	+++
P. parasitica var. sesami	Blight	Local	+++
Pseudomonas solanacearum	Bacterial wilt	Widespread	+++
P. sesami	Angular leaf spot	Widespread	++
PMMV	Virus	Local	++
TUMV	Virus	Local	++
Rhizoctonia solani	Rhizoctonia rot	Local	+
Thanatephorus cucumeris		Local	+
Verticilium albo-atrum	Yellow wilt	Local	+
Xanthomonas ricinicola	Bacterial wilt	Local	+
X. solanacearum	Bacterial wilt	Local	+++
Virus or Mycoplasma	Flat stem	Central China	++

Control methods: A three-years rotation with non-host crops offers an effective method of control. Non-diseased seed application and seed treatment with 55°C water for ten minutes or 60°C water for five minutes have been reported to be effective in the control of the disease. Improving the field management, such as the prevention of drought and waterlogging and increased application of potash and phosphate fertilizer so as to improve the resistance of plants has also certain effects in the control of the disease. The use of resistant varieties such as Xiniujiao, Yiyangbai, Zhuzhi No.1 and No.2 appears to be a more feasible method of control of the disease.

B. Fusarium Wilt (Fusarium vasinfectum Atk. var. sesami Zap)

Fusarium wilt of sesame is a considerably common and severe disease in sesame-growing areas of northern and central China. Generally, the incidence of the disease is from 1% to 5% but it becomes severe when it is over 30%. Plants may be infected at any stage of the crop development, but the infection is more at the adult stage of the plant.

In the seedling stage, infected seedlings may be seen with the appearance of damping-off and withered seedlings. In the last stage, symptoms of the affected plants appear on one side of the root system as red-brown withered stripe and the leaves of the infected side wilt, turn into yellow colour, wither and fall from bottom to top. In the case of damping-off, the diseased part of plants appears to have a pink layer of mildew (conidia and mycelium of fungi). The vascular bundle of the diseased stem becomes brown. Capsules on afected branches are smaller, precocious and easily dehiscing, and they contain thin and shrivelled seeds. The pathogen has two sorts of conidium, and the macroconidia are sickle-shaped and 3-5 septate. The microconidia are ovoid to ellipsoid, and unicellular. It grows at the temperature range of 10 to 35°C with an optimum temperature of 30°C. The pathogen is reported to be seed- soil- and plant debris-borne. It is quite evident that the fungus penetrates the host through the root tip and wound of seedlings and also infects the healthy root directly. Then, it enters into the vessel and finally extends upwards into all parts of plants. The disease primarily occurs in June, and numerously in August. Continuous cropping, high soil moisture and barren sandy loam are favorable for the development of the disease.

The disease could be controlled by using 3 to 5 years crops rotation, use of non-diseased seed or seed treatment with 0.5% copper sulphate preparations for half an hour as an effective control method of the disease. Breeding and applying fusarium wilt-resistant varieties (Xiniujiao, Yiyangbai, Sanyeqi, Zhong zhi No.5) are also effective measures.

C. Virus Disease (PMMV and TuMV

Recently, a new viral disease has appeared on sesame in sesame-growing areas of Henan and Hubei provinces. The diseased area has been gradually increasing since 1980. An epidemic of the disease occurred in Henan privince in 1984, causing a serious loss of about 70% of the yield in some districts. The disease also occurs commonly and is an important problem in sesame production in Hubei province.

The disease begins at the end of June and gets its peak between the middle and end of July. There are two sorts of the main symptom on sesame such as yellow, mosaic, and stunt and necrosis. Yellowing and mosaic are caused by PMMV which is transmitted by Myzus persicae, Aphis glycines and Aphis caraccinara. The transmission of the virus by seeds is reported to be about 1.4%. Stunt and necrosis are caused by TuMV which is transmitted by Myzus persicae and Aphis caraccinara. The period of incubation is about 9 days under sapinoculation. There are no effective methods for the control of the disease at present.

D. Bacterial Wilt (Pseudomonas solanacearum Smith.)

Bacterial wilt of sesame is reported to occur quite severely in sesame-growing areas of southern China, up to 40% incidence which causes the death of plants and results in considerable loss in the yield of sesame.

After the sesame is attacked by the bacteria, symptoms first appear on the stem as dark-green spots and then brown to black streaks. The terminal portion of the stem often shows 2 to 3 ulcer shuttle crevices and then begins to wilt. The lower leaves soon begin to gradually wilt and hang down. The diseased plants appear to be short of water. Thus, they primarily wilt in the day and become normal at night, but gradually lose their ability to recover after several days. The vascular bundle of the root and stem of the diseased plants turns into brown color at last. The pith of the plants also can be infected, and can become hollow. Bacterial ooze can be seen on the surface of the diseased stem, under humidity, which gradually turns into pitch-dark crystal granule. After the leaves are infected by the pathogen, a criss-cross network of the blackish-green streaks of the vein appears on the leaf. When the diseased leaf is seen against sunlight, the centre of the vein seems to be oil-soaked and transparent. The yellow vein of the under-surface of the diseased leaves protrudes up and down like a ripple. The diseased leaves become savoy, brown in color and finally die. Symptoms first appear on capsules as water-soaked spots and then as dark-brown streaks. Such capsules are thin and small, exposing the shrivelled and discolored seed which cannot sprout.

The pathogen mainly perpetuates through plant residues in soil and may persist for 3 to 5 years in soil. the bacteria enter the host through the root and/or the wound of the stem and/or stomata. Infection occurs when the soil temperature is 12.8°C. When the soil temperature is between 21 and 43°C, the higher the temperature is, the more severe the disease will be. The pathogen spreads through running water, subterranean pest and farm tools in the field.

Control method: Since the crop residues in the soil are the most important reservoir of inoculum, the use of over 2 to 3 years rotation with the grass-family crops (cotton, sweet potato etc.) may offer a more effective method of control of the disease. Accumulated water should be drained away at once after a rainfall so as to avoid the spread of the pathogen through running water. Applying enough base manure and increasing to apply barnyard manure and plant ash may improve the resistance of plants and reduce the incidence of the disease.

E. Phytophthora Blight (*Phytophthora nicotinanae* Breda var. *sesami* Pas and *P.parasitica* var. *sesami*)

Phytophthora blight of sesame is rather serious in sesame growing areas of southern China. Over 30% of the incidence of the disease has been reported to cause the death of the plants in Xiangyang prefecture of Hubei province in 1959. The seeds remain shrivelled in the case of severe attack, and the yield and oil content of the seeds drop by a big margin.

Symptoms of the disease mainly appear on the basal portion of the stem as shrunken and ulcer spots, primarily water-soaked, and deep-green spots, and then as dark-brown sunken spots. The cortices of the diseased plants become soft and form a vertical and shrunken crack. The disease mainly destroys phloem and cambium. The fungus from the upper portion of the diseased stem may infect the capsules, thus forming water-soaked, dark-green spots on them. The spots gradully become shruken, sunken and small. In the case of moisture, the white woolly growth of the fungus can be seen on the surface of the affected capsules resulting in the dryness and death of the upper stems and leaves of the infected part. The symptom of the affected leaves is the appearance of larger tawny spots with some ring line. When there is moisture the tawny spots spread rapidly around the spot and the edge of the spot forms a ring-like white growth of fungus (sporocarp of the fungus). If the weather is dry the spots also become dry, thin and open, and the diseased leaves become malformed at last.

The fungus grows well at an optimum temperature of 28°C. The fungus survives in soil, during the unfavorable periods, in the form of dormant mycelium and/or in the form of chlamydospores (or oospores). The pathogen attacks the basal portion of the stem, thus forming a source of primary inoculum. The incubation period is about 10 days after inoculation. The sporangia spreads from the already infected portions of plants through wind, rain and running water. The disease begins at the squaring period of sesame in July and prevails at the beginning of August. Frequently, rainfall and high humidity favor the outbreak of the disease.

Control methods mainly include crop rotation, narrow ridge and deep furrow, drainage of flood water, drop in moisture in the field and so on. Sprayings of Bordeaux mixture (1:1:100) or copper sulphate preparations (0.1%) at the end of June or at the beginning of July, are recommended with effectiveness up to 90%.

F. Bacterial Angular Leaf Spot (*Pseudomonas sesami* Malkoff)

Bacterial angular leaf spot of sesame first appears after the rain in July and largely in the second or last ten days of August. The disease is serious in the rainy year, thus getting a large number of leaves fallen. The bacteria mainly infect not only leaves, but also petiole and stems.

Symptoms primarily appear on leaves as water-soaked spots, and then as black-brown polyangular spots of 2-8 mm. In the case of moisture, bacterial ooze can be seen on the diseased leaves, and the black-brown spots spread along the vein of the diseased leaves becoming a black-brown streak. In dry weather, the spots easily perforate. The severely diseased leaves are malformed and they easily fall.

The bacteria over winter, on the affected leaves refuse and seeds. The optimum temperature for the bacterial growth is 30°C. The disease is spread by wind and rain. Rainfall is favorable for the occurrence of the severe disease.

Control method: Seed treatment with 0.1% Mercuric chloride or 0.5% Copper sulphate or hot water (48-53°C) is effective (80%) for the control of the disease. Spray application of Bordeaux mixture (1:1:100) or Copper sulphate (0.1%) is reported to give 60 to 90% degree of control of the disease at beginning of July. Crop rotation is also an effective method of control.

G. Rhizoctonia Rot (*Rhizoctonia solani* Kuhn)

The pathogen mainly infects the basal portions of the stems of seedlings. Affected plants show all the symptoms of wilt together with black discoloration of the base of stem which frequently breaks off at ground level. The process of the symptoms development is that discoloured spots on one side of the base of stem gradually spread around the stem and the diseased part then sinks, shrinks and rots.

In winter, the pathogen survives through mycelium and sclerotia in soil. The fungus is known to live in the soil for many years. The pathogen spreads through running water, wind, rain and farming operation. Throughout the seedling stage, low temperature, high moisture and poor growth are advantageous to the great occurrence of the disease.

The disease can be controlled by planting in good time, protecting the accumulation of rainwater, frequently intertilling for increasing soil temperature and increasing the application potash and phosphate fertilizer so as to improve the resistance of plants.

H. Leaf blight (*Helminthsporium sesami* Miyake; *H. sesameum* Sac and *Corynespora sesameum* Goto)

The disease may harm leaves, leaf stalks, stems and capsules. It occurs commonly at the mid and late stages of sesame development. Generally, it is not considered as a serious disease.

Its symptom appears on the leaves as brown spots with 4 to 12 mm in diameter, indistinct ring line and black mildew on the spots. The severely affected leaves wilt and die and fall. The spots on the stem and leaf stalk are initially shuttle-shaped and become red-brown and slightly sunken.

The pathogen overwinters through hyphae in the crop debris and also through the conidiospores on the plant debris and seed.

The use of healthy seed, crops rotation, cleaning the field and draining the logged water are effective in controlling the disease. Spray of Bordeaux mixture (1:1:150) is also effective at the initial stage of the disease development.

I. <u>Angular Leaf Spot (*Cercospora sesami* Zimm)</u>

Although angular leaf spot of sesame widely occurs, the disease is reported not to be quite serious. The fungus attacks both the leaves and the capsules. The disease heavily occurs at flowering phase.

Leaf spots are angular or round measuring 1 to 5 mm in size. The fruiting bodies of the fungus might become visible on the lower surface of the leaves, and the color is olivaceous brown. Capsule spots are round with grey centre and dark-brown edge, slightly sunken. Leaf spots break easily, and cause the leaves to fall.

The pathogen is seed-borne. and 16% seed transmission of the pathogen has been reported in China. The stromata in crop debris are able to produce conidia that are spread by wind and rain in the next year. Under rainy and moist condition, the disease may heavily occur.

Seed treatment with hot water (53°C) or 0.1% Mercuric chloride for 30 to 60 minutes, crop rotation, clean cultivation, and 1 to 2 sprays of Bordeaux mixture (1:1:100) before and after flowering phase, are considered as the effective measures of control of the disease.

J. <u>Powdery Mildew (*Erysiphe cichoracearum* DC. and *Oidium erysiphoides*)</u>

The pathogen attacks leaves, petioles, stems and capsules. The diseased portions of plants are covered with white powder (mycelium and conidia), thus photosynthesis of the diseased leaves is much weakened, the plants grow poorly and die earlier than expected. The disease occurs more under late or Autumn sowing. So, its loss in yield is so small and there is no need of controlling it.

Prospects for Research in Future

There are so many sorts of diseases in sesame. With expanding sesame-growing areas and raising fertilizing standard, sesame diseases are becoming more and more serious. Especially in rainy years, charcoal rot, fusarium wilt, phytophthora blight and so on cause large quantity of death to the sesame plant. So increasing the yield and improving the quality of the crop are seriously limited. In order to control the occurrence and harm of these diseases, researchers of plant protection and crop breeding have recently paid a great attention to seeding resistant varieties or disease resistant sources and engaging in disease resistant breeding research. They have also started to identifying abundant germplasm sources resistant to charcoal rot and fusarium wilt and are looking forward to find some good disease resistant sources in China. The varieties with high resistant and good economic character will be applied in the crop production and/or as parent materials of disease-resistant breeding. With respect to disease resistant breeding, the research work at Oil Crops Research Institute of the Chinese Academy of Agricultural Sciences and Agriculture Research Institute of Zhu Ma Dian Prefecture of Henan Province has shown that resistance to charcoal rot of sesame is apparently controlled by dominant gene and that the correlations between parent and filial generation in resistance to the disease are so close that the disease-resistant materials may be selected from the early generation of hybrid. Application of disease-resistant cultivars for control of these disease will be the most effective and economic method. Increasing the collaboration among specialized departments is necessary to speed up the breeding and application of disease resistant varieties.

Recently, the virus disease of sesame has become a new serious disease, and the areas of diseased sesame expanded gradually. Although the sorts and the transmitting ways of the viruses had been studied, the regularity of the occurrence and the control of the disease should also be studied in detail so as to control its damage.

THE PRESENT AND PROSPECT OF SESAME GERMPLASM RESOURCES IN CHINA[1]

Feng Xingyun

Sesame (Sesamum indicum L.) is one of the important oil crops in China, which has a long planting history, large distribution and quite plentiful cultural varieties. The cropping area ranks next to India and the total yield is often the first or second in the world. As a result, China is also known as the "Sesame Kingdom". Sesame is favourable to people as it is a precious oil crop which has high oil content, superior quality, rich nutrition, sweet smell, and other functions to improve health. Growing sesame has an important significance to develope industry and agricultural production and thereby improve the life of people. With the need of world market increasing gradually, much more attention has been paid to foreign trade. Therefore, it is necessary to put much effort in exploring and utilizing the sesame germplasm resources in China for the development of sesame production.

Collection and Arrangement

Two national collections were conducted in 1956, 1970-1980 in China and about 4,000 entries have been obtained altogether whereas more than 170 germplasms were introduced from other countries. So far, 3,135 varieties have been catalogued after field evaluation and sorting out. Out of these, the Chinese germplasm takes 3,016 which came from Hubei, Henan, Anhui, Shandong and Hebei, and other provinces municipalities and districts; adding up to 25 in number, Table 1.

Table 1. Collection and arrangement of Chinese sesame germplasm.

Research content			No. of varieties			No. of provinces cities or countries	
			China	Foreign	Total	China	Foreign
Collection			4000	171	4171	25	20
Arrangement	Cataloguing	Edited	1509	47	1556	9	10
		Editing	1507	72	1579	23	5
		Total	3016	119	3135	25	13
	Catalogued		280	10	290	17	7

Germplasm from Qinghai, Ningxia, Neimong, Fujian and Taiwan will be collected as supplementary, afterwards. A total of 119 entries were introduced from 13 countries such as India, Burma, Japan, America, Mexico, the Soviet Union, Mozambique, Venezuela etc. Besides, germplasm from 5 countries are in field evaluation and from 2 countries did not germinate. Based on their arrangement, we have completed "The Varietal Record of Sesame in China", Table 1.

[1] Paper received but not presented as the author could not attend.

Seed Storage Method

Three methods are undertaken to preserve sesame germplasm resources in China. These are national long-term storage (about 30 years), medium-term storage (about 10 years) carriedout by research institutes, and short-term storage (3-5 years) kept by local organizations. The seeds in long-term storage are preserved in national modern seed bank with low temperature (-18°C), and relative humidity of 50% which is set in Germplasm Resources Institute, CAAS, Beijing. The seeds in medium-term storage are usually put in sulphate dryer or refrigerator. Calcium chloride is used as desiccative, seeds are kept in Kraft paper bag, air-tight with petrolatum. For the refrigerator storage, silica gel is used as drying agent, organic glass as container with rubber plug, air-tight with paraffin and the temperature is kept at 0-5°C. The work has been done by the Oil Crops Research Institute, CAAS. Seds are preserved at normal conditions for short-term storage, with the seed in kraft paper bag placed in cabinets or racks.

In order to find out a simple and economical storage method and to determine the deterioration of seed vigour during the storage, we studied the effect of different storage methods and the decreasing speed of seed vigour. The result showed that the seeds kept in seed cabinets lose their vigour after about four years at the normal conditions in Wuhan. Sprouting power and sprouting percentage are more than 50% with the desiccator storage for 15 years, and still offspring grows fast. This shows that seeds kept in refrigerator decrease thrir vigour slowly than those kept in dryer for the same period, Table 2. It is a better method for the medium-and short-term storage to use disiccator, because of its convinence, low cost and good storage effect.

The speed of seed vigour deterioration varied with seed-coat colour. Seeds with light coat colour and high oil content deteriorated faster, Table 3. On the contrary, dark seed lost vigour slowly. Therefore, we must change the stored seed into new one in accordance with different seedcoat colour.

Research and Utilization

Present Research

The study of sesame germplasm resources in China was done for a short period. Only since the 1930's, there were few researchers who began to collect and sort out. However, starting from the 1950's, it was on a large scale and was more systematically done. The main research contents and results are discussed below:

1. Classification of sesame

Sesame's cultural history was more than 2,000 years in China since it's introduction. There are many different ecological types arising from long time natural selection and artificial breeding. Chinese scientists have studied those cultural varieties systematically. In 1957, Professor Zhan Yingxian of Beijing Agricultural University evaluated for 3 years the varieties from all over the country under the natural conditions in li Daoxhuang, Beijing. According to their seed shape, hairiness, leaf shape, seed colour, flower colour, capsule number in axil, locule number/capsule, and dehiscence of matured capsule, etc, varieties were classified into 52 types and a classified index was also made.

Table 2. Effect of different storage methods on seed vigour.

Storage methods	Storage time: 3 years Sprouting power %	Sprouting percentage %	Offspring growth speed (cm/day)	7 years Sprouting power %	Sprouting percentage %	Offspring growth speed (cm/day)	15 years Sprouting power %	Sprouting percentage %	Offspring growth speed (cm/day)
Seed cabinet	76.4	86.7	0.11	-	-	-	-	-	-
Disiccator	87.7	94.9	0.19	89	91	0.32	63.7	72.7	0.2
Refregerator	96.3	98.1	0.24	91	94.7	0.30	-	-	-

* Three entries were determind in different years with 2 replication.

Table 3. Seed vigour deterioration expression on varieties of different seedcoat color in store.

Method	Color	Storage time: 3 Variety number	Sprouting power %	Sprouting percentage %	Offspring growth speed (cm/day)	7 Variety number	Sprouting power %	Sprouting percentage %	Offspring growth speed (cm/day)
Refri-gerator	White	5	95.3	96.3	0.27	3	88.7	93	0.22
	Yellow	6	95.2	97.2	0.25	3	92.7	95.3	0.26
	Brown	6	97.1	98.3	0.25	3	-	-	-
	Black	6	96.4	98.2	0.23	3	94.3	96.	0.25

In the 1950's, Henan Agricultural College and Agricultural Station classified the Henan sesame varieties according to their simple character. The seven aspects of the classification are as follows:

a. growth character of the plant: one stem type, middle type, branched type.
b. color in seed: white, yellow, red and black.
c. locule number/capsule: tetragonal, hexagonal, octagonal and multigonal types.
d. length of capsule: short, medium and long capsule types.
e. stem color: ordinal, blue and green, white and wujitei types.
f. plant pubescence: no hair, hair, long and short hair, and
g. maturity: early, medium and late maturity.

Since 1960, a systematic research of sesame variety classification has been conducted by the Oil Crops Institute, CAAS and the standard for the various characteristic classifications was also presented. A uniform practical project was made for observing, recording and completing the catalogue of Chinese sesame varieties. In 1986, at the meeting of editing the "Varietal record of Sesame in China" held by cur unit, experts discussed and agreed to choose the plant type, flower number in leaf axil, corolla color, locule number/capsule, capsule shape and seed coat color as agronomic characters to classify the system of sesame in China. They have classified the entries from "Catalogue of Varietal Germplasm Resources of Sesame in China" and "Varietal Record of Sesame in China", and have made an index for these cultivars.

2. Ecological reaction and introducing rule

The research results in Oil Crops Institute, CAAS showed the following:

a) The characteristics of sesame changed regularly with the different geographic latitudes. In the areas with high latitude such as northeast and northern China where long daylight, low temperature and dry climate prevails, plants of sesame were dwarf with fewer branches, lower branch and capsule parts, short distance between stemnode, narrow small and entire leaf blade, and dark-green leaf. They also have stronger capacity to resist draught and freeze. In the areas of southern China with low latitude where the daylight is short and there is high temperature and humidity, sesame grows tall with plentiful branches and leaves, high-located branches and capsules, wider and larger leaf blades, more deep or completed split leaves, light green leaves, less and short stem hair and smaller capsule and seed. It also has higher tolerance of dampness. The characers of varieties in the areas of central China were between those two mentioned above. This demonstrated that characters conform to certain ecological environment.

b) During observation and identification of the introduced varieties from home and abroad, we found that all the varieties from high latitude such as northeast and northern China, USSR, Bulgaria etc., grew faster in seedling period and took a short period of vegetative growth and flowering. Their total growth period was 70-80 days with short plant height, less capsule per plant, susceptibility to waterlogging and low yield. The varieties from low latitude areas such as Yunnan, Guangdong, southern Tibet, Africa, India, and Burma which have tall plants, more branches, small and less capsules, long vegetative growth period, short flowering stage, and extremely late maturity period (about more than 110 days of the whole growth stage). There were few varieties which were not flowering and producing properly making the yield very low, but have strong vigour and resistance to waterlogging. Varieties from Sichuan, Jiangsu and Zhejing, etc., which have similar latitude, showed a similar growth performance with their original regions and obtained a better effect. Because sesame has sensitive reaction to light, temperature and rainfall, its adaptation areas are limited. Thus, it is more efficient to use directly introduced varieties from closed regions or similar latitude areas. Introduced varieties from far away regions or high various latitude areas usually have no value to utilize directly, but it can enrich genetic resources. Also it is worth using certain perfect characters indirectly. In a word, we should put local varieties in first, then introduced varieties as aid.

3. Screening identification for the resistant resources

Sesame is a very sensitive crop to environmental conditions. In sesame producing areas of China, yield was often reduced and even no seed was obtained due to waterlogging and diseases. Hence, it is necessary to study different fields so as to develop resistant sesame varieties.

It has been reported that the most sensitive stage to waterlogging was the flourishingly-flowering. If the plant is affected by waterlogging, its root systems will not respire and absorb normaly resulting in the plant's abnormal water metabolism, leaf blight and withering. The lightly damaged plants were prematurely senile, ended flowering too early, had more imcompletely filled seeds, and their yield and quality were decreased. In the case of the heavily damaged plants, their roots rot and plants die. A singnificant difference of response to humidity was found among the sesame cultivars. Thus, several varieties were tolerant to waterlogging and hence have been selected naturally and artificially. Some of them are 74-10051, Ezhi No.1 and Zhong Zhi No.5, etc.

Study on the root bleeding has been conducted by the Academy of Henan Agricultural Sciences, showing that there are differences of bleeding in the different growth stages of the same variety. This difference between varieties is even more significant. High waterlogging-tolerant varieties have more bleeding and larger surface of root system with more root distribution, long taproot with deep penetration.

The disease called Macrophomina phaseolina is one of the most common and serious diseases of sesame in Hubei, Henan, Jiangxi which are the major sesame producing areas in China. The lower incidence of the disease was 10-15% and the higher incidence was 60-80%. The 1000-seed weight of an infected plant was reduced by 4-14%. The yield per unit area was less (19-81%) and the oil content was decreased by 1-10%. Screening the resistant resources is the effective and economic method to control the disease. A few varieties of higher resistance to the disease have been selected by naturally and artificialy induced identification (e.g. Mianyang Bagucha). Among these, the wild sesame from Congo was immune to the disease.

4. Studies on the relationship of sesame characters

Some professional researchers from Hubei and Henan provinces pointed out that the length of capsule, number of locules and the number of seeds/capsule are stable characters in sesame which possess stronger hereditary capacity. The number of capsules/plant-as a radical factor to yield- is positively correlated to the number of branchs, number of capsules/leaf axil and the height of the plant, and negatively correlated to the locating position of capsule/leaf axil of capsule. Therefore, in addition to the plant height and the locating position of capsule, the number of capsules/leaf axil and branch should also be highly evaluated in order to increase the capsule number/plant. The number of seed per capsule has a positive correlation with the number of locules and the capsule length in a certain range. 1000 seed weight is negatively related to the number of locules, and positively related to the length of capsule. The highest oil content is found in yellow coated and white-coated seeds whereas the brown-coated

seeds rank second. The lowest oil content is found in black-coated seeds Table 4. In addition, both coat colour and production per plant have a close relation with the 1000-seed
weight. Thus, with the change of color in seed coat from light to dark, the oil content decreases, 1000 seed weight increases and production per plant decreases Table 4.

Table 4. The relations between seed coat colour and oil content, 1000-seed weight and yield.

	White	Light yellow	Yellow	Light brown	Brown	Dark brown	Black
Amount of varieties	217	26	35	31	31	12	17
Average oil content	53.31	53.90	53.27	52.12	53.22	51.79	51.48
Range of oil content	47.41-	47.46-	48.85-	49.98-	50.21-	48.65-	47.29-
	58.00	58.14	57.85	56.23	55.59	56.31	56.15
Productivity/plant(g)							
Non-branching	19.39	21.11	20.52	19.10	17.19	18.15	16.32
Branching	21.12	22.64	20.57	21.97	20.97	20.09	16.88
1000-seed weight(g)							
Non-branching	2.62	2.60	2.82	3.07	2.81	2.84	2.75
Branching	2.87	2.89	3.11	3.20	3.20	3.08	2.85

Utilization

The utilization of sesame germplasm resources in China can be divided into three stages:

1. Spontaneous selecting period

Before 1949, farmers in various areas used to cultivate the local varieties which are highly resistant to disaster, stable and high yielding, with high oil content under the local natural conditions. For example, varieties with branches and yellow seed coat, like "Weishiliutiaoqing", "Suiping xiao zihuang" etc. are always used by farmers in Henan. White sesame ("Tianmen Aijioubawangbian", and "Mianyang Bagucha")with high quality and yield is favourite to people in Hubei. In Jiangxi, farmers usually grow black sesame such as "Jinxianjing chaima", "Wuning hezhime" which has short growth stage and which is tolerant to the barren land.

2. Evaluating and examining period

Earlier in the 1950's collecting, sorting out, and evaluating were made on a large-scale nationally. A number of fine local and improved varieties, which could be released directely in the production have been selected in all parts of China, and their yield was also increased. Those days they always released the improved varieties such as "Silingzhau" from liacling, "Batongbai" from Jiling, "Hebei bawingbian", "Jin kouhuang" from Shangchai, "Wuzhuolian" from Xingping country in Shanxi, "Silingzhau" from Fu yang in Anhui, "Jiogentou" from Wuchang in Hubei, "Laohong zhima" and "Xiniujiao" from Xiangyang, "Black sesame" from Wuning in Jiangxi, "Batou" from Shouyuan in guangdong, and "big belley sesame" from Hainan Island. All the above varieties have a high stable yield and high tolerance to stress.

3. <u>The stage of artificial creation and breeding according to our desires</u>

Since 1960's, we utilized the available germplasm in the light of the major problems such as low land, unstable yield, nonresistance to waterlogging and diseases. By a systematic selection and hybrid breeding, we have bred many new varieties such as "Liaozhi No.1" in Liaoling, "Zhuzhi No.2" in Henan, "332" "786" in Hubei, "Zhongzhi No.5", "Yiyang vai", "Xiong Zhi No.1", "Xiangzhi No.2" etc., which have higher and abundant production capacity, but a small adaptive range. The improved varieties bred by hybridization are "Zhongzhi No.7 (Xiniujiox x 786), "Yizhi No.1" (taxigan x Beijing bawangbian), "Ezhi No.1" (Zhongzhi No.7 x Hongmaoxion), "Henan No.1" (Wuchang Jiaoyantou x Nuanchuan sesame), "Yizhi No.1" (Zhongzhi No.1 x 1134" (Ningninjingenhuan), "Zhongzhi No.8" (Zhongzhi No.7-2 x Jiang Ningyougguangxin sesame), "Zhuzhi No.4" (Zhuzi No.1 x Huanchuangaijioubafangma). These have a good and abundant production, strong stress resistance, extensive range for adaptation and other characters. They are also the main varieties which were released and utilized in all parts of China, including: "Zhongzhi No.7" which has large cropping areas in Hebei, Henan, Anhui, Jiangxi, Shichuan, and Zhejiang. The extention of the cropping areas is 134,000 ha, making up about one sixth of the total planting areas in China. It is the favorite variety to the farmer. It also has a ready sale in the foreign market, because of its white seed coat and high content of oil (54%-56%). "Yizhi No.1"possesses early maturity, fine economic character, hard stalk and lodging resistance. It also has larger cropping areas in Hebei, Shanxi, Sansi and north Henan. It is the variety of the largest planting range in sesame productive areas of present north of China.

Since the late 1970's, the requirement for high quality seeds in the international market has influenced the germplasm of the sesame variety. For instance "Yuzhi No.2" (Ezhi No.1 x Xiongzhi No.1) has been lately bred in Hehan having good and abundant production, white seed coat, high oil content and other characters. It is one of the quality and edible oils. It is released in Hehan.

In addition, the variety called "Jiguang No. 1" has been bred in Hainan by using inducing mutation. It is early muturing variety with strong resistance and high oil content (54.17-57.48%). It has a certain release areas in Hainan Island.

<u>Future</u>

Recently, the large-scale collection work of sesame germplasm resources in China has been just finished at its first phase, and gradually turning to the identification and utilization etc., to tackle the low and inbalanced sesame yield, low level of mechanization, low resistance to diseases and so on. To meet the higher need of good quality from the world market, we will enhance the research on sesame germplasm based on the following aspects:

1. selecting and identifying for resistance (to stress and disease) and quality (fat, protein and fatty acid).

2. enhancing the international introduction and exchanging the germplasm as wild species, determinate types and male sterility for enriching the gene pools of the Chinese sesame germplasm and extend the range of utilization of sesame resources.

3. Emphasizing the study on utilization of superior sesame hybrid by the means of chemical emasculation and male sterility, for increasing the yield per unit.

4. bringing forth new ideas of sesame artificial germplasm by using hybridization, artificially induced mutations and biological techniques so as to meet the need of development in sesame production.

5. studying the basic theory of sesame such as the classification, correlation and genetics of its main traits, subhybrid, ecology and introduction, germplasm storage, index and management by computer etc., so as to make new contribution for the development of sesame.

STUDIES ON BIOLOGICAL BASES OF HIGH YIELD CULTIVATION METHODS OF SESAME[1]

Li Chen-hua and Yang Jing-Ze

Climate and soil conditions are the major factors affecting sesame production. Based on the agronomic characteristics and the growth and development of sesame, adopting some adequate cultivation methods that increase sesame yield is the key point of Chinese sesame production. The potential yield of the Chinese sesame varieties, the cultivation methods of sesame to increase the yield, and the biological bases of high yield in sesame production are presented in this paper.

The Biological Bases of High Yield Sesame

1. The dry matter accumulation of high yield sesame

In recent years, the results of the trial which had been conducted in the field showed that adopting effective cultivation methods to advance the use of natural resources such as temperature, sunshine, and heat etc. and to accumulate much more dry matter especially just after the emergence of sesame seedlings is the most important biological base for high yield in sesame production. The relationship between dry matter accumulation and the yield is given in Table 1.

Table 1. The relationship between dry matter accumulation and yield of sesame.

Items	Dry matter in stages								Yield
	Seedling		Early flowering		Flowering		Late flowering		
	g/plant	kg/mu*	g/plant	kg/mu	g/plant	kg/mu	g/plant	kg/mu	kg/mu
high-yield field	10.59	116.5	16.97	186.7	20.8	228.8	31.9	350.9	119.0
average-yield field	10.36	93.2	15.08	135.7	17.2	154.8	27.2	245.8	55.4

* 15 mu = 1 ha

The data analyses showed that although the plant density of high yield field is 2,000 plants more than that of average yield field, not only did the total dry matter of high yield field was 24.95--43.40% more than that of average yield field, but also did the dry matter weight per plant increased 2.22-17.27% during the seedling stage. The yield of sesame was increased by 114.60%. The result indicated that the more dry matter is accumulated, the higher is the yield obtained.

2. Leaf area variation of high yield sesame

Leaf Area Index (LAI) is a very important physiological index of sesame. The LAI can show the situation of growth and development of sesame. There is a significant postive correlation between the leaf area variation, before the later flowering stage, and the yield. The correlation coefficient is $r = 0.96$, the regression equation is $y = 81.89 + 42.202x$. If the expected yield is 100 kg/mu (15 mu = 1 ha), the LAI is 1.4-2.0 in seedlings stage, 3.5-5.0 in flowering stage (largest), and 2.5-3.5 in later flowering stage, Table 2. During the seedlings

[1] paper received but not presented as the authors could not attend.

stage, if the leaf area index was less than the number showed in Table 2, this situation would result from improper plant society (less plant density or inadequate single plant development) so that there is no enough dry matter constantly supplying to maintain high yield. The improper large leaf area caused the seedling to flourish so that the first capsule was set unexpectedly. The less leaf area in the middle period of growth resulted from improper plant society and abnormal single plant development. If the leaf area was improperly large, that could prevent the middle and bottom parts of the plant getting enough sunlight to carry out photosynthesis and the number of capsules was decreased during the later period of the plant development. Less leaf area indicates that the sesame plant has premature sensecence.

Table 2. Photosythesis leaf area variation and the yield of sesame (1985 Linqian, Anhwei).

Varieties	The LAI of different sesame growth stage				Yield kg/mu*
	Seedlings stage	Early flowering stage	Flowering stage	Later flowering stage	
Zhong zhi No.8	1.86	2.87	4.17	2.66	114.0
Zhong zhi No.7	1.94	3.94	5.07	2.68	103.5
Ping Zhi 7267	1.94	2.65	3.61	3.34	115.0

* 15 mu = 1 ha.

Also, inproper large leaf area is easily caused by the leaf disease under the humid temperate climate conditions. The worst was that the diseases can damage all the leaves of the plant. As a result, the proper cultivation methods, such as applying N in the field of weak seedlings, must be adopted in order to enhance the plant development and increase its disease resistance ability. It is also essential to use some proper cultivation methods such as gutter, applying N,P,K etc., in the middle of the plant growth to prevent the leaf from premature senescence and increase the single plant yield.

3. The nutrient dynamic of high yielding sesame

According to the data analyses, N-P-K absorption and dry matter accumulation are increased synchronously, Table 3. The more strong is the root system, the more nutrient can be absorbed. From early flowering stage to flowering stage is the climax period of the photosynthesis and the transformation of dry matter and nutrient of high yield sesame. In this period, 53.60-59.00% dry matter can be accumulated over the total dry matter accumulation, 36.90-46.97% N can be absorbed over the total N absorption, 42.68-51.98%. P_2O_5 can be absorbed over the total P absorption, and 43.28-47.033% K_2O can be absorbed over the total K_2O absorption. Although the climax of N-P-K absorption and the dry matter accumulation take place synchronusly in the average field, the absorption and accumulation are much less than that of high yield. The dynamics of nutrient content absorption was that in the early growth period of sesame, in average yield field, the quantity of absorption was a little more than that of high yield field, and in the middle and later growth stages, the quantity of absorption is much less than that of high yield field.

Table 3. The N,P,K, absorption ratio (%) in the different growth and development stages of sesame.

Items	Seedling stage High yield field	Seedling stage CK	Early flowering stage High yield field	Early flowering stage CK	Flowering stage High yield field	Flowering stage CK	Later flowering stage High yield field	Later flowering stage CK	The required quality of nutrient to produce 50 kg seed (kg/mu)
N	10.7	14.05	35.1	43.6	71.96	79.7	88.6	89.3	5.38-3.4
P_2O_5	5.31	3.65	18.7	19.7	70.7	59.5	94.86	90.5	1.93-1.09
K_2O	11.57	12.13	44.95	42.85	92.28	75.6	96.78	98.6	5.18-4.59
Biological Products(%)	5.71	5.38	19.66	16.47	78.8	55.0	87.95	79.8	

During the same process of vegetable development and reproductive development which take place synchronously, dry matter deficiency and the shorter seta as well as less number of flowers and capsules cause the decreasing yield of sesame. In order to constantly supply enough dry matter and get higher yield, enough fertilizer must be used pre-sowing and some N must be applied, in the period of growth of the plant, according to the soil fertility and the plant development situation as well as the requirement of yield.

4. Sesame yield component

No matter if the varieties are non-branching or branching under the same plant density (although the growth vigour is different), the variation of the number of capsule/plant is more than the number of seeds/plant). There is a significant positive correlation between the yield and the number of capsules/plant; for example in Zhong Zhi No.8, r = 0.9337 and regression equation is y = 72.709 + 2.469x, Table 4. The number of capsules is affected by the length of seta, seta coefficient (podding stem length/height of the first podding site) and the podding density (number of capsules/podding stem height). The proper plant density must be arranged and the adequate cultivation methods must be adapted to increase the height of podding stem, to enhance the number of capsules/plant and to decrease the height of first podding site.

Table 4. The correlation analyses between yield of sesame and its components.

Yield component	Yield	No. of capsule/	Podding stem coefficient	Podding stem length	No. of seeds/ plant
No of capsule/plant	.9337**				
Podding stem coefficient	.9194**	.8853*			
Podding stem length	.8893*	.9514**	.8455*		
No. of seeds/ plant	.5985	.7982	.5446	.6331	
Podding density	.7065	.8674*	.5779	.6639	.3710

* and ** significant at the .05 and .01 levels.

The Potential Yield of Sesame

Sesame is not a low yielding crop. The complex factors contributing to the low yield of sesame include improper cultivation methods. Also, the importance of sesame production is not known by most farmers. As a result, the high yield potential of sesame can not be exploited. There are some good examples for high yield in sesame, Table 5.

Table 5. The yield of different sesame varieties.

Varieties	Area (mu)	Place	Yield (kg/mu)*	Year
Zhong zhi No.8	1.1	Jiayu county Hubei	136.35	1984
Zhong zhi No.7	1.7	Linque county Anhuwi	140.5	1984
Zhong zhi No.7	3.0	Linque county Anhuwi	135.0	1985
Ping zhi 7267	1.75	Linque county Anhuwi	130.65	1985

* 15 mu = 1 ha.

Cultivation Methods of High Yielding Sesame

1. Cultural practices

In Yangtze and Huai valley, flooding and drought damages take place alternately. Most of the cultivated soil is defficient in contents. Diseases of K deficiency are also discovered in some parts of this area. So the series "high yield cultivation methods in Yangtze and Huai valley" based on our trial conducted in this area was presented. The basic methods of sesame cultivation such as the rotation system and other practical methods are adopted to prevent flooding and drought damages and to maintain enough seedlings. Concerning the practical methods, first of all, a) introducing high quality seeds, b) the use of narrow-furrow and deep-gutter, c) applying fertilizer scientifically, and d) tip pruning in adequate time. In recent years, the series methods have been extended to 20,900 mu, resulting in more than 20%.

2. Adopted ground coat cover

According to the relevant reports, the ground coat cover cultivation can keep the heat, prevent and control flooding and drought as well as disease damage. Sowing seeds in advance in normal years and the use of ground coat cover cultivation in Chinese northeast and north regions, when planting spring-sesame, can increase the soil temperature and hasten the sesame development. It is also an essential method to increase the sesame planting area. The methods can be used in the Yangtze and Huai valley, when planting summer-sesame, to prevent flooding and drought damage and to get high yield, especially in the years of too much rainfall. In these areas, ground coat cover is a very important method to achieve higher and stable yield.

3. Use the intercropping and the relay intercropping methods to make the sowing date in advance

From south to north in the sesame growing area of Yangtze and Huai valley, the average daily temperature gradually rises up to 20°C from the middle of May. This temperature is adequate for sesame sprouting and emergence of seedlings. If the temperature, sunlight and heat are effectively used from the middle of May to the early days of June, the big problem of sesame sowing date can be solved. For example, in Henan Provience, sesame seeds were scattered in the unharvested wheat field, which makes the sowing date in advance about 2 weeks. Since the maturity date of rapeseed, barley and bean is early, growing sesame after these crops can make the sesame sowing date about 1 week in advance.

4. Applying the plant physiology and biochemistry knowledge

The results from the field trial conducted in recent years showed that it is an effective method to apply the plant growth regulator to control the height of first podding site and to achieve high yield of sesame.

REVIEW AND FORECAST OF SESAME BREEDING IN CHINA[1]

Chen Hexing

Sesame (Sesamum indicum L.) is one of the main oil crops in China, and has an important position in domestic and foreign production. It has been cultivated for a long time in China. Farmers have much experience, but scientific research institutions did not conduct sesame breeding until liberation. Sesame breeding was formally started in the 1960s. During the last 30 years, 22 new varieties were bred.

I. Rough introduction on the basis of research on sesame breeding

1. Professor Zhan Yingxian (Beijing Agricultural University) has published a book entitled "Sesame and its cultivation" in 1957, which has an important role for the widespreading of sesame basic theories.

2. Professor Liu Houli (Huazhong Agricultural University) has led and carried out the studies of sesame genetic regularity during the later 1950s and earlier 1960s, which set up the first example and theoretical basis for cross breeding. Professor Liu presentd the idea of the desired plant patterns.

3. Professor Fu Jiarui (Zhongshan University) published a paper on sesame illuminative experiment in 1960, which indicated that varieties from different latitudes have different response to illuminative time, which built the foundation of sesame varietal introduction.

4. Scientist Chen Cuiyun (Oil Crops Institute, CAAS) has led and carried out the studies of sesame varietal resources between 1962 and 1964. From his research on more than 3,200 varieties in 24 provinces, cities and autonomous regions in China, the author primarily explicited the following several issues:

   a) varieties from different regions have obvious different characteristics in Wuhan, which provided basis for classification and introduction of sesame varieties.

   b) there are complementary relations between main economic traits of sesame.

   c) there are close relations between the resistance of variety and original area or characteristics, which provided a direct basis for resistance breeding. The author mentioned that "sesame resistance breeding can begin from the identification of soak-resistance" and meanwhile claimed that sesame is the most soak-sensitive during the transfer from vegetative to reproductive growths.

   d) there is variance of some 10% in oil content in varieties of the same seed color or the ones with different seed color, which provided the basis for quality breeding.

   e) there are many similar characteristics between varieties in the same region, which provided a rough sketch for varietal ecological division into districts.

[1] Paper received but not presented as the author could not attend.

5. Scientist Liu Jiaring (Henan Academy of Agricultural Sciences) conducted studies on relations between main economic traits of sesame during the early 1960's.

6. Professor Yang Hongyun (Wuhan University) conducted studies on the fertilization biology in eary 1960s, and elaborated that sesame fertilization is "one-to-one", and other theoretical issues which have important practical meaning.

<u>II. A survey on progress of sesame breeding</u>

Sesame breeding can be divided in four phases in China.

1. The first pahse was on collection, trimming, identification and systematic selection of native varieties in the 1950s.

   a) during cooperative transformation of agriculture (1950s), more than 3,000 local varieties were collected, providing the basis for the research in the 1960s and catalogue in the 1970s of varietal resources.

   b) during these years, with trimming, a group of good local varieties was identified and some good varieties such as "786", "332" etc. were systematically selected.

2. From 1960s onwards, it was the phase of new varieties selected from systematic selection to cross breeding.

   a) in 1959, under the guidance of Professor Liu Houli's sesame genetic regularity, scientist Chen Cuiyun led and conducted sesame cross breeding. This was the beginning of cross breeding.

   b) Oil Crops Institute of CAAS, Zhu Madian Agricultural Research Institute of Henan, Crops Research Institute of Hebei conducted cross breeding of high yield as a main goal during the 1960s, and produced the first group of varieties by cross breeding. Zhong Zhi 7, Zhu Zhi 1, Ji Zhi 1 and so on, providing experience for sesame cross breeding.

3. It was the phase on resistance breeding as a main goal in 1970s.

   a) this is the explorative phase on resistance breeding. By studying varietal resources, it was found out that varieties originally from southern China have more soak and disease resistance than the ones from Hubei and Henan, but their economic traits are worse and their growing period longer (short-day varieties). Then came the attempt to transfer the resistant genes to "786" and "332" good varieties, and to make their resistance and high yield complementary, but failure was the result in spite of the many back-crosses and multiple crosses.

   b) by artificially soaking at sesame beginning of flower in 1974, the auther began to select soak-resistant and disease-resistant sesame. Not only was a group of soak- and disease-resistant varieties (lines) identified, but Zhong Zhi 8 was directly selected by artificial soak identification in earlier generations as well. The method of artificial soak identification has already been used by Chinese sesame varietal researchers.

   c) new varieties were directly selected by using middle kind varieties as parents whose economic traits and resistance were complementary. Zhong Zhi 7, Zhong Zhi 8, Yu Zhi 2 etc, for example, are the new varieties.

d) measures of heterosis, yield and oil content in several places and several crosses produced by artificial crossing were done in the institute from the middle of the 1960s to the end of 1970s. The heterosis was obvious. The yield increased by 30%, and the oil content was from middle to high pattern. Soak and disease resistance was also observed to have advantage. The problem on seed production of larger acreages is not solved by experiments with male-killers.

4. It was transferred to the phase on ways of complex breeding of high and stable yield and quality in 1980s.

III. More progress of sesame breeding

After liberation, particularly since 1970s, 22 new sesame varieties have been bred early and late in China. Among these new varieties, 11 were bred by systematic selection, 10 by cross breeding, and 1 by laser breeding. The acreages of good varieties is about 45% in total sesame growing in China. Good varieties yearly increased production vlaue by more than 50 million yuan.

IV. Characteristics and levels of sesame breeding in China

1. The characteristics of breeding are:

   a) it runs from simple to deep and from small to large,
   b) the goal is clear, it demands to have a big progress in short time,
   c) basic research is closely related to breeding,
   d) cultivation, soil and fertilizer and plant protection are the works in which breeding is the centre, and
   e) Identifying artificial soak-resistant variety was feasible and generations were doubled in local fields.

2. The level of new varieties are:

   a) there is some increase in the level of grain yield. The yield level of a single variety, Zhong Zhi 7 was 140 kg/mu in large acreage. According to the trial results, Zhong Zhi 7 mean yields were higher by 13.5% than the local good varieties and by 5.5% than the good variety "786" in 99 regional trials. Zhong Zhi 8 was higher by 7.7% than Zhong Zhi 7 in 108 trials. The yields of 4 varieties were higher than Zhong Zhi 7. Among these varieties, Yu Zhi 1 mean yield was 68.9 kg/mu, higher by 2.4% than Zhong Zhi 7 in 27 productive trials.

   b) Sesame oil content of 53% is common in China, whereas new breeding varieties gave over 56%. For instance, the oil content of Zhong Zhi 8 was 53.74-60.57%, mean 56.34%, and higher 1.4% than Zhong Zhi 7 in 44 places. Oil content is an important index of quality breeding at present.

V. Main problem and direction of effort on sesame breeding

A group of new varieties having an important role has been bred for the last 10 years, but it did not have a great breakthrough when compared with other field crops. So the following research works must be strengthened:

1. Expand the research on resistant germplasm resources in order to provide reliable parent materials.
2. Research on resistant genetic regularity in order to raise the breeding efficiency.
3. Research on the correlation between level resistance and characteristics.
4. Research on breeding ways and methods in order to overcome the limits of sesame interspecific crosses.
5. Research on sesame ecological breeding and its genetic regularity.
6. Research on the many ways of quality breeding and uses.
7. Research on the propagation of good varieties and its system.
8. Research on the production of good crosses and the technique of producing seeds.

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STUDIES ON SESAME VIRUS DISEASE IN CHINA[1]

Shujun Yang, Zilin Yu and Zeyong Xu

Sesame, (Sesamum indicum L.) as one of the main oil crops in the country, is affected severely by virus disease which reportedly occured as high as 85% in some sesame producing regions in recent years. The description of sesame mosaic disease in 1959 is the first record of virus disease in China. Later on, some researchers carried out the experiment on aphid-transmission and electronmicroscope observation of sesame yellowing leaf roll and yellow mosaic disease. However, the pathogen of these visus disease has not been known. In other countries such as India, many studies focused on sesame leaf roll disease and few on other virus diseases. In this study, we tried to identify the two visus isolates obtained from diseased sesame plants with symptoms of yellowing mosaic on leaves (YMo-I) and dward crinkle necrosis both on leaves and stems (DNe-I) in Wuchang during 1985-1986.

DNe-I mechanically infect 13 crops included in Chenopodiaceae, Cruciferae, Leguminosae, Solanaceae, Amaranthaceae and Pediaceae. For instance, it infects Chenopodium amaranticolor, C.quinoa, Gomphrena globosa locally and Brassica campestris and B. chinensis systemically. Myzus persica and Aphis craccivora can transmit the isolate in nonpersistent manner and transmission rate is 11.4% and 13.5% respectively. The isolate remains infective in buffered plant extracts after storage for 4 days, diluting to $4x10^3$ and heating for 10 min. at 60-65°C. Purified preparation of which A260/A280 is equal to 1.24 and Amax/Amin equal to 1.19 contain flexious filamentous particles of c.770μm long which have single peptide of 30,700 D. The titer of antiserum to the isolate is 1:256 in micropreciptin test. In thin section of infected oilseed rape tissue, pinwheel scroll and straight laminate cytoplasmic inclusions which belong to the third subgroup of potyviruses can be observed. In ELISA serological test, DNe-I is closely related to turnip mosaic virus (TuMV), weakly related to peanut stripe virus (PStV) and peanut mottle virus (PMV), and not to soybean mosaic virus (SMV) and watermelon mosaic virus -2 (WMV-2). On the basis of these properties, the isolate is identified as turnip mosaic virus. It is firstly reported that TuMV naturely infects sesame and causes severe disease in China.

YMo-I can infect by artificial inoculation 12 crops included in Chenopodiaceae, Leguminosae, Solanaceae and Pedaliaceae. It's local hosts include C. amaranticolor and C. quinoa and systemically infecting hosts include peanut and soybean. It is transmitted by M. persica, A. craccivora, and A. glycines nonpersistently in higher transmission rate which is 57%, 37.5%, and 27.5% respectively. The purified viruses are flexious filamentous particles. YMo-I induce typical pinwheel and scroll cytoplasmic inclusions just as those of I subgroup of potyviruses in diseased sesame tissues. The isolate is serologically related to PStV, WMV-2, weakly related to SMV, PMV and not to TuMV. The virus transmission rate is 1.4% through seeds from artificially infected sesame plants of which the yield loss is about 87.3%, 75.3% and 10.4% as different inoculating time from seedling to capsule forming stage. According to all the properties described above, YMo-I is identified as peanut stripe virus.

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[1] Paper received but not presented as the author could not attend.

DEVELOPMENT OF OILSEED PRODUCTION AND SCIENTIFIC TECHNOLOGY IN CHINA[1]

Guo Qingyuan

Rapeseed, soybean, peanut, sesame, sunflower, flax and cottonseed are the main resources of edible oil in China. These oilseeds contain rich oil and protein which can be used as food, feed and other purposes. Oilseed production is important in the economic development of china.

I. Main Growing Regions of Oil Crops

Soybean is grown in every province of China, but the main growing regions are in the northeast of China, the Huang-Huai Plain and the Lower Yangtse Valley. In 1985, Heilongjiang, Jilin, Liaoning provinces in the northeast of China had 3 million hectares and 4.6 million tons, 39.4% and 43.7% of the national soybean area and production, respectively. The Huang-Huai Plain has 2.5 million hectares and 3 million tons, 32.9% and 28.8% of the national soybean area and production, respectively. Soybean area of the Yangtse Valley had 1.3 million hectares. The main rapeseed growing regions are in the Yangtse Valley, which accounts for 80% of the national area and production total. Among provinces of the Yangtse Valley, area and production of Sichuan and Anhui provinces are over 667,000 hectares and 1 million tons, respectively.

The main peanut growing regions are the Huang-Huai Plain, the Yangtse Valley and southern China. Area and production of the Huang-Huai Plain are 60% and 70% of the national total respectively. In 1985, Shandong province had about 918,700 hectares and 2.62 million tons, 28% and 38% of the national peanut area and production respectively.

The main sesame growing regions are the Huang-Huai Plain, the middle and lower Yangtse Valleys. Among the provinces, the sesame production in Hubei, Henan and Anhui was 20, 21, and 19% of the national total in 1985 respectively. Sesame rotates with wheat, rapeseed, soybean and other crops, double or triple cropping a year.

The main sunflower growing regions are northeast, north and northwest China. Their sunflower areas are 98% of the national total.

Linseed is mainly produced in the northwest and north of China. Among them, the area of Gansu Province is the most.

II. Development of Oilseed Production

Oilseed production in China has been quickly increasing for the last few years. It reached 26.28 million tons in 1985 and was in an increase of 10.7 million tons or 68% from 1980, Table 1.

[1] Paper received but not presented as the author could not attend.

Table 1. Chinese oilseed situation* in 1980 and 1985.

Crops	1980			1985			% in 1985 (1980 = 100)		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Soybean	108400	73.0	7.94	115770	91	10.50	106.8	124.7	132.2
Rapeseed	42660	56.0	2.38	67410	83	5.61	158.0	148.2	235.7
Peanut	35980	100.0	3.60	49770	134	6.66	138.3	130.1	185.0
Sesame	11640	22.0	0.26	15780	44	0.69	135.6	200.0	265.4
Sunflower	12670	71.8	0.91	22110	78	1.73	174.5	108.3	190.1
Linseed	10550	25.8	0.27						

* Area (thousand mu, 1 mu = 1/15 ha),
Yield (kg/mu),
Production (million tons)

Soybean originates from China. Chinese soybean production in 1936 was 11.3 million tons or 91% of the world total. Afterwards, soybean production decreased sharply. The production was 5.1 million tons in 1949, 6-8 million tons in 1960s and over 10 million tons in 1985. Production increased during the last few years mainly by raising yield. Soybean yields were 615, 720, 1095, and 1365 kg/ha in 1949, 1965, 1980, and 1985, respectively. Peanut, rapeseed, sunflower and linseed productions have developed quickly during the last few years. Rapeseed and peanut production were the first in the world in 1985. Edible oil production and purchase amount in China have been increasing for the last few years with the development of oilseed production, Table 2.

Table 2. Edible oil production and purchase amount from 1976 to 1985 in million tons.

Year	Production	Purchase amount	% Purchase
1976	1.63	0.83	50.8
1977	1.66	0.88	52.8
1978	2.07	1.15	55.9
1979	2.47	1.53	62.1
1980	2.75	1.95	71.1
1981	3.66	2.79	76.4
1982	4.29	3.08	71.9
1983	4.02	2.63	65.4
1984	4.79	3.23	67.4
1985	5.79	3.96	68.4

III. Development of Science and Technology on Oil Crops

There are organizations of oil crops research in the Chinese Academy of Agricultural Sciences, provincial academies of agricultural sciences and universities or colleges of agriculture. In China, there are about 1300 scientists engaged in studies of soybean, rapeseed, peanut, sesame, sunflower, linseed, safflower and other oil crops, and obtained 265 achievement prizes awarded by the state, ministries and provinces during 1980-85. The major development of research on oil crops are as follows:

1. Germplasm resources (about 30,000) of oilcrops have been collected and collated. Germplasm resources lists of soybean, rapeseed, peanut, sesame, sunflower have been compiled and some of them have been published. Their chemical compounds and resistances have been identified, and some germplasm resources are of high oil or protein content and disease resistance.

2. A total of 484 new varieties of oil crops were bred during 1950-1983, including 261 soybean varieties. The new variety yields are higher about 10% than the former ones. Some of them have a high disease resistance and are adaptable to wide regions and different cropping systems. Rapeseed and soybean plants have been cultured by tissue culture and cell-fusion. Heterosis has been used for oilseed production.

3. Rational distribution and synthetic high-yielding cultural technology of oil crops were proved in different regions and cropping systems.

4. Technology of economically applying fertilizers in oil crops was proved by nutritional characteristic and fertilizer tests under different soils and yield levels.

5. The epidemic law of major diseases and pests in oil crops were proved and they can effectually be controlled.

6. Apparatuses of analysing oil crops quality were studied and made. Computer is used for data processing in research.

EDIBLE OIL CROPS IN THAILAND[1]
WITH SPECIAL REFERENCE TO SESAME AND SUNFLOWER

Kovit Kovitvadhi

Abstract

It is anticipated that self-sufficiency in vegetable oils has already or almost been achieved. The comparative price of raw materials and efficiency in oil processing will determine the key vegetable oils in the future. Unit cost of production of palm oil will decrease with further increases in yields with maturation of those palm trees already established and should put palm oil in the lead. However, the rapidly increasing demand for meal to service the feed sectors will maintain soybean in a strong position. These two crops will not compete for land, but for oil market share. The unique quality of soybean oil gives an advantage in certain food processing industries. Cheap rice bran, which is available in large quantities and not efficiently utilized at present provides a big potential for oil crushing. Yet, the possibilities of blending or substitution has to be fully exploited. All these factors require careful evaluation by policy makers before the formulation of recommendation concerning vegetable oil production strategy in future.

Background

1. Before the 1960s, there were many oil producing crops grown in Thailand, but only minimal amounts of vegetable oils were extracted, mostly from coconut and peanut, by many small factories. These vegetable oils were supplementary to homemade cooking oils, mainly lard.

2. The discovery of Cholesterol as a health hazard was recognised in the 1970s and had an increasing effect on the majority of housewives' preference for vegetable oils.

3. Concurrently, the establishment of modern feed and animal industries generated strong demands for protein supplements, especially for soybean meals. In response, several oil extracting factories underwent substantial expansion and modification to satisfy this growing demand for both oil and meal. Attempts were also made to diversify the raw material base through the utilization of rice bran, kapok and cotton seed to fully exploit local resources and year round operation.

4. With increasing demand from the animal production industry, total meal output could not keep pace with requirements of the feed industries. Importation of soybean for oil and meals were made and increased continuously.

5. The government, being aware of the rising trade imbalance, initiated several necessary measurements to reduce dependency on imports and to conserve foreign exchange. Crops that received priorities for promotion were soybean, oil palm and coconut. In addition, the potential of rice bran, which was then underutilized, was closely investigated for the possibility of oil production. Efforts to be self-sufficient in the vegetable oil sub-sector were awarded top priority.

[1]The editor apologizes to the auther for excluding soybean, groundnut, oil palm, cocount, rice bran, kapok seed, and cotton seed. The purpose is to make the presentation more relevant to this workshop. However, these field crops or crop trees were excluded only from one section "Production, constraints and development potential" which does not affect the general meaning behind this presentation.

6. Balance sheet of edible oils and caput from 1980 to 1986 and also projection for 1991, the end of the Sixth National Economic and Social Development Plan, and 1997, the beginning of the Eighth Plan, are given in Table 1. It is shown that production increases were slow at the beginning, but rapid expansion was achieved between 1982 (130,000t) and 1986 (220,000t). On the consumption side, steady increases were observed during the period. The balance sheet indicates that deficits consistently declined until 1984 and surplus was achieved in 1985. However, even with overall self-sufficiency, certain types of vegetable oils which could not be produced within country were still imported.

7. Data on per capita consumption of vegetable oils shows an increase of 5-6% per annum. This has resulted from the growth of direct consumption, the food processing and the non-food industries.

8. Projections indicate that there will be an outgrowth in all items. Output is expected to double to 556,420t in 1997 and consumption of edible oils will reach 298,000t and 378.000t in 1991 and 1997 respectively. Caput is expected at 5.25 kg in 1991 and 6.13 kg in 1997. In balance, the oil surplus will grow to 180,730t in 1991 and will remain at that level until 1997. These projections were based on a comprehensive analysis of data from various sources with appropriate adjustment.

Table 1. Production, consumption and caput of vegetable oils during the period of 1980-1986 and projection for 1991 and 1997.

Year	Production ('000t)	Consumption ('000t)	Balance ('000t)	Caput (kg)
1980	89.07	185.88	-96.81	4.01
1981	90.68	161.07	-70.39	3.39
1982	130.20	167.43	-37.23	3.45
1983	140.63	188.37	-47.74	3.81
1984	167.41	204.44	-37.03	4.06
1985	247.98	223.04	+ 24.94	4.35
1986	260.03	256.53	+ 3.50	4.92
1991	478.85	298.12	+180.73	5.25
1997	556.42	378.12	+178.30	6.13

Source: Wonghanchao *et al*. 1987

9. Production and consumption of the various edible oils for 1986 are presented in Table 2. Palm oil ranks first in both production and consumption followed by coconut, soybean and rice bran respectively. These four major edile oils accounted for 90% of both categories. About 3,960t of palm oil and 2,910t of rice bran oil were surplus while 3,500t of soybean oil was imported. Certain food-canning industries require only soybean oil to meet the standard of importing countries. Palm and coconut oils are classified as hard oils while others are termed soft oils.

Table 2. Types of vegetable oils produced and consumed in 1986 (in '000 t).

Types of oils	Production	Consumption	Balances
Palm	135.61	131.65	+ 3.96
Coconut	45.07	45.07	0.00
Soybean	36.12	39.68	- 3.56
Rice (bran)	16.81	13.90	+ 2.91
Peanut	8.59	8.56	+ 0.03
Kapok seed	8.82	8.82	0.00
Cotton seed	8.12	8.12	0.00
Sesame	0.89	0.83	+ 0.06
Total	260.03	256.53	+ 3.50

Source: Wonghanchao _et al_ 1987

10. The minor vegetable oils include peanut, kapok, cotton seed and sesame. All are produced from crops which are grown for other lead industries and oil extraction is made from commodity surplus or from by-products to earn extra revenue. These oils, except sesame, are blended with other soft oils before marketing. Sesame oil, which is superior in quality and commands a premium price, is marketed as a pure product. Data suggests that these minor vegetable oils play a minimal role in the country's oil sectors.

Sesame

11. Sesame is a traditional crop in Thailand. It is drought resistant and can be grown before the main rice crop and also after harvest of upland crops to exploit remaining soil moisture. Three types of sesame are grown: white, black and red. The black-seeded varieties are for direct consumption, but some small seeds as well as the red seeds go for oil extraction. Statistics, Table 3, shows slight increases in both acreage and production largely due to stable price and market demand. Erratic rainfall within growing seasons also affected the output considerably. Heavy rain during harvesting also damages yield, crop output and seed quality.

Table 3. Sesame statistics during 1977-1986.

Year	Harvest area ('000 r)	Output ('000 t)	Yield (kg/r)	Farm price (B/kg)	Farm value (mill.B)
1977	220.0	23.4	106	8.93	209
1978	289.1	29.9	104	8.59	257
1979	228.0	21.7	95	11.32	245
1980	245.0	27.1	111	12.49	339
1981	257.4	28.5	111	10.14	289
1982	213.6	22.4	105	9.83	221
1983	194.8	16.3	84	12.38	202
1984	230.0	22.1	96	11.69	258
1985	259.3	25.4	98	11.17	284
1986	265.0	26.4	100	8.90	236

r = rai = 0.16h; B = US$ 0.04
Source: Ag. Stat. Cropyear 1986/87, OAE

12. The cost of production is small and mainly includes family labor. Non-cash production costs of red and black sesame were about 350 B/rai (1B = 0.04 US$; 1 rai = 0.16ha) while those for white seed, which requires several sprayings, appeared to be 500 B/rai. Farmgate price for the white seed is about 14 B/kg and for the red and black at 10 B/kg. Sesame is popular as a catch crop to obtain additional incomes, but prices can drop significantly with over production. Two new short duration varieties, one black- and one white-seeded, have been released by DOA (Department of Agriculture).

13. There are no statistical data available for sesame oil production and consumption since it is included with other vegetable oils, Table 4. It is estimated that about 10% of the total output or 2,500t of seeds were crushed for oil, giving about 1,000t of oil per annum. Sesame oil with its unique properties is used only in special cooking and medicinal therapy. It also has a long shelf life due to its content of a anti-oxidant substance. In addition, relative higher prices make sesame oil less popular than other vegetable oils in the markets. Only the consumers who have long been acquainted with this edible oil are prepared to pay a premium price.

Table 4. Balance sheets of other vegetable oils during 1977-1984 (in '000 t).

Year	Output	Import	Export	Consumption
1977	4.5	0.1	0.1	4.5
1978	4.7	1.1	0.1	5.7
1979	7.7	2.3	0.3	9.7
1980	18.8	3.5	9.9	12.4
1981	19.0	2.2	11.4	9.8
1982	19.7	0.9	14.5	6.1
1983	17.0	4.3	10.3	11.0
1984	118.3	3.7	6.3	15.7

Source: OAE Bulletin no. 41/1985

Sunflower

14. This crop has not been grown for oil extraction in Thailand even though research programs have been carried out for decades. The main constraints has been the lack of adapted varieties giving satisfactory seed setting. Agronomically, there is a good potential to grow sunflower at the end of the rainy season on residual soil moisture after a corn crop.

15. Recently an Australian Seed Firm, in collaboration with DOA and Bank of Agriculture, and Agricultural Cooperative, have initiated a pilot project to promote sunflower for oil crushing. Supplies of imported hybrids, inputs and supervision is provided and price guarantee at harvest are an integral part of the package. Results of trials set in 1986 showed that farmers were able to achieve a yield of 150 kg/rai compared to that of 350 to 450 kg/rai under the project. From the information available, it is clear that sunflower can be grown as a second crop if more on-farm adaptive research is carried out to solve certain problems.

16. The introduction of sunflower into the oil crop commodity possibilities will create furthur opportunity for farmers to diversify their outputs. Furthermore, the facilities of existing oil extraction mills will have access to more raw materials thereby improving efficiency and supply of feed stuff. Soybean and sunflower will not compete for land but for share in oil uses.

Recommendations

17. It is realized that soybean and oil palm are the major vegetable oil producers and both commodities will provide for self-sufficiency in the near future. To avoid increasing competition between these two crops, a production policy is now required.

Soybean: Local supply of soybean meal must be increased to cut down imports which ae currently about 50% in feed mixes. However, self-sufficiency in meal would undoubtedly create an oil surplus. At present, it is difficult to find export markets particularly since domestic soybean oil price is exceptionally high. Furthermore, it is problematic whether soybean can compete with palm oil in the internal market. One possibility is to develop special products relative to market needs for down stream processing eg. paints, varnishing oils, alkyds, resins etc.

An alternative approach is to modify the current quota system by allowing predetermined imports of soybean meals. The higher price of the locally produced meals could be adjusted by cheaper foreign materials. As a result, the costs of the feed mix will be reduced substantially to enable animal products to be more competitive in the international markets. Finally, continuous attention must be given to reducing local costs of production through improved yield levels. This would result in the soybean price which will be more favorable in both national and international markets.

Palm oil: In the near future, when all palm trees are fully matured, surplus of palm oil will be obtained. Strategy of production cost reduction should come before maximum yielding in order to make the oil cheaper. In addition, improved efficiency in processing, transportation, distribution and marketing should also be a priority. Down stream developments for diversification of end uses is an important alternative.

Adoption of trade barter system with the Middle East for fossil oil and with other edible oil-deficient countries are being explored.

Other oil crops: These should be promoted on the basis of their own specialities with higher quality products for better prices. The supplies of these materials for oil crushing are possible when there are surplus or from their by-products. In the future, the shares of these minor vegetable oils will likely diminish in the proportion of the growth of two major oils: soybean and palm oil.

Assistance to Increase and Sustain Vegetable Oil Production

18. Vegetable oil production and industries in Thailand has passed the take-off stage and reached self-sufficiency. There are now several aspects to improve both research and developments. Priorities are summarized as follows:

Soybean: Expansion of soybean to the new and marginal areas such as central and lower northeast where soils are poor and rainfall is erratic. This approach would substantially improve both income and diet of people in those rural areas. Adaptive research and appropriate development programs are equally required. It is also desirable to develop simple food products for improved nutrition of the rural poor.

Oil palm: New hybrids and sufficient seed for future uses in new replantations are urgently required. All of the palm trees grown totally depend on foreign planting material, and hence their adaptability is questionable.

Efficiency in oil processing should be improved. Wastes and by-product of oil extraction as well as local sources of fuel should be utilized within the system.

Down-stream developments and possibilities of soybean and palm oils should recieve priority so as to make full use of the surpluses. Product diversification should aim at both domestic and international markets, especially for non-food industries..

Finally, market intelligence is necessary in order to adjust or modify the internal planning in line with the international market situation. These are the major activities that require assistance and collaboration from abroad or international bodies.

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SESAME IMPROVEMENT - ACHIEVEMENTS AND PROSPECTS IN THAILAND

Wasana Wongyai

Sesame can be planted either in the paddy lands or in the upland areas in Thailand. In the paddy field, sesame is planted before rice as early as February in the Northeast or as late as mid-April in the North and Central plains. If sesame is planted later than the above mentioned time, the risk of being destroyed by rainfall in June will be high. In the upland areas, sesame is planted after the harvesting of field crops such as corn and casava between end of August and mid-September.

The region known as the major sesame production area is the North. The area planted to sesame has been extended to the Central plain, and some provinces in the Northeast and the South, Fig.1.

Sesame Cultivars Developed in Thailand

The work on sesame varietal improvement has been initiated by the Department of Agriculture (DOA) in 1974. The first variety "Roi-et 1" was released in 1984 as a result of varietal introduction from overseas. It is an early maturing variety with white seed coat and dehiscent capsule. However, most of the farmers still grow local varieties. In 1987, the new variety of sesame, "Mahasarakam 60" has been released by DOA. This variety is a high yielding one selected from the germplasm introduction from India. It is an early maturing variety with large seed, white seed coat and indehiscent capsule.

Recently, Kasetsart and Khon Kean universities were involved in sesame breeding activities. The program included germplasm collection and breeding. Universities are mainly involved in basic research in breeding and genetic studies of the crop whereas DOA is concerned with practical breeding.

Germplasm collection

The success of any breeding work depends very much on the availability of the required genetic variability. The collection included local and overseas varieties. Germplasm collections have been evaluated for agro-morphological characters, seed characters, disease and insect reaction. Results of the evaluation have been computerized to facilitate the selection of genotypes with a combination of desirable traits. The selected lines from germplasm evaluation have been tested for yielding ability, Table 1. The selections were based on maturity, height, plant type and disease and insect resistance. Emphasis was placed on early maturing variety which could be used in the cropping pattern in Thailand. However, the yield of these varieties is lower than that of the local high yielding variety, Nakornsawan. Promising lines have been utilized for the cultivar development.

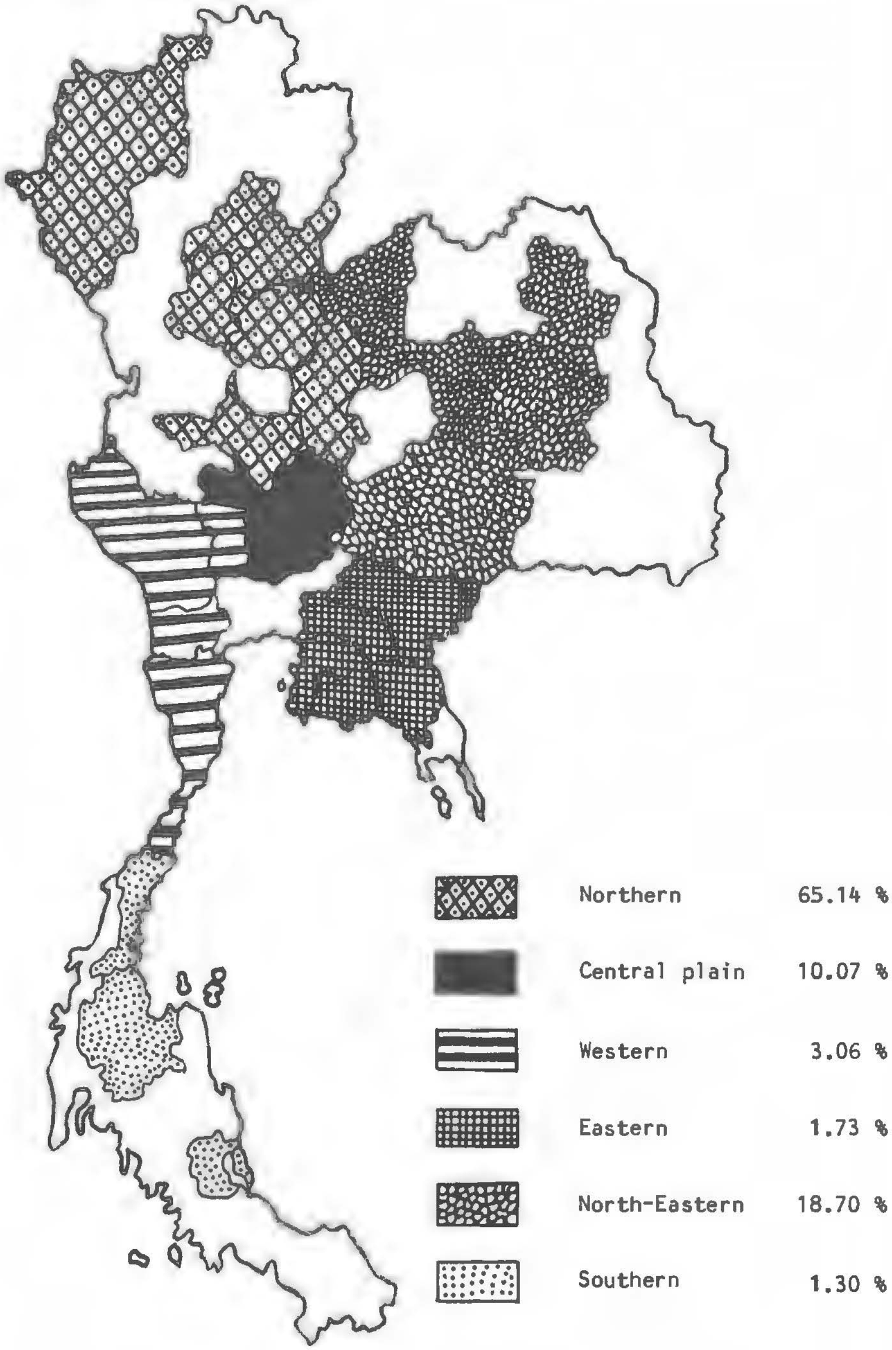

Fig.1, Sesame production area in Thailand.

Table 1. Mean yield and other agronomic characters of selected sesame lines tested at Farm Suwan in April 1987.

Pedigree	Days to flower	Plant height (cm)	Capsules per pl.	Yield (kg/ha)	Capsules per axil	Capsule type	Branching habit
1st Set							
SM 0002	30	143	61	575	1	Bi	B
SM 0004	32	145	66	264	3	Bi	B
SM 0005	32	152	77	335	3	Bi	B
SM 0009	32	142	69	589	3	Bi	B
Sm 0010	32	141	84	270	3	Bi	NB
Sm 0038	29	98	50	666	3	Bi	NB
Sm 0039	34	163	56	316	1	Bi	B
Sm 0044	31	125	56	209	3	Bi	NB
Sm 0046	30	119	45	513	1	Bi	B
Sm 0047	31	124	48	358	1	Bi	B
Sm 0048	29	799	42	491	1	Bi	B
Sm 0052	30	113	54	781	1	Bi	B
Sm 0061	31	196	52	334	3	Bi	B
Sm 0062	30	106	52	334	1	Bi	B
Sm 0066	30	113	44	330	3	Bi	NB
Sm 0071	30	129	68	323	3	Bi	B
Sm 0072	30	119	55	406	3	Bi	NB
PI 154298	30	94	60	567	1	Bi	B
Roi-et	30	72	60	330	1	Q	B
Nakornsawan	35	133	55	1001	1	Q	B
cv (%)	2.84	6.67	19.68	29.47			
LSD 0.05	1.23	11.40	16.38	191.43			
0.01	1.64	15.17	21.81	254.82			
2nd set							
Col.2-118	30	105	53	570	3	Bi	NB
Col 2-142	32	99	35	311	3	Q	B
Col 2-20	33	141	57	789	3	Q	B
Col 2-130	30	149	46	574	1	Bi	B
Col 2-115	35	130	100	362	1	Bi	B
Col 2-56	32	142	45	789	1	Q	B
Col 2-227	32	148	88	545	1	Bi	B
Col 2-136	30	88	65	425	3	Bi	B
Col 2-159	31	118	55	313	3	Bi	NB
Col 2-121	32	130	55	517	3	Bi	NB
Col 4-81141	30	125	53	609	3	Bi	B
Col 4-712	29	76	56	269	3	Q	NB
Col 6-616,30A	30	87	54	370	3	Q	NB
Col 6-125,BON	30	99	43	458	1	Bi	B
Col 6-43	30	140	78	745	1	Bi	B
Col 6-ANNA	31	118	53	246	1	Bi	B
Col KU-TC 16	30	105	50	605	1	Bi	B
Col KU-63	30	110	45	299	3	Bi	NB
Roi-et	30	112	51	285	1	Q	B
Nakornsawan	36	114	65	835	1	Q	B
CV *%)	3.62	6.41	12.67	22.74			
LSD 0.05	1.59	10.77	10.34	159.8			
0.01	2.11	14.34	13.77	212.7			

* Bi = Bicarpellate, ** B = Branching, Q = Quadricarpellate,
NB = Non-Branching or single stem.

Breeding

Breeding objectives can be derived from the environmental condictions and the existing cultural practices of the farmers in major sesame growing areas as mentioned before. Besides the high yielding potential, the other characteristics considered as desirable are: earliness, determinate type of growth, indehiscent capsule, large seed size, and white or black seed coat.

A crossing program has been started in DOA since 1980, and very recently at Kasetsart and Khon Kaen universities. Pedigree and bulk breeding methods are used in the breeding program in KU whereas KKu uses the population improvement by using S_1 progeny testing. Advanced segregating populations are planted for further evaluation and selection so as to give a final proof for the release of superior lines.

Continuous development of high yielding varieties and improved cultural techniques are being introduced to increase the yield of the newly developed cultivars.

THE CULTIVATION OF SESAME IN NICARAGUA

R.A. Marenco Mendoza

Abstract

Sesame is considered as a traditional crop in Nicaragua. A total of about 7500 ha are sown annually in the Pacific Region of the country. There are two growing periods, the first from May to August in which 23% of the area is planted. The remainder is sown in the second growing period from August to December. The sesame producers grow an average of 4.1 ha, the average yield being 517 kg/ha. The main varieties sown are "Red China" (63%) and "Mexicana" (15%) both of these are susceptible to shattering and Macrophomina phaseoli. The principal causes of low yields are: 1) The use of low level of technology, 2) the high incidence of weeds, 3) the attack of insects and diseases, and 4) the susceptibility to shattering of our varieties. Therefore, the research is focussed on the search for varieties resistant to our main pests and less susceptible to shattering, with the objective of increasing production and productivity. The government created the "Arlen Siu" company which as well as providing a processing industry is also responsible for gathering together the national production.

Sesame has been cultivated in Nicaragua since the year 1939, so along with sorghum and maize, it is known as a traditional crop. Nearly all of it is grown by small farmers either individually or in co-operatives. Due to the climatic conditions of the country, this can be sown in two seasons, at the beginning and half-way through the rainy seasons. In either period of planting, sesame is one of the more profitable crops for the small farmers and also for the country as a whole, as it requires little inputs. Consequently, the government, since 1979 (Triumph of the Revolution), took the decision to initiate and promote the development of the crop by starting up a state company whose objectives are improvement of production and productivity, and technical assistance for the small farmer.

Socio-Economic Importance

At the moment there exists around 2500 producers who cultivate a total of 7630 ha. These farmers grow sesame in monoculture or intercropped with food crops. Of the area cultivated, 1772 ha (23%) are planted in the first period, May to August, and the remaining 77% in the second period, August to December. Eighty percent of sesame producers cultivate areas of less than 5 ha. each, the national average being 4.1 ha, Table 1, Fig 1. Due to the fact that sesame uses a low level of technology, the outputs reached are equally low. The national average output is 517 kg/ha, with 46% producing less than 400 kg/ha, Table 2, Fig 2. However, despite the fact that the majority of producers obtain economic benefits with yields above 250 kg/ha; from the point of view of the small farmer this crop is inconvenient in that it leaves little by-product for animal feed. This limits the areas of sesame sown, but the most important limitation in the country is that it is very labour-intensive needing between 35 to 64 labour days/hectare according to the technological level of the farmers.

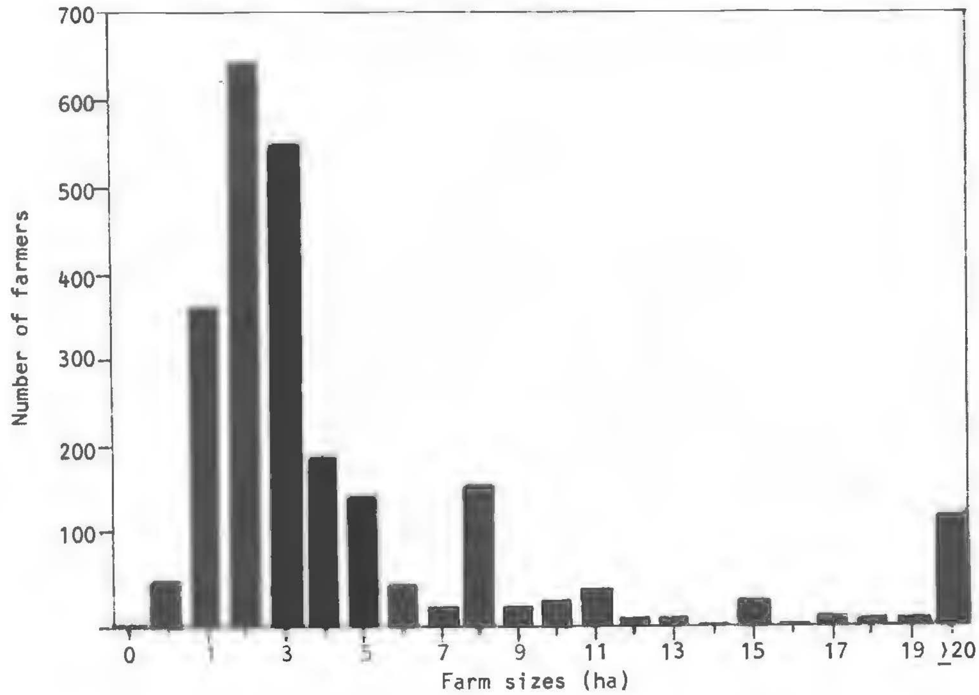

Figure 1. Frequency distribution of number of sesame farmers over farm sizes in Nicaragua.

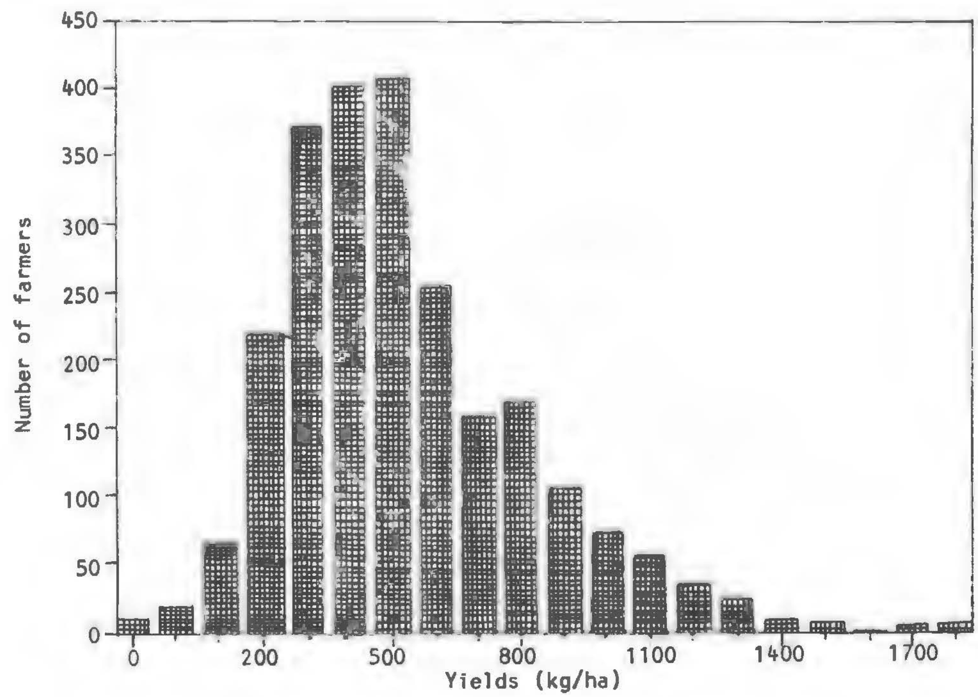

Figure 2. Frequency distribution of number of sesame farmers over classes of yields in Nicaragua.

Table 1. Number of sesame producers according to the size of the farms in Nicaragua.

Size of farms (classes) ha	Growers No. *	Growers %
< 1	50	2
1 - 1.5	1025	41
1.51 - 3	575	23
3.1 - 5	350	14
5.1 - 8	225	9
8.1 - 20	150	6
> 20	125	5
TOTAL	2500	100

* estimated.

Table 2. Number of sesame producers according to yields in Nicaragua.

Yield of seed (classes) kg/ha	Growers No.*	Growers %
<100	25	1
101 - 200	300	12
201 - 400	825	33
401 - 600	700	28
601 - 800	350	14
801 -1000	175	7
> 1000	125	5
	2500	100

With regard to forms of production, since 1979 the integration of the farmworker into co-operatives has been encouraged. The aims of this are to improve the standard of living of the farm worker at the same time as improving the level of technology and the production of the crop. Around 20% of the area sown is actually land belonging to co-operatives.The areas cultivated and the yield obtained in the last five years are presented in Table 3. As the prices vary each year, the sesame crop usually earns 3-6 million dollars for Nicaragua.

Table 3. Production, yield and areas cultivated with sesame in Nicaragua.

Years	Production (1000 kg)	Areas planted (ha)	Yield of seed (kg/ha)
1982	5037	9800	514
1983	11303	15400	734
1984	7561	15400	491
1985	3014	8190	368
1986	3641	7602	479
1987	3941	7623	517*

* estimated.

Climate and Soil

In Nicaragua sesame is cultivated on the Pacific Region below heights of 200m above sea level, Fig.3, where there is an annual rainfall of 1000-1500 mm distributed as is presented in Fig 4. This distribution allows for two harvests during the rainy season; one in May-August using short cycle varieties (90 days) and another in August-December with intermediate and longer maturing varieties (110-115 days).

Due to the geographic location of the country (10.5-15°N) the variations in temperature are minimal. The annual average being 27.4°C with a monthly variation of 26 to 29.5°C. The biotemperature calculated using the Holdrige [1] formula is 22.5°C.

[1] HOLDRIDGE, L.R. Ecologia basada en zonas de vida. IICA, 1982. 216 p.

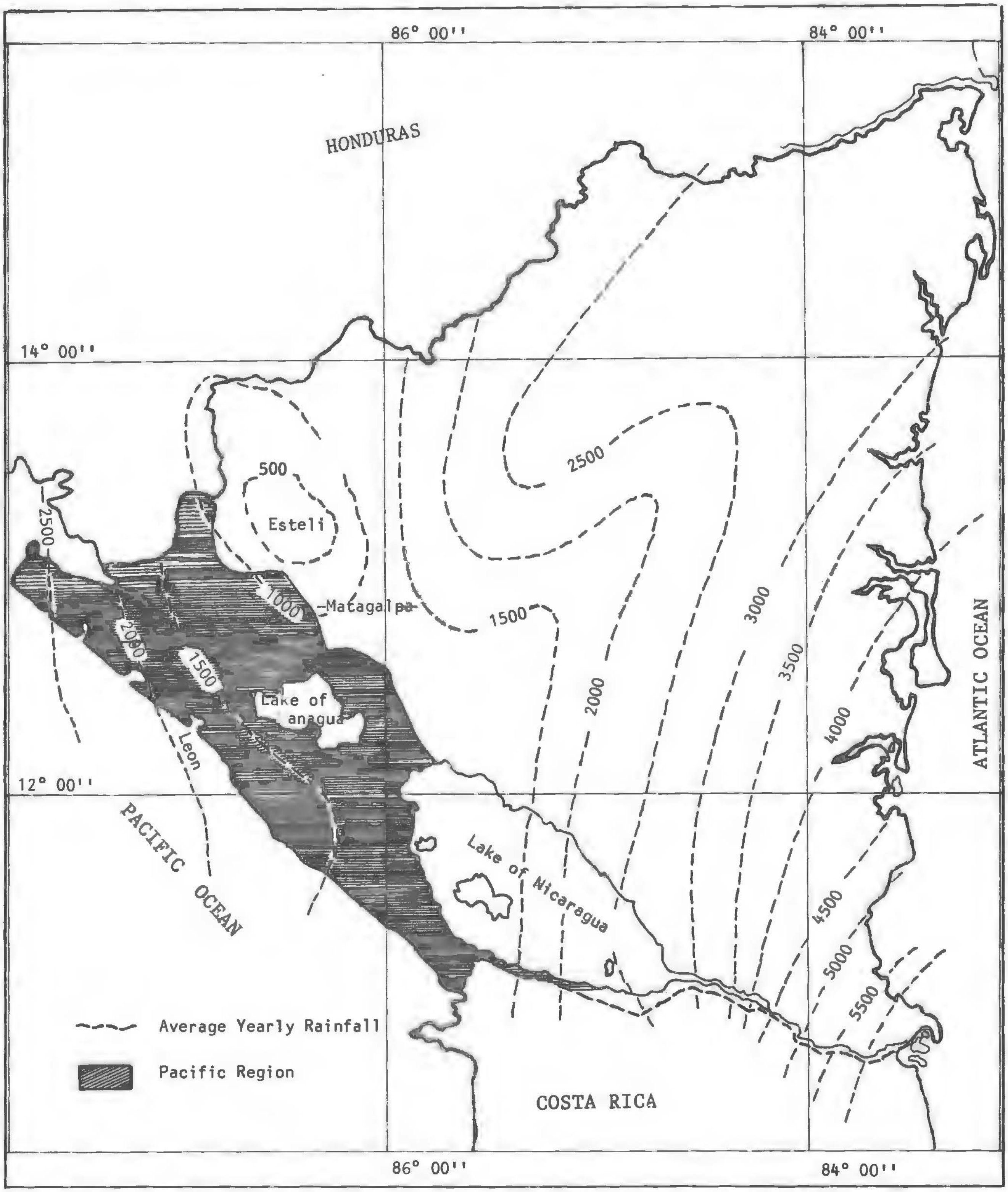

Figure 3. Map of Nicaragua.

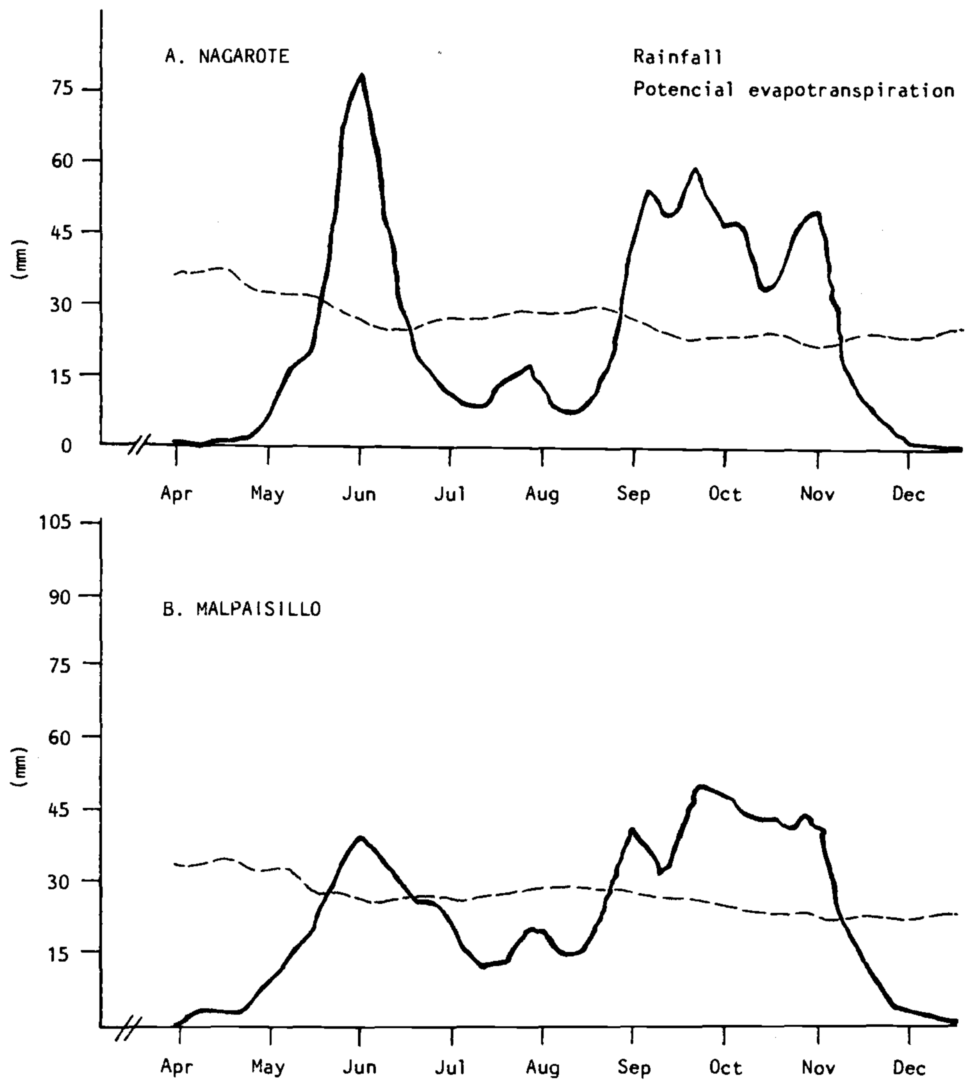

Figure 4. Precipitation and evapotranspiration acumulated for five consecutive days from localities where sesame is cultivated in Nicaragua.

A. Nagarote
B. Malpaisillo

Source: Agrometerological department, MIDINRA. (Ministry of Agricultural Development and Agrarian Reform).

In general, the soil where sesame is cultivated is well-drained and varies from flat to slightly undulating with gradients of less than 8%. The soil texture is sandy to sandy-loam and of moderate fertility: 1.5-3% organic material, 12-16 Ug/ml of phosphorus, 1.2-1.5 meq/100 ml of potassium, 15-20 meq/100 ml of calcium, 4.5-6 meq/100 ml of manganese, 4-5 Ug/ml of zinc, 15-20 Ug/ml of copper, and 50-80 g/ml of iron. The element P,K, Mn, Zn, Cu and Fe are determined using the Olsen method and Ca and Mn with ClK 1N.

Production practices

Fertilization

The more modern producers use 130 kg of a formula that contains NPK (10-30-10 or 12-30-10/hectare applied at sowing). Thirty to forty days after sowing, 64-128 kg of Urea (46% N) are applied per hectare. The other producers use little or no fertilizers.

Control of weeds, insects and diseases

The most common method used for weed control is mechanical. The "Machete" or the cultivator are used. Only a small number of producers make use of chemical control; in this case 1.5 liters of trifluraline is used per hectare. Insects can feed on sesame from the time of planting until harvest, Table 4. Insecticides are recommended to control these insects throughout the growing period, during which the crop is sprayed 2-4 times.

Sowing and varieties

In the first growing period varieties of the short cycle (90 days), predominantly "Precoz" and "Ometepe", are used. In the second growing period varieties of the intermediate and longer cycle (100-115 days) are sown. The most common being "Red China" 63% "Mexican" 15%, "Cuyumaqui" 11%, with the remaining 11% made up of other varieties.

Density and distance of sowing

The varieties of the short cycle are sown at a distance of 40-60 cms between furrows, those of the intermediate cycle and longer at a distance of 60-80 cms. In both cases, 4.5-5.0 kg of seed are used per hectare.

When the plants reach a height of 10-15 cms they are thinned out leaving each plant 12-15 cms or 15-20 cms apart, according to the variety.

The most important diseases which attack sesame are those that rot the base of the stem, and this is most severe in soils with insufficient drainage. The principal causes of this fungal disease have been identified as being *Macrophomia* sp., *Fusarium* sp. and *Rhizoctonia* sp. The only methods of control recommended by the Cotton Experimental Center (CEA) are to rotate crops and at the same time to avoid planting in soils with poor drainage.

The harvest

The harvest is picked using manual labour only. When the crop reaches maturity the plants are cut down with "Machetes" and left for 7 to 10 days. Later, when they have lost all their foliage they are grouped together vertically in bundles of 2000 to 2500 plants. When 10-20 days have passed, and the capsules have opened, the seeds are then collected. This is done by manually beating the plants to release the seeds.

Table 4. Pests that attack the sesame crop and the main insecticides recommended in Nicaragua.

Pests	Part of plant attacked	Insecticides recommended Insecticide a.i/ha	Dose
Nezara viridula	Flowers and capsules	Malathion or Methyl Parathion	0.4-0.6 l
Spodoptera spp.	Leaves, flowers and capsules	Bacillus thuringiensis	1 kg*
		Clorpiriphos	.5 - 1 kg
Heliothis spp.	Flowers and capsules	Deltametrina	7.5-10 g
		Cypermetrina	75-80 g
Trichoplusia ni	Leaves	Deltametrina	7.5-10 g
		Cypermetrina	75-80 g
Estigmene acreae	Leaves	Deltametrina	7.5-10 g
		Cypermetrina	75-80 g
Colaspis spp.	Leaves	Deltametrina	4-6 g
		Cypermetrina	40-60 g

* Commercial product.

Research

The main causes for its present low yield are:

1) Use of low level of technology (Indigenous cultural practices).
2) Weed presure.
3) Damage by insect and diseases.
4) Shattering losses due to high susceptibility of capsule splitting at maturity.

For this reason the main objectives of the research programme are:

1. To find varieties resistant to the main insect pests and diseases.
2. Non-dehiscent type varieties.
3. Development of production technology suitable for our small farmers.

Commercialization

In order to promote and encourage the development of the crop as well as to offer technical assistance to the producers, the government founded a state company "Empresa Procesadora Arlen Siu" with the aim to expand and increase the production and productivity of this crop. This company's other function is to buy up the crop from small farmers.

Acknowledgement

The author wishes to express his sincere thanks to Ings E. Baltodano and R.Garcia, Director and Vice-director of the Arlen Siu company, respectively, for their valuable help.

DISCUSSION - SESSION VI

In this session, country reports of representatives from the Philippines, China and Thailand were given.

- About sesame in the Philippines, Dr. Tepora answered that sesame is grown in a rice-based farming system. Commercial production of sesame is limited. Cultivation is on a small scale mainly by households for house consumption. About sunflower, there exists a wide genetic variability in the breeding material. However, mutation breeding was used for single characters and not mainly to generate variability.

- To questions asked about conditions favouring the outbreak of virus diseases on sesame in China, Dr. Lili answered that the temperature (over 20°C) during the growing period, the dry weather during flowering, aphid attack transmitting viruses and growing susceptible varieties are the main reasons. Phyllody is not an important disease in China.

SESSION VII

NETWORK AND SUNFLOWER

<u>Chairman</u>: M.Oggema

<u>Rapporteurs</u>: H.Belayneh
N.Tepora

ADVANCES IN SUNFLOWER RESEARCH

Walter Dedio

The improvement in sunflower breeding has made a tremendous leap in the last 20 years when, in the late 1960's, cytoplasmic male sterility was discovered and shortly after that the fertility restorer genes. It was thus possible to obtain genuine hybrids and take advantage of the heterosis which resulted in up to 25% increase in yield over the open-pollinated varieties that were previously grown.

Besides yield, other improvements were made with hybrids, such as improved disease resistance, lodging resistance and self-compatibility.

The first hybrid that was commercially grown in North America was 894 or types related to it. It outyielded Peredovik by about 18%, had better lodging resistance and being more uniform, matured somewhat earlier. It also had resistance to downy mildew, which was lacking completely in the open-pollinated varieties, and improved resistance to rust and Verticillium wilt.

A continuous progress has been made since the introduction of the 894 -type hybrids. From the 1985-86 data, Table 1, where 27 hybrids were tested in six locations in Manitoba, Canada, one can see that the more recent hybrids are considerably superior to Cargill 204, the only 894 hybrid tested. When the 26 hybrids were compared to Cargill 204, the mean yield and the oil content were higher by 7% and 5% respectively, resulting in a 12% higher oil yield. The more recent hybrids also tend to be earlier and are considerably better in lodging resistance.

Table 1. Comparison of Cargill 204 (a 894 type) with 26 more recent hybrids in the 1985-86 Manitoba Sunflower Trials.

Hybrid or Variety	Yield kg/ha	Yield % of Cargill 204	Oil (%)	Oil % of Cargill	Oil yield kg/ha	Oil yield % of Cargill 204	Maturity days	Lodging (%)
Best hybrid	2741	123	48.7	112	1215	125	106	0
Mean	2390	107	45.7	105	1092	112	117	15
Cargill 204	2230	100	43.6	100	972	100	119	51
Saliut (Open-pol.)	2022	91	45.8	105	926	95	111	30

In the last few years, a considerable emphasis has been placed on short-statured hybrids and their earliness. The short hybrids are easy to harvest, less susceptible to lodging and tend to shatter less as the plants do not sway as much in high winds and there is less bumping of heads against each other.

Because of rather short seasons in North America where sunflowers are grown, early maturity is fairly important particularly in Canada. Our main goal at the Morden Research Station has been to develop early maturing varieties that would be suitable over a wider area than in the area where the crop is now grown. We now have some promising hybrids that mature up to 20 days earlier than the 894 types, which will be under extensive testing in the next few years.

Future prospects

The progress will continue in the development of better yielding oilseed varieties with higher oil content. There is the potential of increasing the oil content considerably, as germplasms are available with much higher oil than the present commercial hybrids.

Besides the oilseed types, non-oil types of sunflower varieties are being developed for special uses. The biggest group is the non-confectionary or the birdseed type which makes about 15% of the North American sunflower market. This type of sunflowers are distinguished by striping and are larger in size. The biggest size in this category is used for roasting, the intermediate size is dehulled and used in baking, while the smallest size is used as birdfeed. The non-oilseed type generally outyields the oilseed type by a slight margin, but the breeding is not as far advanced as the oilseed type in terms of maturity and lodging resistance.

Sunflower oil from the Northern American production areas typically has from 65 to 70% linoleic acid and 20% or less oleic acid. High linoleic acid is desirable when oil is used in soft margarines or salad dressing. For frying, however, higher percentage of oleic acid is preferred as it results in a greater oxidative stability. In 1980, a few seeds of the variety Prevenets, which produces oil with 70-80% oleic acid content were released to the West by the USSR. This character has been transferred to more agronomically suitable lines in the United States and a high oleic hybrid is being marketed by one U.S. firm.

A problem that has been plaguing growers all over the world is depredation by birds. Realizing this problem, the U.S. has developed three composites which offer some protection against birds. They were released as BRS-1, BRS-2, and BRS-3. Although not completely resistant, the birds do seem to prefer the normal types and will only eat these lines when other lines are not available. The resistance seems to come from the combination of morphology of the head and the bracts and the color of the seed which is usually white or gray. The synthetics, however, were rather low yielding and late maturing with low oil content, (Table 2).

Table 2. Comparison of Performance of bird resistant synthetics with some of the commercial hybrids (mean of 3 North Dakota, U.S.A. locations, 1983).

Variety	Yield (kg/ha)	Oil (%)	Days to flower	Bird damage (%)
BRS 1	972	37.5	78	1
BRS 2	1014	37.1	79	1
BRS 3	1201	37.9	77	1
Cargill 207	1930	40.6	75	1
D0705	1547	45.9	72	5
IS7111	1549	47.6	70	7
S316	1753	47.0	74	2
S1888	1668	45.6	73	11

Since the release of the bird resistant synthetics, breeders in U.S. and Canada have made some improvements in the germplasm by extracting inbred lines and making hybrid combinations. We were able to obtain hybrids which yield considerably better, with higher oil content and earlier maturity than the original synthetics. Several of these lines will be released shortly.

The other chemical constituents in the sunflower hull that have been found to be bird repellant are the anthocyanins. Because it has a high hull anthocyanin content, Neagra de Cluj is a vigorous line with large heads but the oil content is less than 30% and it may have a better bird resistance than the three BRS synthetics from NSDU. The anthocyanins from the crushing industry could also be a valuable by-product in that they can be used in food colouring. We have several other lines with anthocyanins in them and these are being converted into parental lines which will subsequently be put into hybrid combinations.

Diseases such as rust, downy mildew and Verticillium wilt which occurred in the North American sunflower fields have been largely kept under control through breeding. One disease, sclerotinia, is by far the most serious disease spreading worldwide and causing stem and head rot. Attempting to incorporate resistance is a slow process and hence only small achievements have been made in improving the resistance to this disease. Some hybrids in our sclerotinia test do show somewhat better resistance to the disease but it is doubtful that we will ever get complete resistance to it.

Since most of the cultivars grown in the Western world are of the hybrid type, many lines with good agronomical characters have become available and could be exploited in composing a valuable synthetic. The problem with these lines is that they have been selected for self-compatibility which is not desirable in an open-pollinated variety as it is essential that cross-pollination occurs. Therefore, it will be necessary to incorporate self-incompatibility back into the synthetic. This can be accomplished by using an open-pollinated variety as a donor for self-compatibility and lines with desirable agronomic characters as recurrent parents. Selection for self-incompatibility, which is conditioned by dominant genes, will have to be carried out each generation. This is a tedious procedure as bagged heads with low seed set will need to be selected. We have made the first cross in 1987 using the Peredovik and Chernianki 66 varieties and the germplasm is available for anyone to do further selection.

Because of the limited resources and expertise available in some of the member IDRC countries, we are willing to make the initial crosses and make the germplasm material available for selection under local conditions. Exchange of germplasm would be useful since both countries can benefit from it.

DISCUSSION - SESSION VII

Dr. Walter Dedio reviewed the progress made in sunflower research in Canada and the United States, and outlined the future prospect on the crop; then, the discussion was held from which the following points emerged:

- Several questions were raised concerning the use of hybrids. In India the aim is to saturate maximum area with promising hybrids. However, early open-pollinated varieties are most popular as it fits very well in intercrop, relay crop, etc. Hence the efforts are not only to breed potential hybrids but also to improve populations particularly early maturing populations. In Pakistan, the hybrid coverage is more than 3/4 of that of open-pollinated varieties. The rest of the member countries are pushing for open pollinated varieties. It was indicated that there is an urgent need to collect the available open-pollinated varieties from member and non-member countries and distribute for utilization by participating countries.

- A concern was expressed that sunflower is sold on weight basis and there is a problem of getting hybrids with high oil content accepted by growers. Of the member countries, Oil Crops Development Ltd of Kenya is providing hybrid seed free to avoid entry barrier for the farmer and at the same time to encourage the farmers. The company is also offering some kind of premiums for the farmers' produces. On the otherhand, the local varieties with low oil content are receiving low prices. It was felt that the price issue should be looked into by the steering committee.

- Bird resistance was the other point for discussion. It was indicated that all efforts to develop bird resistant varieties failed to be a complete success. The inbreds that made the bird resistant (BR) hybrids were extracted from BR synthetics. It may be possible that some of the BR characteristics are lost when selection was carried out. The BR lines are self-compatible which is desirable in hybrids but not in open-pollinated varieties. It was felt that there is a need for basic study on BR inbred lines. Drooping heads is thought to be one of the characters contributing to bird resistance. Others are tightness of seeds, concave head and bracts extending over the head.

- Responding to what plant population is recommended in Canada, it was stated that a population density of 20,000 plants/acre (58,000 plants/ha) is being used in trials, which is the high end of the recommended range.

- It was reported that there is only one source of cytoplasmic male sterile line in use. In view of the danger that may be associated, when the sterility is linked to some disease/pest susceptibility, there has been efforts to find new sources of cytoplasmic male sterility and new CMS have been found including three from Morden Research Station. However, these new sources do not work with the existing restorers. When the CMS lines are released in USA and Canada, the combining ability data are supplied and the breeders go by that. For other countries, the combining ability should be determined for local areas before lines go into making the composite.

- In reply to a question as to the work done on drought tolerance or resistance, it was mentioned that not much work was done on this aspect. However, there is an open-pollinated variety that show drought tolerance which could be made available on request. There is also a Russian line (Dosky 265) but no idea about the seed source. Views were expressed that special emphasis should be laid on drought tolerance. The drought screening program to be started in Zambia will be strengthened so that it can serve beyond the national boundary.

SESSION VIII

NETWORK AND GROUP DISCUSSIONS

Chairman: A.Omran

Rapporteurs: K.Riley
B.Singh

INTER-REGIONAL TECHNICAL COOPERATION FOR THE IMPROVEMENT OF SESAME PRODUCTION

Amram Ashri

Abstract

An FAO/IAEA Expert Consultation was held in Vienna, Austria, on September 14-18, 1987. The experts first reviewed the needs for sesame improvement and the approaches to achieve this goal. The experts then prepared a project proposal for inter-regional cooperation for the improvement of sesame production, for funding by FAO and/or UNDP and/or other potential donors. The project proposal is described below.

Introduction

The Plant Production and Protection Division (AGP) of the FAO (in Rome) has recognized for some years the urgent need to improve sesame production. Expert consultations dealing with the various constraints and the potentials of sesame were organized by the FAO in 1980 and in 1984 and some of the conclusions and recommendations of these meetings were carried out.

The Joint FAO/IAEA Division (in Vienna) has also been interested for some years in the role of induced mutations and plant breeding in the improvement of oil crops, with projects also in sesame.

An FAO/IAEA Expert Consultation on breeding improved sesame cultivars was held in Vienna, Austria on September 14-18, 1987 with 10 participants: V.Benjasil (Thailand), R.D. Brigham (USA), J.I. Lee (R.of Korea), B.Mazzani (Venezuela), R.Pathirana (Sri Lanka), Beng Ho Lee (R. of Korea), A.Omran (IDRC Ethiopia), A.Micke (IAEA/FAO Austria), C.R. Pineda (FAO Italy), and A.Ashri (FAO/AGP Consultant Israel. The main objectives of the meeting were to study the needs for sesame improvement and the approaches to achieve this goal and to prepare a project proposal for inter-regional cooperation for the improvement of sesame production. The group reviewed the status of the crop, the needs and the recommendations of the previous FAO Expert Consultations on sesame (1980 and 1984). The group updated the breeding objectives for low- and high- input conditions and ranked the priorities of breeding for resistance to diseases. With these in mind the experts prepared a project proposal entitled "Technical Cooperation among Developing Countries for the Improvement of Sesame Production".

The Expert Consultation emphasized sesame as a typical crop of smallfarmers with 99.9% of its area in the developing countries. Since research and development of this crop has lagged considerably, and since none of CGIAR international research institutes deal with sesame, FAO was urged by the expert consultation to lead the efforts to improve sesame production and to arrange the financial support for the project as soon as possible from its own resources and/or the UNDP and from donors (governments, foundations).

The project objectives

The participants, after extensive deliberations, concluded the following:

a. Breeding improved cultivars offers the best strategy to increase the productivity of sesame,

b. Research efforts in sesame have been accorded low priority and the breeding efforts are hampered by various factors, chiefly:

   i) lack of co-ordinated programs,
   ii) scarcity of trained personnel,
   iii) limited germplasm resources,
   iv) narrow range of genetic variation in many national programs,
   v) unavailability of genes for highly desirable traits such as seed retention and resistance to certain diseases and other pests, and
   vi) lack of supporting agronomical and physiological research.

Therefore, in order to overcome the above, and to provide the necessary impetus to sesame breeding in relevant countries, the participants developed the proposal for inter-regional technical cooperation.

The main objective of the project is the support to sesame producing countries in their efforts to improve the agricultural production and the socio-economic status of their populations specially in reference to their diet. The project's aim is to reduce the need of these countries to import edible oils and sesame seeds (for confectionary purposes) and to improve their exports where applicable (e.g. Sudan). The project will endeavour to give sesame it proper place in reference to other food and cash crops grown in these countries. The project is envisioned as multiphased, with the first phase being three years.

The long-term objective of the project is the improvement of sesame production in each of the participating countries through a cooperative breeding program, emphasizing higher and more stable yields, plant characters adapted to low- and high- input production systems, high reproductive to vegetative ratio and pests' resistance.

The immediate objectives of the project are:

- To strengthen the capabilities of the national research institutions and other organizations responsible for sesame development.

- To develop, supply and exchange widely variable, genetically divergent breeding material.

- To establish efficient cooperation among sesame breeders in the participating countries.

It is expected that the project, as designed, will contribute to the growth of technical cooperation among the participating developing countries. As their national capability in the development of sesame increases, so will their ability to technically assist each other, train their personnel, and cooperate in coordinated regional undertakings in this field.

The project will include a mutation breeding component which will be subcontracted to the specialized Joint FAO/IAEA Division. Its objective will be the supplementation of available sesame germplasm (cultivars, collections) in order to enhance the prospects of sesame breeding. The Joint FAO/IAEA will use the procedures of the IAEA Research Contract Program. Ten to twelve institutes selected from those doing sesame breeding will be invited to submit "Research Contract Proposals" to IAEA. After proper evaluation, research contracts will be concluded with those selected for a period of up to 5 years.

Organizational aspects

The main responsibility for the development and implementation of the project activities will rest on the appropriate government agencies concerned with research and development of sesame. The project and its chief technical advisor will provide the coordination arrangements to promote, support, and ensure interchange of breeding materials, information, experience and expertise among the participating countries. Governments will be requested to designate national institutions to be responsible for the implementation of the project activities in the country and to name the national project coordinator.

The project will cooperate with other institutions conducting research and development in related areas, and with other agencies working with sesame, such as the IDRC Oil Crops Network for East Africa and South Asia.

The project will be subject to periodic review in accordance with the policies and procedures established by the FAO or other funding agency for monitoring the implementation of the project.

New FAO Project Proposal for Sesame Improvement

After Dr. A.Ashri outlined the project, a special recommendation was presented to the workshop assembly who endorsed it. (See Discussions and Recommendations, page 317).

BRIEF REPORT ON THE SPECIAL BRASSICA MEETING

Hiruy Belayneh

A special Oilseed Brassica Meeting was held at Uppsala, Sweden, from 6-8 May 1987. It was organized jointly by the International Development Research Center (IDRC) and Swedish University of Agricultural Science. The aim of the meeting was to bring together selected senior oilseed scientists from seven countries to discuss issues focussing on oilseed Brassica and to formulate a Brassica Committee.

Presentation and Discussions

The country presentations started after introductory statements which were addressed by the IDRC representatives. It has been mentioned that oil crops such as groundnut, sunflower, soybean and rapeseed have research strength in developed countries. In addition, ICRISAT and INTSOY are involved in supporting needs of groundnut and soybean research respectively. The basic concept of creating a steering committee on an oil crop such as oilseed Brassica is to help each other to keep right up to-date with ideas and methodologies in addition to interchanging germplasm, sharing results and materials and discussing on current research advances. Organizers of international oilseed congress (rapeseed, sunflower, etc.,) and leading research centers could help with their experience and ideas if the committee activities are linked with their activities. It was further mentioned that oil crops such as niger and sesame deserve a special research unit for which negotiations are going on.

The details of the country's presentations will be found in the Manuscript Report published by IDRC as MR-168e. The most striking feature of these presentations was the difference between countries in the level of development of scientific capability. Every one emphasised that rapeseed research should not be done in isolation under national programs. The creation of a committee was found being helpful for future collaborative research. The discussion that followed contains six parts:

1) germplasm
2) training
3) collaborative research
4) information exchange
5) linkage
6) priorities

Germplasm

Although germplasm was a difficult topic, the meeting has reached on the following agreements:

1) The type of material for exchange should be released varieties or single plant selections.
2) Any exchange activity should go through official government channels and the quarantine requirements ought to be fulfilled.
3) There should be reciprocation in exchange.
4) There should be regular exchange of finished breeding materials through a system of international or regional nurseries, and a trial for local evaluation. As a first step, the network advisor will collect a set of materials and dispatch them to the participating countries.

5) It was agreed that Dr. Downey should make available the updated list of released oilseed Brassica varieties with their year of release, distinguishing characters and useful traits. Other oilseed Brassica breeders will then be approached to add their released varieties. As a second step, it was recommended that authorities in Ethiopia be approached to allow the released varieties to be received and stored for future use.

6) It was recommended that the characterization of each variety should be done at a single location.

It was suggested that the Plant Genetic Resource Center/Ethiopia (PGRC/E), which is the center for Brassica carinata collection, should be requested to provide long-term storage facilities for these released varieties. It was agreed that scientists from non-network countries who might be willing to exchange their collection of released oilseed Brassica varieties should also be contacted. PGRC/E agreed to undertake this activity. Necessary fund for rejuvenation, characterization and dispatch will be considered upon request by the IDRC.

Training

Mainly because of the shortage of trained researchers and the need for the oilseed improvement in member countries, the short- and long- term training was strongly endorsed. Most of the training could be handled through the respective projects. Short-term trainings in specialized area of activities could be arranged so as to upgrade the level of scientific capabilities. Young scientists can spend six months in the appropriate place like Canada and Sweden in order to become familiar with the recent research development. The two types of Brassica short-term training to be considered for the region are:

1) Laboratory training on oil, meal quality and quantity determination.

2) Methods of crop improvement in Brassica crops.

Participants from Ethiopia, Pakistan, China, Canada and India indicated that a short (10-15 days) technical-level training could be organized in their countries. Dr. Zhang Yan from China has already submitted a detailed report on the background and advantages of their laboratories for holding the regional training program on rapeseed quality analysis. The financial support will come from IDRC. The second type of training for crop improvement is suggested to be held in a country like Ethiopia.

Collaborative research

Constraints in the respective countries were pinpointed and countries with common problems/approaches were grouped for a possible collaborative research. It was agreed that the collaboration needs careful planning. Then, the problems under the different disciplines were discussed in relation to the solution and means to tackle them. The task of eliminating Alternaria and white rust susceptibility in released oilseed Brassica varieties will be followed by Canada, China and India. Indian and Chinese lines with resistance or tolerance to Alternaria and white rust would be assembled and distributed by Dr. Downey as nursery for testing and to be used by interested members. It was also proposed that Egypt, Kenya, China, Pakistan and Canada could exchange information on Sclerotinia. Information will be also exchanged between Canada, Australia and Kenya about the blackleg problem. Dr. Downey would supply information to Kenya on the set of lines developed in Australia. Aphid resistance is a very important aspect in several countries. The collaboration will be in the training of the biology of the insect, control methods and standardization of methodologies as well as in information and line exchange. Two known Indian scientists are reviewing the relevant literature on the techniques of screening and breeding aphid resistance and the review will be circulated. Other pest problems are more difficult to solve by breeding. Orobanche will be receiving some attention in Ethiopia, Egypt and Nepal. Available information and promising lines will be exchanged. The Orobanche screening program on fababean will be used as model and each country will develop a sick plot. Some efforts towards developing ideotypes for intercropping will be made and the desirable varieties will be exchanged among member countries. The hybrid work sounded as though it is well along the road in Canada, China and India. These countries will work in close collaboration so as to exploit hybrid vigor soon.

Some of the member countries have a wealth of experience on drought and salinity work. Laboratory and field screening techniques will be shared through the exchange of information. India will provide information for distribution.

Steady progress is being made in the quality work. However, the trade-off between quality and yield was raised. The meeting also discussed the problem of calibration and chemical problems. Standard set of samples will be circulated for the purpose of assisting the participating countries in calibrating and standardizing glucosinolate determination. These points are to be further discussed in other forums.

Linkage

It was proposed that the representative of the oilseed Brassica group should contact the G.C.I.R.C., board of Directors of the Brassica Committee and discuss the possible linkage with their activities and bulletin. The idea of associating the Brassica part of the "Oil Crops Newsletter" with the established "Cruciferae Newsletter" was also welcomed. It was also recommended that the Agricultural Canada Research Station, Saskatoon should update and produce the Brassica bibliography that was last produced in 1980.

During the last part of the meeting, the delegates agreed that a separate Brassica Sub-Network of the Oilcrops Network be formed, and elected Dr. Hiruy Belayneh and Dr. Basudeo Singh as the chairman and co-chairman of this sub-network respectively. The sub-network committee will guide the oilseed researchers in Asia and Africa through bilateral cooperative research on common problems. Bangladesh, China, Egypt, Ethiopia, India, Kenya, Nepal and Pakistan are members of the committee while Canada, Australia, Sweden and other European countries are welcome as guest members. The details including the investment required will be considered carefully after the detailed project document preparation. It is the responsibility of the chairman to organise the committee meetings and act as a spokesman for the Brassica Committee.

SPAAR: SUPPORT FOR RESEARCH NETWORKS IN AFRICA

G.C. Hawtin

The Special Program for African Agricultural Research (SPAAR) is an association of donor agencies established in 1986, with the objective of coordinating external support for agricultural research in sub-Saharan Africa. Representatives of the donor agencies concerned meet twice per year together with representatives from Africa. A series of working groups have been set up to address a range of issues, for example information systems, training, forestry, research policy and priority setting, and research networks.

The working group on research networks has attempted to list all networks operating in Africa, and has classified them into three groups:

I) Information exchange networks,

II) Scientific support networks, (e.g. international nursery networks of IARCS) and

III) Collaborative research networks in which the members carry out specific research or other activities in support of needs identified by the network, and the results of which will benefit other members.

Approximately 40 networks have been identified by SPAAR which fall in category III. The donors asked the working group to evaluate these networks and make recommendations to them as to which ones are of top priority to be considered for additional funding - this funding to go specifically to support the African national research programs to enable them to more fully participate in collaborative research activities.

It was assumed that in most cases there is adequate support for networking *per se*. The criteria used by the working group in evaluating the networks included:

a) the priority assigned to the research topic by the national programs involved,
b) the degree of participation of the national programs in decision making within the network; the existence of a steering committee.

Based on the deliberations today and tomorrow, and the earlier meeting on Brassica oil crops, a schedule will be agreed upon for preparing these proposals. The full involvement of all the national programs concerned, is essential. It is hoped to have a comprehensive proposal for submission to SPAAR by early-mid April 1988.

DISCUSSION - SESSION VIII

- Dr. Ashri described the FAO initiative in 1986 in bringing together a consultative group to consider needs and methods for sesame improvement. A proposal was formulated for consideration by UNDP. The proposed project would concentrate on breeding sesame, by identifying countries with capability to carry out necessary activities. Long term and immediate objectives were formulated. Strengthening of participaing countries, including training will be emphasized. Once the project is funded the countries will be identified. This will be done through FAO. FAO/IAEA will review proposals from countries for support.

- A meeting between IDRC and FAO, Dr. Ashri, Dr. Omran took place last Saturday when it was agreed that IDRC and FAO would keep in touch and collaborate to insure that the maximum "mileage" was achieved from the IDRC and FAO initiatives on sesame.

- Dr. Basudeo Singh described the recently completed report co-authored by himself and Dr. Bakhetia. The report seeks to review the known work on aphid screening methods and come up with best methods for screening. Seedling survival along with adult plant scoring are needed. Resistant sources within the Brassica species were not identified. Other species are resistant. Attempt to introgress resistance from these other species into oilseed Brassica. Breeding approaches suggested. The recommendations in this report might be used for other crops. It was agreed that the report be circulated to oilcrop workers in all crops, as it is the first time this information has been brought together.

- Dr. Hawtin made a short presentation on SPAAR. (The Special Program for African Agriculture Research). One aspect of SPAAR was to examine networks. Upto 70-80 "networks" are in Africa now. Three types of networks are identified. The third type is collaborative networks when countries undertake research for use beyond their national boundaries. Two criterea were discussed:

  1) to what extent does research have impact outside the country?
  2) is network "bottom up" i.e. decision making done at country level?

  The number was narrowed down to 14 networks. For these 14 networks, proposals for funding were invited specifically, to help the countries with small, under-funded programs to contribute better to the networks. Funding from donor to the network to be given for specific country research. In Brassica sub-network, several of the proposed activities could be considered as proposals for funding. There is no guarantee of getting funds if research proposals are formulated, however, this procedure will help to bring the oilcrops network to international attention.

- New issues (networks) can be brought up later for funding but no formal mechanism exists. The fact that Oil Crops Network has no International Centre backing is an advantage in getting SPAAR interest.

SESSION IX

REPORTS AND RECOMMENDATIONS

Chairman: G.Hawtin

Rapporteurs: R.Pathirana
M.Rai

DISCUSSIONS AND RECOMMENDATIONS (R)

I. SUNFLOWER

A. Collaborative Research

Priorities for constraints and collaborative research needs are tabulated for each country, Table 1. Some of the high priorities are:

1. Sclerotinia

Management practices (irrigation, planting methods etc.) are best methods to date to control the disease.

R1: IT WAS RECOMMENDED THAT:

1) DR. DEDIO AND OTHER MEMBERS SEND INFORMATION TO THE COORDINATOR TO BE DISTRIBUTED TO INTERESTED MEMBER COUNTRIES.

2) DR. HAWTIN AND DR. DEDIO TRY TO FIND A SCIENTIST TO WRITE A CRITICAL REVIEW.

3) THERE IS A NEED TO LOOK FURTHER INTO BIOLOGICAL CONTROL AND CULTURAL PRACTICES AS MEASURES AGAINST THIS DEVASTATING DISEASE.

2. Downy Mildew

Resistance is available against race 1 and 2. Sick plots are established in some countries.

R2: IT WAS RECOMMENDED THAT:

1) RESISTANT MATERIAL AVAILABLE IN NORTH AMERICA WILL BE SENT TO THE NETWORK BY DR. DEDIO.

2) NETWORK MEMBERS WILL ALSO SEND ANY INFORMATION OR MATERIAL THEY HAVE.

3) THE COORDINATOR WILL CONTACT THE FRENCH AND YUGOSLAV SCIENTISTS DIRECTLY AND DURING THE INTERNATIONAL CONFERENCE TO GET MATERIAL AND INFORMATION.

4) RESISTANT LINES RECEIVED FROM NORTH AMERICA, EUROPE AND NETWORK MEMBERS WILL BE DISTRIBUTED BY THE COORDINATOR TO ALL INTERESTED SCIENTISTS IN THE REGION.

3. Drought

Information on techniques to tackle this problem will be sought. The importance of cultural practices to improve moisture penetration and conservation was stressed. Earliness is one of the escape mechanisms. Tolerance to drought was reported and will be further tested.

Table 1. Priorities of constraints of sunflower research and production (1 = Low priority, 3 = High priority).

	Countries*													
Factors	Ph	Et	Eg	Ke	Za	Pa	In	Ug	Th	Ca	Ta	Ne	Su	Total
DISEASES														
Leaf Spot	2	-	-	1	1	2	3	-	3	-	1	3	1	17
Leaf Blotch	1	-	-	-	-	-	-	-	-	-	1	-	-	2
White Mold	3	3	3	3	2	2	1	2	-	3	2	2	2	28
Leaf Blight														
Rugose Mosaic	-	-	-	3	-	-	-	2	-	-	3	-	-	8
Yellow Ring Spot	-	-	-	2	2	-	-	3	-	-	3	-	-	10
Downy Mildew	-	3	1	3	1	1	3	3	1	1	-	1	3	21
Rust	-	2	-	2	-	1	1	-	-	1	1	1	2	11
Powdery Mildew	3	-	-	-	-	-	-	1	-	-	1	1	1	7
Wilt	2	1	2	1	1	2	2	?	?	1	-	2	1	15
Charcolet - Macrophomina	2	-	2	1	-	3	-	?	-	-	-	?	2	10
INSECTS, PESTS														
Cut Worms	2	1	2	1	3	1	1	3	2	2	-	2	1	21
Boll Worms	1	1	3	1	-	2	1	2	3	-	1	-	3	18
Hairy Caterpillar	2	-	-	-	-	3	1	2	1	-	-	3	-	12
Tobacco Caterpillar	2	-	-	-	-	3	1	2	1	-	-	3	-	12
Termite	-	1	-	1	3	-	1	-	1	-	1	1	1	10
Plusia Semi	-	-	?	1	1	2	1	1	1	-	-	1	?	8
Flee Beetles	-	-	?	-	-	-	-	?	-	-	-	2	3	5
Niscus Stinging-Bug	-	-	?	-	2	-	-	-	-	-	-	-	-	2
Blister Beetle	-	-	?	-	-	-	-	-	-	-	-	-	1	1
Nematodes	1	-	?	1	1	?	1	2	-	-	?	1	-	7
Rodents		-	-	-	-	-	-	1	-	-	2	-	3	6
Birds	2	3	3	3	3	3	3	3	3	2	3	1	3	35
OTHERS														
Weeds, Parasites	-	2	2	-	-	-	-	-	-	-	-	?	-	4
Salinity/Alkalinity	-	-	2	-	-	1	2	-	-	-	-	-	-	5
Acidity	-	-	-	-	3	?	-	2	-	-	-	?	-	5
Drought	2	3	-	2	3	2	3	3	1	1	1	2	3	27
Plant Height	3	3	2	-	-	1	-	2	-	2	?	2	2	17
Earliness	3	3	3	2	2	2	2	3	2	3	2	3	3	33
Oil %	3	3	3	3	3	2	3	3	3	2	3	3	3	37

* Ph = Philippines, Et = Ethiopia, Eg = Egypt, Ke = Kenya, Za = Zambia, Pa = Pakistan, In = India, Ug = Uganda, Th = Thailand, Ca = Canada, Ta = Tanzania, Ne = Nepal, Su = Sudan.

R3: IT WAS RECOMMENDED THAT:

1) ZAMBIA WILL CONTINUE WORKING ON SELECTION CRITERIA ESPECIALLY THE ROOT SYSTEM. THEY WILL USE THEIR SOUTHERN RESEARCH STATION WHERE DROUGHT IS PREVALENT AND WILL CONCENTRATE ON MORPHOLOGICAL CHARACTERS ASSOCIATED WITH DROUGHT. NETWORK MEMBERS INTERESTED IN HAVING THEIR LINES TESTED FOR TOLERANCE TO DROUGHT SHOULD SEND THEM TO THE ZAMBIA PROGRAM.

2) DR. DEDIO WILL SEND A FEW AVAILABLE TOLERANT LINES TO THE NETWORK ADVISOR TO BE FURTHER DISTRIBUTED TO MEMBER COUNTRIES.

4. Birds

Dr. Dedio has lines with resistance or tolerance to birds. The mechanism is not yet known.

R4: IT WAS RECOMMENDED THAT DR. DEDIO WILL MAKE AVAILABLE THIS MATERIAL AND THE COORDINATOR WILL BE RESPONSIBLE TO FIND AN INSTITUTION IN THE REGION TO STUDY THE RESISTANCE MECHANISM IN THESE LINES AND POSSIBLE STRATEGIES FOR THEIR IMPROVEMENT.

5. Earliness/Oil content

These characters are available in the germplasm and should be exchanged directly through the network.

R5: IN ADDITION TO DIRECT EXCHANGE, IT WAS RECOMMENDED THAT COMPOSITES BE RAISED AT THE NETWORK HEADQUARTERS WITH MATERIALS CONTRIBUTED FROM DIFFERENT COUNTRIES, THEN LEFT TO RANDOM MATING FOR 1-2 SEASONS AND DISTRIBUTED TO MEMBER COUNTRIES FOR SELECTION. THESE COMPONENTS CAN INCLUDE INBRED LINES ETC. WHICH ARE NOT OTHERWISE MADE AVAILABLE FOR DIRECT EXCHANGE.

6. Leafspot and all other diseases

A large number of disease problems are tabulated in one to few countries.

R6: IT WAS SUGGESTED THAT:

1) THESE DISEASES CAN BE DISCUSSED IN DETAILS IN THE NEXT WORKSHOP WHERE PLANT PATHOLOGISTS WILL ALSO BE INVITED.

2) IN THE MEAN TIME, MEMBER COUNTRIES WHO HAVE SIMILAR PROBLEMS (AS IN THE TABLE) SHOULD COMMUNICATE WITH EACH OTHER AND WITH THE COORDINATOR WHO MAY BE ABLE TO ORGANIZE SOME BILATERAL WORK.

B. Links

R7: IT WAS RECOMMENDED THAT:

1) CONTACT BE ESTABLISHED WITH ORGANIZATIONS DEALING WITH SUNFLOWER, SUCH AS:

THE AMERICAN SUNFLOWER ASSOCIATION
THE EUROPEAN SUNFLOWER NETWORK WITH FAO
THE AUSTRALIAN SUNFLOWER ASSOCIATION AND
THE INTERNATIONAL SUNFLOWER ASSOCIATION BASED IN AUSTRALIA.

2) THERE IS A NEED TO SEND MEMBERS TO THE 12^{TH} INTERNATIONAL SUNFLOWER CONFERENCE TO BE HELD IN YUGOSLAVIA IN JULY 1988 ... TO INITIATE CONTACT AND USE THEIR TIME TO MAKE THE NETWORK KNOWN. IDRC MAY BE ABLE TO SUPPORT ONE OR TWO INDIVIDUALS WHO HAVE SUBMITTED PAPERS TO THE CONFERENCE. THOSE MEMBERS, TOGETHER WITH THE COORDINATOR, CAN ESTABLISH RELATIONS, FIND WAYS OF COLLABORATION ESPECIALLY WITH REGARDS TO PUBLICATION AND GERMPLASM RESOURCES AND AVAILABILITY, AND ISSUES OF INTEREST TO NETWORK MEMBERS. THOSE PARTICIPANTS WILL BE REQUESTED TO SUBMIT A SHORT REPORT TO THE OILCROPS NEWSLETTER.

II. SESAME

Priorities of constraints and collaborative research needs are tabulated for each country, Table 2.

A. Insect Pests

1. Shoot webber: (Antigastra)

This was by far the most serious pest identified by the group. There is evidence that genetic variability exists in sesame germplasm for different levels of susceptibility or resistance.

R8: IT WAS RECOMMENDED THAT THE SEARCH FOR GENETIC RESISTANCE BE INTENSIFIED BY THE COUNTRIES CONCERNED.

India (Thangavelu) reported that 3 lines, free of Antigastra have been identified. The resistance of these lines was now being confirmed. The Sudan (Ahmed) reported that the local germplasm in Sudan were less attacked. Tanzania (Chambi) reported that hairy types were found to be more susceptible, but succulent types were more attacked. He also reported that there is less attack during rainy weather, as a fungus has been noted which attacks the larva.

R9: IT WAS RECOMMENDED THAT MORE WORK IS NEEDED TO INVESTIGATE IF THE FUNGUS COULD BE USED IN A BIOLOGICAL CONTROL PROGRAMME.

Other possible control methods were discussed such as:

1) Planting early, as late-planted sesame is more attacked.
2) Topping the growing point prevents late infestation.
3) Double or multiple cropping.
4) Insecticides are generally expensive for sesame farmers, and may not be very effective, as there is a range of planting times in farmers' fields and the insects killed in one field come back from another.

R10: IT IS RECOMMENDED THAT:

1) DR. THANGAVELU TO COMPILE THE INFORMATION AVAILABLE IN INDIA ON INSECTICIDES (AGREED).

2) COLLABORATIVE ACTIVITIES WERE SUGGESTED TO:

A) IDENTIFY WAYS OF RAISING ANTIGASTRA TO GET HIGH POPULATIONS.
B) DEVELOP WAYS OF IMPROVED SCREENING.
C) STUDY THE CAUSES IN FEEDING PREFERENCES FOR DIFFERENT SESAME TYPES.

Table 2. Priorities of constraints of sesame reserch and production (1 = low priority, and 3 = high priority).

Factors	Countries*																	
	Su	Et	So	Ke	Ug	Ta	Za	Pa	In	Ne	Sr	Th	Ch	Ph	Bu	Ko	Ni	Total
1. INSECT PESTS																		
Antigastra	2	3	3	3	0	3	?	?	3	3	3	2	3	1	?	?	1	30
Aphids	0	2	0	2	?	3	?	?	1	2	0	0	2	2	?	?	0	15
Storage pest	2	0	2	1	?	2	?	?	2	0	1	1	-	-	?	?	0	13
Seed Bug	3	0	0	0	0	0	?	?	2	0	0	0	2	2	0	0	2	11
Acherontia	0	0	0	0	0	0	?	?	0	2	3	-	2	3	?	?	0	10
Mites	0	0	0	2	2	0	?	?	0	1	0	0	1	1	?	?	0	7
Gallmidge	0	0	0	1	?	1	?	?	2	?	2	0	0	0	?	?	0	6
Cotton green bug	0	1	0	0	?	0	?	?	1	1	0	?	0	0	?	?	1	4
Flee Beetle	0	0	0	0	0	3	0	0	0	0	0	0	0	0	?	?	0	3
2. DISEASES																		
Phyllody	3	2	1	1	-	1	-	-	3	3	2	2	1	2	-	-	0	21
Macrophominia	2	2	0	1	1	-	-	-	3	2	3	1	2	1	-	-	2	20
Fusarium	1	2	1	1	1	-	-	-	2	3	3	2	1	2	-	-	-	19
Powdery Mildew	0	1	0	1	-	3	2	-	3	2	3	2	1	2	-	-	0	19
Phytopthera	1	1	1	1	?	?	?	2	2	1	3	2	2	2	-	-	0	18
Cercospora	1	1	2	2	?	3	?	?	2	2	1	1	1	0	-	-	0	16
Xanthomonas	2	3	1	1	-	2	-	-	2	1	0	-	2	1	-	-	1	16
Pseudomonas	2	3	0	1	-	2	-	-	2	1	0	-	2	0	-	-	1	14
Alternaria	0	1	0	1	-	-	-	-	2	3	0	0	1	0	-	-	1	11
Leaf curl	0	1	0	1	-	2	-	-	1	2	0	1	2	1	-	-	0	11
Corynespora	0	1	0	0	?	1	-	-	2	-	0	0	1	-	-	-	0	5
PMMV	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2
TUMV	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2
3. OTHER CONSTRAINTS/NEEDS																		
Seed Retention	3	3	3	3	-	3	?	-	3	3	3	3	3	3	-	-	3	36
Harvest Index	3	3	3	3	-	3	?	?	3	3	3	3	3	3	-	-	3	36
Wide Adaptability	3	3	3	3	-	3	?	?	3	3	3	3	3	3	-	-	3	36
Yield Potential	3	3	3	3	-	3	?	?	3	3	3	3	3	3	-	-	3	36
Growth Habit	2	3	3	1	1	3	?	?	2	2	3	3	3	3	-	-	3	32
Maturity	3	2	3	2	-	3	-	?	3	3	2	3	3	3	-	-	1	31
Drought	3	3	3	2	1	2	2	?	3	1	2	2	3	3	3	1	1	34
Stand Establishment	2	2	3	2	2	-	?	?	3	2	2	2	2	-	-	0	1	25
Root System	2	3	2	2	3	-	?	?	2	1	2	2	2	2	-	-	1	24
Inter Cropping	0	3	3	3	3	3	?	?	3	-	2	0	3	0	-	-	-	23
Fertilizer Response	1	1	2	1	-	3	?	?	3	2	1	1	1	2	-	-	2	22
Branching	2	2	2	1	9	3	-	?	3	2	3	1	1	1	-	-	1	22
Sequential Cropping	0	2	2	1	0	0	?	?	3	-	2	3	3	3	-	-	1	20
Relay Cropping	0	2	3	2	-	1	-	?	2	-	1	-	2	0	-	-	2	15
Mechnical Harvesting	3	3	2	-	-	-	-	?	-	-	-	-	-	-	-	1	3	12
Water logging	0	1	0	1	-	3	-	?	1	-	-	-	3	-	-	-	1	9
Salinity	0	2	0	0	0	0	1	?	1	-	0	1	1	3	-	-	0	9
Post-harvest losses	3	3	3	3	?	1	-	?	3	0	3	3	3	3	-	-	1	29
Weed Control	2	2	3	3	?	3	-	?	2	3	3	1	3	3	-	-	3	30
Fertilizer Response	-	-	+	-	?	-	-	?	+	+	-	-	+	+	-	+	+	-
Hybrid Varieties	0	0	0	0	0	0	-	-	1	0	1	0	0	0	0	0	0	2

* So = Somalia, Sr = Sri Lanka, Ch = China, Bu = Burma, Ko = Korea, Ni = Nicaragua; the rest are as in Table 1.

2. Aphids

It was noted in the germplasm literature that aphid resistance had been identified in such crops as cowpeas and alfalfa. It was agreed that screening for genetic resistance to aphids should be strengthened. The methods identified for screening for aphids in mustard may be useful.

R11: COLLABORATIVE PROGRAMS WERE SUGGESTED TO UNDERSTAND THE BIOLOGY OF THE APHIDS AND IDENTIFY CAUSES FOR PREFERENCE IN FEEDING.

3. Storage pests

Several suggestions were discussed:

1) Regular cleaning of stores.
2) Fumigation with insecticides.
3) Mixing the seed with activated clay.
4) Treating the seed with neem leaves or neem oil.

R12: 1) IT WAS RECOMMENDED THAT MORE INFORMATION IS NEEDED ON ACTIVATED CLAY FROM INDIA.

2) COLLABORATION WAS SUGGESTED TO:
A) IDENTIFY SUITABLE SAFE INSECTICIDES AND
B) IMPROVE ON-FARM STORAGE OF SESAME.

B. Diseases

1. Phyllody

India reported that the only confirmed resistance is in the wild species (*S. alatum* and *malabaricum*) but some cultivated lines with less incidence are being investigated. It is difficult to screen for this pest as incidence varies from season to season.

R13: COLLABORATIVE NEEDS WERE SUGGESTED TO:

A) STANDARDIZE METHOD FOR RELIABLE SCREENING (THIS IS BEING DONE IN INDIA).

B) DEVELOP A DNA PROBE FOR THE MICROPLASMA-LIKE ORGANISMS. (THIS WILL BE DONE IN ISREAL). THIS PROBE CAN BE USED TO SAMPLE BOTH THE JASSID POPULATION (VECTOR) AS WELL AS THE INCIDENCE OF MLO IN THE SESAME LINES.

2. Macrophomina

In his book "Diseases of Annual Edible Oilseed Crops" of 1985, Dr. S.J. Kolte reported sources of resistance to this disease. Screening for resistance may be more difficult because the disease attacks many plant species. However, screening resistance sources should have priority.

R14: COLLABORATIVE ACTIVITIES WERE RECOMMENDED TO:

A) CHECK SOURCES FOR RESISTANCE.

B) ATTEMPT TO IDENTIFY IF THERE IS RACE SPECIALIZATION FOR SESAME. THIS WORK WOULD TAKE A LONG TIME, AND INCLUDE SEVERAL OTHER HOST CROPS.

3. Phytophthora

Resistance has been reported from several sources. Korea and Sri Lanka have developed innoculation methods.

R15: IT WAS RECOMMENDED THAT:

1) THE REPORTED RESISTANCE SOURCES TO BE COLLECTED AND TESTED.

2) THE KOREAN METHOD FOR INNOCULATION TO BE DEVELOPED AND TESTED.

3) WILD SPECIES TO BE UTILIZED (S. RADIATUM IS RESISTANT).

4. Powdery Mildew

This disease may be caused by several different pathogens. Oidium is the major pathogen. Resistance to Oidium has been reported from several sources. This disease is serious in India and Tanzania. Late attack in other countries may make it less serious there.

R16: IT WAS RECOMMENDED TO:

1) ASSEMBLE SOURCES OF RESISTANCE AND SCREEN FOR THE MAJOR PATHOGEN WHICH OCCUR IN EACH COUNTRY.

2) DEVELOP METHODS FOR EFFECTIVE SCREENING.

5. Fusarium

Resistance sources have been identified in cultivated lines, as well as S. radiatum. Fusarium often acts with other soil-borne pathogens to cause wilt in sesame.

China has developed a method of screening for Fusarium resistance.

R17: IT WAS RECOMMENDED THAT:

1) CHINA SUPPLIES INFORMATION ON THE SCREENING METHOD TO THE NETWORK COORDINATOR FOR DISTRIBUTION.

2) RESISTANT SOURCES TO BE COLLECTED AND TESTED IN DIFFERENT COUNTRIES, ALONG WITH MORE SCREENING OF GERMPLASM.

6. Other Pests and Diseases

Other pests and diseases "not covered by the above discussion" are still important in localized areas.

R18: CONCERNING OTHER DISEASES/PESTS, IT WAS RECOMMENDED THAT INFORMATION ON RESISTANCE SOURCES AND METHODS OF CONTROL TO BE COLLECTED, AS WELL AS METHODS OF SCREENING FOR RESISTANCE.

C. Other Constraints or Needs

1. Seed Retention

Although there is no useful non-shattering type after extensive searching, it was recommended that efforts continue for identifying types with better seed retention. These types could have:

- indehiscence
- strong placentation
- delayed dehiscence
- tip opening
- pinched at top of capsule
- upright capsules

R19:COLLABORATIVE PROGRAMS WERE RECOMMENDED TO:

A) INVESTIGATE EFFECTS OF HORMONE TREATMENTS.

B) CONTINUE A PROGRAM ON INDUCED MUTATION.

2. Harvest Index

Discussion revealed that there is need to identify more efficient plant types which partition more of total nutrients to the seed. An increase in sink size is probably required.

More efficient types for better harvest index could include:

- shorter internodes,
- basal capsule setting,
- linear leaves,
- longer capsules,
- many seeds/capsule,
- 3 capsules/leaf axil.

R20:COLLABORATIVE ACTIVITIES WERE RECOMMENDED TO TEST THE VALUE OF THE VARIOUS TRAITS WHICH LEAD TO BETTER HARVEST INDEX.

3. Maturity

Discussion revealed that there is need for:

a) Long-medium-short duration types to fit into specific environments and cropping systems.

b) Uniform capsule maturation.

c) Testing germplasm for appropriate duration in each country.

R21:COLLABORATIVE PROGRAMS WERE RECOMMENDED TO:

A) DEVELOP UNIFORM CAPSULE MATURATION,

B) LINES WITH MORE UNIFORM MATURATION TO BE EXCHANGED, AND

C) CONTINUE ON START MUTAGENIC TREATMENTS.

4. Stability (over years)

Need was recognized to develop types which yield more consistently from one year to the next in a given location. Wider adaptability across sites could be a way of achieving greater stability.

R22:COLLABORATION WAS RECOMMENDED TO:

A) IDENTIFY METHODS THAT CAN EFFECTIVELY EVALUATE STABILITY, AND

B) SCREEN GERMPLASM OVER YEARS AND OVER LOCATIONS.

5. Drought

Two types of mechanisms effective in drought conditions could be:

a) Drought tolerance.
b) Drought escaping.

R23:COLLABORATIVE PROGRAMS WERE RECOMMENDED TO:

A) IDENTIFY THE EFFECTIVENESS OF METHODS OF SCREENING FOR DROUGHT RESISTANCE, PARTICULARLY THE LINE-SOURCE SYSTEM DEVELOPED AT ICRISAT, AND

B) SCREEN GERMPLASM UNDER EXISTING DROUGHT CONDITIONS IN EACH COUNTRY.

6. Stand Establishment

Sesame seeds are small, and are often planted in an uneven, poorly prepared seedbed. Better establishment is normally achieved by good seedbed preparation.

R24:IT WAS RECOMMENDED TO:

1) TEST SMALL SIMPLE PLANTERS THAT DRILL THE SEED MORE UNIFORMLY (SIMPLE OX-DRAWN OR OTHER HAND PLANTERS).

2) CHECK WHETHER LARGER SEEDS WITH GREATER SEED RESERVES AND MORE VIGOROUS EARLY GROWTH WILL IMPROVE STANDS.

7. Weeds

Weeds are important, especially during early plant establishment and growth in sesame.

R25:IT WAS RECOMMENDED TO:

1) SCREEN THE GERMPLASM FOR VIGOROUS EARLY GROWTH.

2) EXCHANGE INFORMATION ON HERBICIDES AND OTHER METHODS OF CONTROL, INCLUDING MULCHING.

3) CROP ROTATION.

8. <u>Intercropping</u>

Sesame is frequently intercropped. Either a tall intercrop (maize, sorghum, millet, pigeon pea) or a shorter intercrop (groundnuts) may be used. If a taller intercrop is grown, sesame types should be branched, tall and with shade tolerance. A shorter intercrop may require sesame types which are low-growing and compact.

R26:COLLABORATION WAS RECOMMENDED TO:

A) IDENTIFY GERMPLASM TYPES THAT FIT A PARTICULAR INTERCROPPING SYSTEM FOR EACH COUNTRY,

B) DEVELOP A SCREENING METHOD THAT CAN BE USED IN EARLY STAGES OF BREEDING,

C) EVALUATE METHODS FOR COMPARISON AND ANALYSIS OF INTERCROPPING, AND

D) EVALUATE SPREAD OF DISEASE AND PESTS IN INTERCROPPING SITUATIONS.

D. New FAO Project Proposal for Sesame Improvement

After Dr. A.Ashri outlined the project, the following conclusion and special recommendation were presented to the workshop assembly who endorsed it:

"Sesame is an important oil crop of the developing countries (99.9% of the area) grown almost exclusively by smallholders. The crop has many desirable agronomic and economic characteristics and it produces a high quality edible oil. Its yields, though, are generally low, due partly at least to the lack of research and development. The national research efforts in its areas of adaptation have been limited and none of the international agricultural research institutes deals with it".

R27: "THEREFORE, THE ASSEMBLY STRONGLY RECOMMENDS THAT INTENSIFIED. COORDINATED INTERNATIONAL RESEARCH EFFORTS BE UNDERTAKEN TO DEVELOP MORE PRODUCTIVE CULTIVARS AND IMPROVED CULTURAL PRACTICES FOR LOW INPUT CONDITIONS AND FOR HIGHER INPUTS.

"THE ASSEMBLY RECOGNIZES THE SUPPORT OF THE IDRC OF CANADA TO SESAME RESEARCH IN THE PAST DECADE AND URGES ITS ENHANCEMENT.

"THE ASSEMBLY HAS NOTED WITH SATISFACTION THE EFFORTS OF THE FAO TO INITIATE A COORDINATED INTER-REGIONAL SESAME RESEARCH EFFORT, AND URGES POTENTIAL DONORS TO SUPPORT AND FUND THE PROJECT.

"THE ASSEMBLY URGES ALL INTERNATIONAL ORGANIZATIONS SUPPORTING SESAME RESEARCH TO COORDINATE THEIR PROGRAMS WITH EACH OTHER AND TO WORK TOGETHER WITH INTERESTED NATIONAL ORGANIZATIONS.

"THE ASSEMBLY HAS NOTED WITH SATISFACTION THE SUPPORT OF THE IBPGR AND FAO TO THE PROJECT SO AS TO ASSEMBLE AND DESCRIBE THE GERMPLASM RESOURCES OF SESAME. ALL SESAME RESEARCHERS ARE URGED TO COOPERATE BY DEPOSITING THEIR VARIETIES IN THE COLLECTION WITH DR. ASHRI. IT IS URGED THAT THE PERMANENT ARRANGEMENTS FOR THE COLLECTION WILL BE CONSIDERED".

E. Other Areas of Importance Not Considered During This Discussion

1) Harvest technology.
2) Research-extension-links.
3) On-farm trials.
4) Farmers training.
5) Village level processing.
6) Evaluations of national oilcrops systems and policies.
7) Need for small scale farm machinery.

R28: IT WAS RECOMMENDED THAT THESE ISSUES BE ADDRESSED BY THE SESAME SUBNETWORK STEERING COMMITTEE AND APPROPRIATE ACTION SUGGESTED.

III. GENERAL

A. Germplasm

- It is difficult for commercial seed companies to make freely available anything except hybrid material (sunflower) for research or testing.

- The main interest of participants is to exchange open pollinated material and breeding lines.

- Feedback to the donor countries on performance of material and crosses was considered essential by participants.

- The fact that some countries cannot contribute many varieties at the present time must be recognized. These countries should be included in the process of germplasm exchange. They should be encouraged to collect their local farmers' material which may be low yielding but may have desirable characteristics.

- All countries are ready to exchange their material through official channels.

R29: IT WAS RECOMMENDED THAT:

1) PARTICIPANTS ENDORSE THE EARLIER RECOMMENDATION TO SUPPLY THE NETWORK COORDINATOR WITH UPTO 3 GOOD VARIETIES AND 6 GERMPLASM LINES FROM EACH COUNTRY. THE ADVISOR SHOULD DISPATCH THE SEEDS IMMEDIATELY IF SUFFICIENT QUANTITIES ARE RECEIVED (MINIMUM OF 500G) OR MULTIPLY AND DISPATCH IN CASE OF SMALL QUANTITIES. LINES WITH SPECIFIC DESIRABLE TRAITS TO BE SENT TO THE COORDINATOR (SMALL AMOUNTS OF SEEDS SHOULD SUFFICE). SUPPLIERS OF GERMPLASM WILL BE ELIGIBLE TO RECEIVE MATERIALS.

2) FOR COUNTRIES RELUCTANT TO DISTRIBUTE INBRED LINES (SUNFLOWER) AND OTHER BREEDING MATERIALS FOR TESTING AND RESEARCH, IT WAS ACCEPTED THAT THESE LINES SHOULD BE COMPOSITED BY THE COORDINATOR FOR ONE YEAR PRIOR TO DISTRIBUTION TO NETWORK PARTICIPANTS. SEPARATE COMPONENTS CAN BE FORMED, EG. FOR EARLINESS, HIGH OIL CONTENT ETC.

3) FEEDBACK TO DONORS SHOULD BE DONE THROUGH THE NETWORK, WHICH CAN PUBLISH THE PERFORMANCE OF THE MATERIAL IN THE NEWSLETTER, AND DIRECTLY TO THE COUNTRY OF ORIGIN.

4) THE NETWORK WILL KEEP A RECORD OF ACCESSION NUMBERS OF ALL MATERIAL RECEIVED FOR FUTURE REFERENCE. A DESCRIPTION OF PROMISING MATERIAL (SELECTED CRITERIA) CAN BE PUBLISHED IN THE NEWSLETTER. RECEIVING COUNTRIES SHOULD KEEP RECORDS OF THE ORIGINAL PEDIGREE OF ACCESSION NUMBER AND ENSURE THE ORIGINAL DONOR GETS DUE CREDIT IF ANY VARIETIES ARE RELEASED FROM THIS MATERIAL.

5) A SMALL PORTION OF ALL THE MATERIAL RECEIVED WILL BE KEPT IN COLD STORAGE AT PGRC/ETHIOPIA AND/OR ELSEWHERE. NETWORK TO CONSIDER LONG TERM ARRANGEMENTS FOR SESAMUM GENUS STORAGE IN COLLABORATION WITH IBPGR/FAO/PGRC ETHIOPIA.

6) EACH COUNTRY WILL CIRCULATE ITS PRIORITIES AND PROBLEMS TO OTHERS (THROUGH NEWSLETTER?) FOR SUGGESTIONS OF GOOD MATERIAL.

7) THE IBPGR GERMPLASM COLLECTION (A SET OF ALL RELEVANT ACCESSIONS) SHOULD BE OBTAINED FOR EVALUATION AT ONE OR TWO LOCATIONS IN THE NETWORK REGION. EACH COUNTRY IS TO COLLECT SESAME GERMPLASM INCLUDING LAND RACES AND WILD SPECIES AND SEND TO DR. ASHRI WHO WILL ASSEMBLE ON BEHALF OF IBPGR. EVALUATION OF ALL MATERIALS WILL BE DONE, FOLLOWING IBPGR DESCRIPTORS. THE MOST INTERESTING ENTRIES WILL BE SENT TO THE ADVISOR FOR WIDE DISTRIBUTION WITHIN THE NETWORK.

8) THE PROJECTED UNIT IS ASKED TO UNDERTAKE WIDE CROSSES BETWEEN CULTIVATED AND WILD SPECIES POSSESSING SPECIFIC DESIRABLE TRAITS, TO DO THE PRE-BREEDING AND DISTRIBUTE GENERATED MATERIALS.

B. Information Exchange

- Selected references with abstracts are already published in newsletter and reprints can be provided on request.

- Searches on specific topics are also provided.

R30: IN ADDITION TO EXCHANGE OF INFORMATION FOR ALL THE COLLABORATIVE ACTIVITIES, IT WAS RECOMMENDED THAT:

1) SUPPLYING PACKETS OF BASIC SET OF REFERENCE BOOKS COULD BE CONSIDERED BY SPAAR.

2) SUBNETWORK MEMBERS TO GET THE CURRENT LITERATURE SEARCH ON REQUEST TO THE COORDINATOR.

3) SCIENTIFIC ARTICLES WILL IN FUTURE BE CHANELLED BY THE NETWORK TO THE RELEVANT NEWSLETTERS OR JOURNALS (GCIRC BULLETIN AND CRUCIFEREAE NEWSLETTER FOR BRASSICA, SUNFLOWER YEARBOOK AND HELIA FOR SUNFLOWER, ARACHIS NEWSLETTER FOR GROUNDNUTS, AND FAO SESAME AND SAFFLOWER NEWSLETTER), WHILE THE OILCROPS NETWORK NEWSLETTER WILL CONCENTRATE ON IMMEDIATE RESULTS, SHORT COMMUNICATIONS ABOUT RELEVANT ACTIVITIES AND OTHER CROPS.

C. Training

- The need to identify training needs on oilcrops in each country was discussed. As scientists in most countries are involved in more than one oilcrop, training on oilcrops, rather than just one crop, is preferable.

- The idea of having a technical course similar to the sesame/safflower training course was supported by all participants. Training will include all technical aspects and will be for technical staff involved in oilcrops research.

R31: IT WAS RECOMMENDED THAT:

1) A TRAINING COURSE BE HELD IN A MEMBER COUNTRY OF THE NETWORK PREFERABLY IN AFRICA. FAO WILL BE APPROACHED BY THE NETWORK COORDINATOR TO EXPLORE THEIR INTEREST IN HELPING TO SUPPORT THIS COURSE.

2) COORDINATION SHOULD IDENTIFY OTHER TRAINING NEEDS AND IDENTIFY OTHER APPROPRIATE COURSES OF REFERENCE (STATISTICS, CROPPING SYSTEMS, ETC.) WHICH MAY ALREADY BE ORGANIZED.

3) NETWORK TO CONSIDER UPGRADING TRAINING IN BREEDING OF OILCROPS.

4) THE NEED FOR A MORE ADVANCED TRAINING FOR SENIOR SCIENTISTS WAS RECOGNIZED. DETAILS FOR THIS TRAINING WILL BE DEFINED AT A LATER STAGE.

5) INDIVIDUAL TRAINING OR SCIENTIFIC VISITS, AS REQUIRED, TO BE ARRANGED THROUGH THE COORDINATOR.

D. SPAAR

The introduction by Dr. Hawtin about this Special Program for African Agricultural Research excited the participants who asked for more details. Some of the details discussed were:

1. Budget could be in the range of 40,000-60,000 US$.
2. Proposals to include:

- a back-ground statement,
- how research will be of benefit,
- to be fairly specific but not totally so,
- clear statement on objectives, methodology,
- linkages with other programs are important,
- to be aimed at Africa but also linked with Asia,
- to be aimed at research and not just academic,
- who will do what?, and
- the smaller (4-6 pages) the better.

During discussions, seven African countries (Sudan, Ethiopia, Kenya, Uganda, Tanzania, Zambia, Somalia) showed interest and promised to prepare proposals.

R32: IT WAS RECOMMENDED TO SEND DRAFT PROPOSALS TO NETWORK ADVISOR END OF FEBURARY, TO BE CIRCULATED TO INTERESTED COUNTRIES DURING MARCH AND GET BACK BY APRIL. THE NETWORK ADVISOR WILL PUT PROPOSALS TOGETHER FOR SUBMISSION TO SPAAR.

E. Subnetworks of the Oilcrops Network

The number of the workshop participants was large enough as a forum for election based on absolute majority and one vote for each country. Fourteen countries participated. The chairmen were elected one each from Asia/Africa. In addition to the Brassica subnetwork, two more subnetworks were formed and chairmen elected as follows:

Subnetwork	Chairmen
1. Brassica	Dr. Hiruy Belayneh (Ethiopia)/ Dr. Basudeo Singh (India)
In addition to:	
2. Sunflower	Dr. Mangala Rai (India)/Mr. T.C. Riungu (Kenya)
3. Sesame	Dr. S.Thangavelu (India)/Mr. M.E. Ahmed (Sudan)

R33: IT WAS RECOMMENDED THAT:

1) THE 4TH SUBNETWORK (OTHER OILSEEDS) TO BE FORMED DURING OR AFTER THE 2ND INTERNATIONAL SAFFLOWER CONFERENCE TO BE HELD IN INDIA, JANUARY 1989. THE TWO NEW CHAIRMEN WILL BE ADDED THE ABOVE SIX TO FORM THE INTERIM STEERING COMMITTEE FOR THE NETWORK.

2) THE INTERIM STEERING COMMITTEE SHOULD PREPARE A CONSTITUTION TO BE PRESENTED IN THE NEXT FULL NETWORK MEETING. THE COMMITTEE SHOULD DECIDE ON THE FOLLOWING (AMONG OTHER TOPICS):

- THE STATUS OF CO-OPTED MEMBERS TO BALANCE DISCIPLINES (ECONOMICS, AGRONOMY, POST-HARVEST, PATHOLOGY ... ETC.),
- TIMES AND PLACES OF MEETINGS.
- CONTINUITY OF NETWORK AND/OR SUBNETWORKS.
- HOW FUTURE MEMBERS BE ELECTED.

R34: IT WAS RECOMMENDED THAT:

1) AFTER THE ESTABLISHMENT OF THE SUB-NETWORKS, THE FOLLOWING SCHEDULE MAY BE FOLLOWED:

1988/89	BRASSICA AND OTHER CROPS CAN MEET (LINKED) WITH INTERNATIONAL SAFFLOWER MEETING IN JANUARY 89.
89/90	FULL MEETING OF NETWORK.
90/91	SUB-NETWORKS SESAME/SUNFLOWER.
91/92	BRASSICA SUB-NETWORK + OTHER CROPS.

2) THE STEERING COMMITTEE OF THE NETWORK SHOULD MEET ANNUALLY IN CONNECTION WITH ONE OF THE OTHERS.

3) BECAUSE OF IMPORTANCE OF DISEASES, THE NEXT FULL NETWORK MEETING TO BE DEVOTED TO PATHOLOGY AND THAT TWO LEADING INTERNATIONAL PATHOLOGISTS ARE INVITED TO THIS MEETING. THESE SCIENTISTS DO NOT HAVE TO BE OILCROPS SCIENTISTS. A SESSION ON PROCESSING/POST-HARVEST SHOULD BE ALSO INCLUDED.

G. Other Aspects

R35: IT WAS RECOMMENDED THAT: NATIONAL POLICIES, PRICING, MARKETING, POST-HARVEST PROCESSING, BY-PRODUCTS, STORAGE ETC. ARE OF INTEREST TO ALL CROPS OF THE NETWORK AND SHOULD BE ADDRESSED BY THE STEERING COMMITTEE AND APPROPRIATE ACTION SUGGESTED.

SESSION X

CLOSING REMARKS

Chairman: K.Riley

Rapporteurs: V.Eylands
B.Lubuzya

KENYA'S OUTLOOK FOR YEAR 2000

AGRICULTURE CHALLENGES/OPPORTUNITY[1]

N.V.Popat

Abstract

1. Background

   (a) Population growth 3.5-4% p.a., i.e., ±38 million in year 2000.
   (b) High to medium potential land availability fixed; not much room for expansion. Of 44.6 million ha, only 5.2 million ha are available for milk and crop production.
   (c) Farmers must lead the country's development both agriculturally and in development of non-farming rural activities.

2. Goals

   (a) To double the yields of all food crops for: food security, export of cash crops for foreign exchange earning, and increasing the farmers income so as to drive rural development, i.e. increasing rural employment.
   (b) To control increase of acreage and yields of tea and coffee, which will continue to be the biggest foreign exchange earner.
   (c) To reduce the import gap in growing market of wheat, rice, meat and vegetable oils. However, in year 2000, nearly 600,000t of wheat will be imported.

3. Action plan

   (a) Research on improved hybrids for doubling yields.
   (b) Improved marketing of fertilizer in appropriate packaging for use by small-scale farmers.
   (c) Organized T & V program.
   (d) Improved marketing of crops.
   (e) Improved price-structure of crops.
   (f) Improved controls on credits for the farmers.

Kenya's Agriculture Targets for Year 2000 (Sessional Paper 1)

A. Goals

1. The farmers must continue to lead the country in economic development by:

   - providing food for a population of ±38 million,
   - generating farm-family income growing at 5% p.a.,
   - absorbing new farm workers at the rate of 3% p.a.,
   - supplying export crops sufficient for 150% increase in export earning, and
   - stimulating nonfarm rural activities (commercial sector).

[1] Source: Sessional Paper No. 1 of 1986.

2. The nation should continue to be self-sufficient in maize, beans, potatoes, vegetable, milk, beef and meat products and other foods. The biggest challenge is doubling the yield of maize and milk without a large increase in the land. The government will strive to reduce the import gap in wheat, vegetable oils and rice.

3. Improvement in marketing of all agricultural output, by improving infrastructure in rural areas (roads, banks, market place etc.).

4. All the above must operate within the constraint of available high potential land, i.e., improving productivity by:

   a) using appropriate varieties, fertilizer and better farm practices,
   b) applying amicable pricing and marketing policy (prompt market payment), and
   c) continuing the research on high yielding varieties and crops for marginal land.

B. Kenya's Production Characteristics

1. The total land area is 44.6 million ha. Only 8.6 million ha are of medium to high potential, of which 3.4 million ha are for grazing, beef, stock production and national park. Thus, 5.2 million ha are available for crop and milk production.

2. Table 1 indicates how the land was divided amongst both food and cash crop in 1983/84 (maize and beans can be classified together because of intercropping). The high gross value crops/produce shown in the table (*) account for 86% of land utilization and 83% of the total farmgate value.

3. The goals for year 2000 will focuss on seven commodities as follows:

Crop	Goals
1. Coffee 2. Tea	High value crops for Agricultural income and exports. This sector creates more farm labour as it employs 1.4-2.0 man-year/ha, i.e. approx. 450,000 men on continous basis.
3. Maize 4. Wheat 5. Milk 6. Meat	For food security, and also labour. Maize/millet etc. employ approx 0.5 man-year/ha, i.e 1983/84 $\sim$ 2.2 million.
7. Fruits 8. Vegetable	Horticultural produce, for both food and exports.

Other crops will remain important to both farmers and the government. These are mainly sorghum, millet, rice, root crops, sugar and oil crops. Such crops are likely to enhance rural development and also supplement the food and cash requirement of the farmer.

4. To achieve the goals, requirements have been set out as in Table 2. This was based on a population of 20 million in 1984 rising to ±38 million in the year 2000 at 3.6% p.a. It can be 40 million.

Table 1. Area and value of food and cash crops, 1983/84.

Crop/produce	Area '000 ha	Farmgate value million KSH	KSH/ha
Milk (Forage land)*	2400	168	70
Maize*	700	172	153
Beans*	500		
Root crops*	400	84	205
Sorghum/Millet	350	15	48
Coffee*	150	225	1489
Wheat*	110	21	191
Cotton	100	4	32
Fruits*	100	32	296
Sugar	90	(37)	(432)
Tea*	80	123	1325
Sisal	60	11	137
Vegetable*	40	35	913
Cashewnut	20	4	162
Groundnut	20	2	84
Barley	16	4	249
Sunflower	10	2	141
Pyrethrum	10	4	419
Rice	10	5	519
Tobacco	5	5	885
Others	29	82	N/A
Total	5200	1035	N/A

* High gross value crops.

Production Prospects for Local Oils

A. Statements of Facts

1. Kenya's population growth is at ±4% p.a.
   1970 - 10 million
   1986 - 21 million
   2000 (E) - 35-38 million (growth rate 3.5% p.a.)

2. Per capita consumption of visible fats/oil and the total volume has grown over the years as follows:

Year	Per caput (kg)	Total volumes (ton)
1970	1	10,000
1986	5.0	105,000
2000	6.0	220,000

Table 2 Requirements from the year 1984 to the year 2000.

Crop	Year 1984 Area ('000 ha)	1984 Prod. ('000 t)	2000 Area ('000 ha)	2000 Prod. ('000t)	Remarks
Maize	700	2100	800	4400	Double productivity (3.0 - 5.5t/ha)
Wheat	110	214	110	400	Double productivity continue to import (rising from 160,000 to 600,000 tons).
Milk	2400	1600	2400	3600	Improved farming, breeds etc. to more than double output. Production is in litres.
Coffee	150	115	275	354	Yield up from 0.8 to 1.3 t/ha. Export earning up from 170m to 550m, KSH.
Tea	83	117	124	264	Yield up from 1.4 to 2.1 t/ha. Export earning up from 130m to 296m, KSH.
Horticulture	140	809	≃ 200	≃2180	Yields and marketing improvement. Exports up from 85m to 350m KSH. Export quantity up from 12% to 19% of total crop.
Beef	-	190	-	420	Imports will be in the region of 120,000t.

Source: Page 14 para 2.23 of Sessional Paper 1.

The Kenyan figures are low when compared with averages of other countries and the world at large:

	Per Capita Kg (1986)
Developed countries	23.6
Developing countries	7.3
World average	11.5

3. Major inputs in the manufacturing of edible oils and fats (shortening, fats and margarine) continues to be palm oil from Malaysia. In 1986, Kenya spent close to US $42 million of foreign exchange in importation of palm oil at average price of US$ 400/mt. This figure will rise to over US$ 90 million by the year 2000, at the same price. The 1986 amount represents a substantial portion of foreign exchange earning of tea.

4. Edible oils and fats are price-controlled under specific item order. This has helped the growth of the market. Table 3 shows the comparative price of 1 kg of Kimbo, comparative indices of inflation price movement in constant money and exchange rate over the period 1982-1986. Note the following:

(i) Price of fats has gone up by 12% over 5 years against inflation of 61%. This has been possible because the world prices of oils and fats over the period have fallen significantly.

(ii) The consuming price of fats in Kenya is below that of producing countries like Malaysia. (Kenya per kg price is US$1.2; Malaysia per kg price for similar product is US$1.4 with local duties.

Table 3. Comparative price of 1 kg of Kimbo.

Year	Current price (KSH/kg)	Price index	Inflation index	Exchange rate (KSH/US$)
1982	18.0	100	100	11.
1983	20.05	111	115	13.
1984	22.05	122	125	14.5
1985	22.05	122	139	16.
1986	20.15	112	150	16.5
1987	20.15	112	168	16.7

(iii) The government has always recognized the edible oils and fats are essential for healthy diet and have therefore given appropriate duty remissions to encourage consumptions at relatively low prices, and averting the need for price increases due to international price fluctuations.

5. The world outlook of the prices shows that:

(a) World output of oils (currently at 73 million tons) is likely to increase annually by approx. 700,000 tons. This growth (1% p.a.) will mainly come from developing countries. Thus, on an average supply will be higher than demand.

(b) Heavy subsidies of EEC and support price program of USA will continue to depress the world oil prices in medium term, Figure 1.

(c) Palm oil, a perennial crop, continues to be a lowest-cost oil ≤US$250 per tonne, and future supplies are likely to increase especially from S.E Asian countries.

6. It is envisaged that the oils and fats market will grow and Kenya may continue to enjoy low consumer prices of oils and fats as long as foreign exchange continues to be available for free importation of edible oils and if the local oil production is not supported.

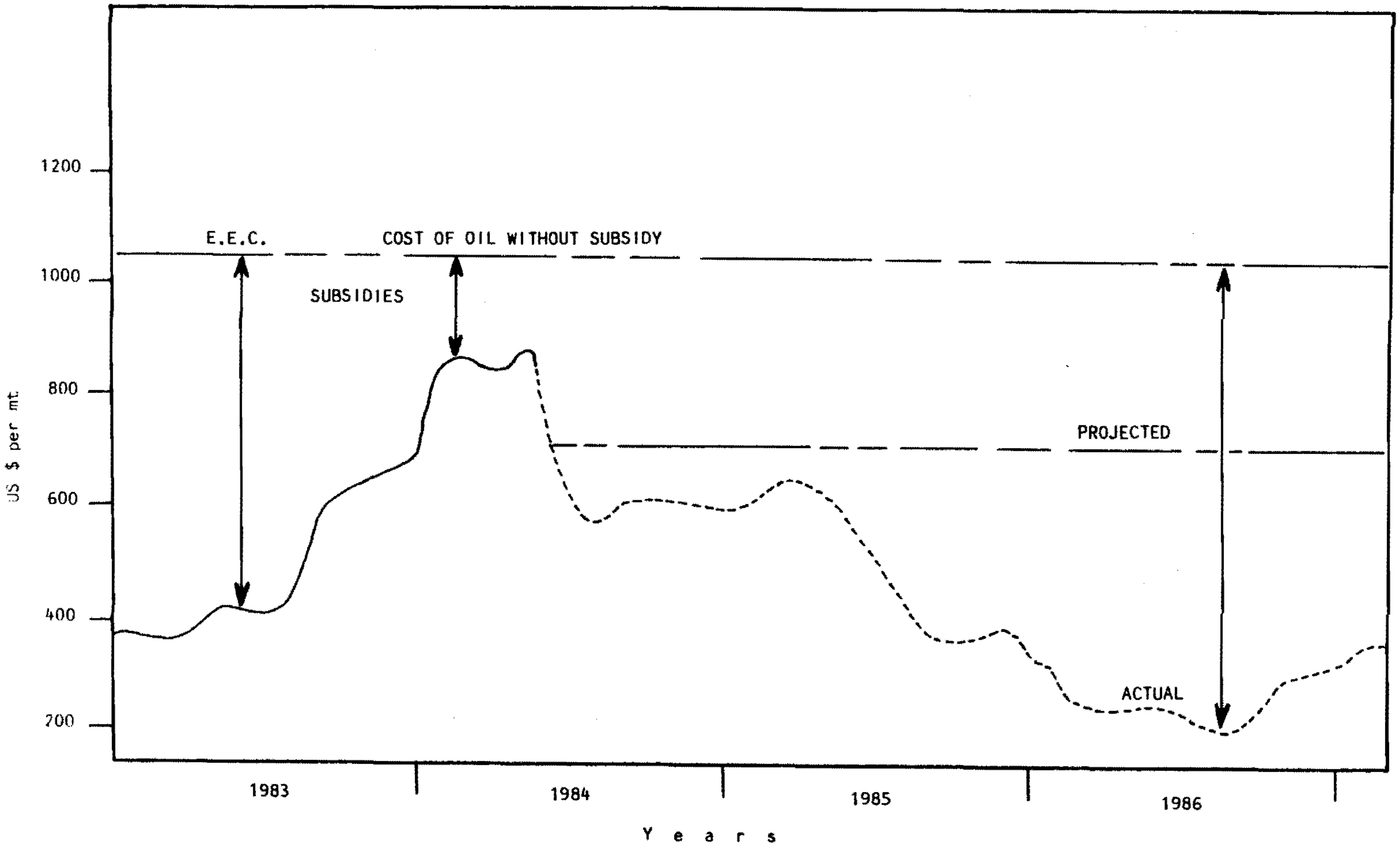

Figure 1. Project evaluation of palm oil price.

B. Local Oils - National Objective

1. With the background highlighted in section A, it is clear that the development of local oils must be a national objective, and in the interest of the whole country at large, and in line with the government Sessional Paper objectives. This development will enhance:

   (a) the development of infrastructure in rural areas,
   (b) organised promotion and marketing of seeds, thus providing an additional cash crop to the farmers,
   (c) research work towards improvements of hybrids and development of alternative crops,
   (d) the growth of animal feed industry as protein cake can be available locally, and
   (e) the saving of foreign exchange: in year 2000 50% substitution will reduce foreign exchange spending by nearly US$45 million at US$400/mt palm oil.

2. To achieve this goal, work has been going on since 1972. However, the first breakthrough came in 1979 when the Ministry of Agriculture (MOA), East Africa Indistries/Oil Crops Development (EAI/OCD) and Kenya Seed Co.(KSC) embarked jointly to achieve this noble goal. A joint research station was set up at Wanguru, with the following objectives:

   - Variety selection and screening.
   - National performance trials.
   - Hybrid seed multiplication.
   - Seed distribution and marketing of the crop.

3. By 1980 it was concluded that the country has potential to grow oilseeds, and responsibilities were split amongst the partners as follows:

   (a) EAI/OCD undertook to promote the growth of oilseeds both on small-scale and large-scale. It was recognized that the crop will not compete with food crops, and will be grown in rotation with wheat and barley (in case of oilseed rape) and wheat and maize (in case of sunflower).

   (b) KSC was charged with responsibilities of multiplying the good quality hybrid seeds in conjunction with National Seed Quality Control Station-Lanet (NSQCS).

   (c) MOA, through its research station, undertook to continue with research work geared for long-term development of various varieties and testing the effects of various inputs.

   The project thus was put on a national footing in 1982, under the umbrella of OCD, a division of EAI. Finally a separate company "Oil Crop Development Ltd" (OCDL) was formed in 1985 with Commonwealth Development Corporation (CDC) and International Finance Corporation (IFC) as shareholders. Figure 2 shows how the interaction between various interested parties work, for the benefit of the scheme.

Oil Crop Development Ltd Growth and Current Status

1. Sunflower growth:

1982/83	1800	tonnes of seed
1984/85	3600	" " "
1986/87	16000	" " "

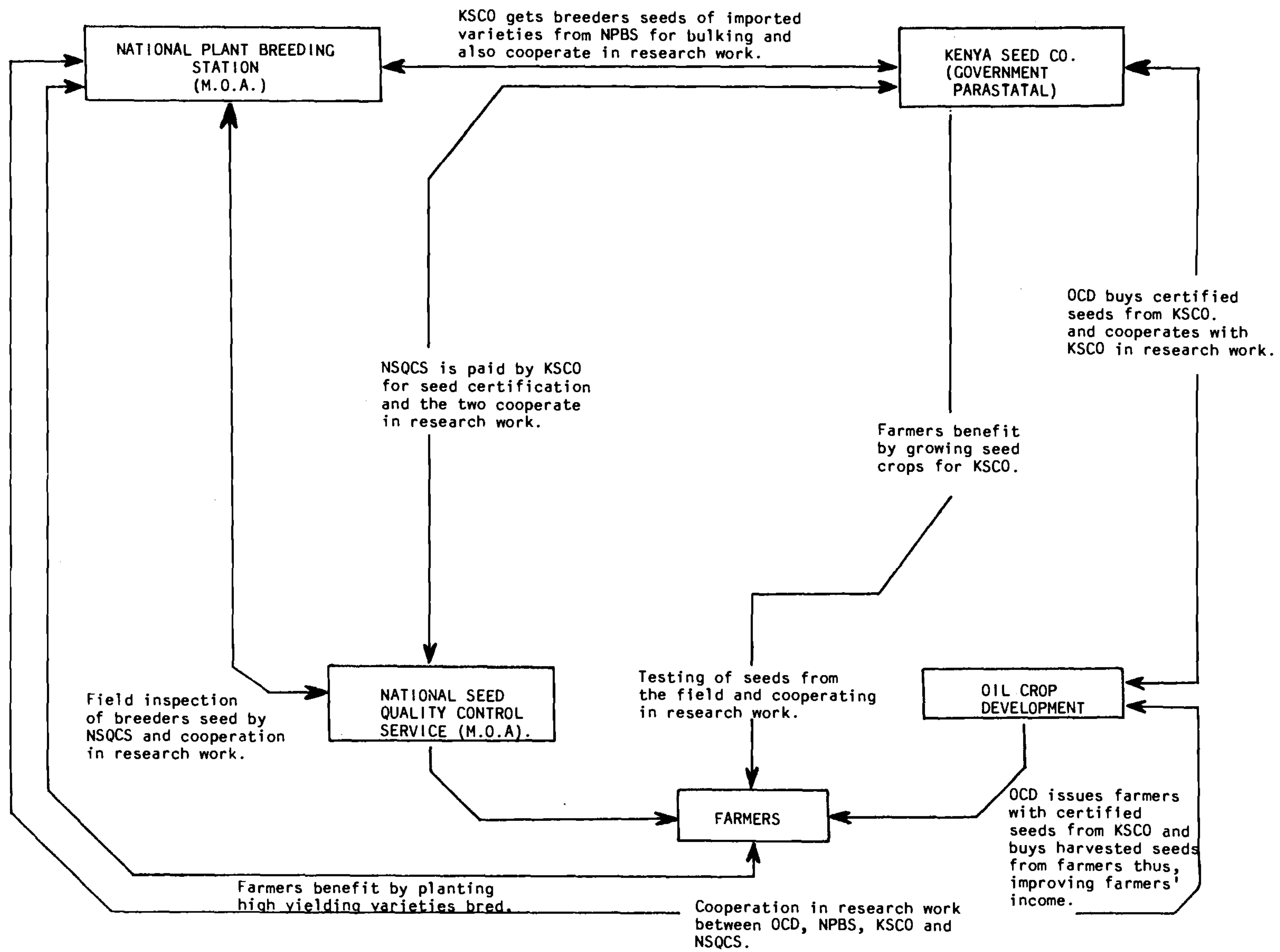

Fig.2. How OCD has continued cooperating with government institutions in the promotion of oil crops since mid-70's.

2. Extension staff covering:

Districts	20
Divisions	64
Locations	135
Farmers	80,000

3. Animal feeds industry stimulated by supply of local protein source.

4. The OCD Scheme has a well organised promotional structure in which inputs by M.O.A. Research and Kenya Seed Co. is fully recognised. This promotional structure is well illustrated diagramatically in Figure 2.

5. The current strategic issues are:
   (a) Farmer profitability through pricing, yields and inputs.
   (b) Cost of local production vs cost of imports.

6. The key areas for resolution are:
   (a) Cost/competitive disadvantage to be removed.
   (b) Promoters to be recognized and given moderate protection.
   (c) Farmers to be paid economic price for crops.

CLOSING ADDRESS

Hugh Doggett

It gives me great pleasure to be here at this most encouraging and innovative workshop. The oils used by the peoples of the developing world supply important components to their diets. Some of them have received little or no research attention in the past. The network was formed to rectify this deficiency, and that is the reason for our meeting here this week.

It is clear that the oilseeds common to Ethiopia and to Peninsular India had a common origin. They were separated from interbreeding for many years, and so have diversified and accumulated different genes controlling the characters which contribute to yield and to adaptation. We are familiar with the wonderful new material which was generated when the northern flints and southern dent maizes were crossed together; and also when the southern kafir sorghums were interbred with the northern milos in the U.S.A. Bringing together the long-separated populations of the Ethiopian and Indian oilseeds is sure to be equally fruitful.

When at ICRISAT, I was able to negotiate four oilseed projects with ICAR's approval - one on sesame in Coimbatore, one on safflower in Indore, one on mustard at Hissar, and one on rapeseed at Pantnagar. These took some time to come through. Only today have I learned that the all Indian Coordinated Oilseeds Project was itself only finalized in 1976.

In 1977, I moved to the chair in the IDRC office which Andrew Ker now occupies; I have been delighted to find today the same dedication on the part of that office's staff that existed ten years back. With the aid of my colleagues, we were able to negotiate a Highlands Oilseeds and a Lowland Oilseeds project in Ethiopia. Dr. Abbas Omran has already mentioned the other IDRC oilseeds projects in the network region.

Many locations of agricultural research stations in the developing world are isolated from their fellow workers engaged in similar research. I had learnt these disadvantages myself over the 10 years at Ukiriguru in Tanzania, and 13 years at Serere in Uganda. I recognized that my work would have been much more effective had there been more interaction with other cereal breeders, and a greater diversity of germplasm available.

Better provision of more scientific information on what other sorghum workers were doing would have been of great value. In IDRC, we were learning from the Asian Cropping Systems Network how important the provision of such services could be. We were galso learning from Dr. Pexy Carangal how effectively a good Network Coordinator* could provide support of these kinds to the scientists in the network. Dr. Gordon Banta also had an important input to the successful development of the ACSN network operations.

The pieces were in place for the development of an oilseeds network: a network coordinated by an advisor who would aim to provide as much as possible of the kind of interaction and back up which had been so lacking at Ukiriguru and Serere, and which had been shown to be so effective in South East Asia.

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*IDRC prefers the term "Network Advisor" to "Network Coordinator", because some people associate "coordination" with bureaucratic chairborne administration.

With much cooperation from Ethiopia, Dr. Ken Riley moved up to Holetta and began this task. He was followed later by Dr. Abbas Omran.

IDRC realized that the meetings of the network were growing too large to be efficient. With several crops to cover, the next step was to hold workshops on one, two, or three of the crops concerned, depending on how many researchers were involved. Dr. Geoffrey Hawtin and his colleagues recognized that even this was inefficient. There was also the desire to link up with world research on some of the oilseeds, notably Brassica and Sunflower. The next step has now been taken with the development of the Brassica sub-network, following the last workshop.

In this workshop, we have been preparing two more sub-networks. The best way to linking together the important smaller oilseed crops (niger, safflower, linseed and castor) - which have few researchers - is under active consideration. IDRC thus plans to have a network linking a group of sub-networks serving researchers on the neglected oilseeds of the developing world. But the objectives remain unchanged: meetings of scientists in workshops at appropriate intervals, interchange of visits, effective germplasm exchange, and good information support.

The next special aspect of this workshop has been the welcome presence of Dr. Pineda of FAO, Dr. Micke of IAEA, and Dr. Ashri as FAO consultant. FAO has been planning to provide assistance to the development of the oilseed crops for several years, and a project has been drawn up to support national program efforts on sesame, which have been outlined to you. Because of our activities which are complementary, we are looking forward to a close cooperation between FAO, IDRC and the network so that the best possible use could be made of the scarce resources available.

Dr. Hawtin has outlined to us the possibilities of SPAAR channelling aid from major donor agencies to countries of the network, perhaps through the network itself. Such action would represent another welcome way to provide additional financial support, in research areas of common interest, to member countries of the network.

A noteworthy addition to the disciplines contributing to our workshops was the economics presentation by Dr. Carlos Zulberti. We all need to appreciate the economic background against which we are working. Is the research we are doing really important, if there is plenty of cheap palm oil being produced rather reliably in Malysia and Indonesia? If the protein cake remaining after the oil has been extracted has a good export price, then the oil may be only a by-product which the producer can afford to sell cheaply. Governments have difficult decisions to take on these matters, and it is important that we should all understand the problems. Is soya growing more profitable than sunflower growing, if the soya yields more protein-rich cake commanding a better price than the oil?

The decision on whether to import cheap oil rather than to encourage production within the country is influenced by the value of that production in other than cash terms. If the oil is produced by smallholders, then they have their own supply of this essential food for the cost of growing it which is often a question of physical effort rather than of spending money. It may be possible to have the oil extracted from the seed by paying the owner of a local extraction plant a small fee, keeping both the oil and the cake for home use. Part of the oilseed harvest may be bartered for other requirements in the village. Food security is improved in such a system, and work is provided for the people involved. Importing oil achieves neither purpose. Supposing some catastrophe or calamity seriously reduces the amount of foreign oil available for purchase? At least, this pushes the price up, and at the worst it results in the people being very short of oil. Further, the Kenya studies show that the return which the smallholder can get from local extraction is perhaps 50-70% greater than if he sells the crop. Often, the real cost to the government for the foreign exchange used in buying imported oil may be substantially higher than the amount of US dollars spent on the oil.

Carlos Zulberti has proposed two main ways in which governments can protect the internal oilseed producer:

a) internal prices may be fixed and a variable levy imposed on imports, depending upon the external price of oils. The money collected from this levy is used to finance the production of oil-protein seeds (oilseeds) within the country. There is no market competition.

b) a fiscal levy may be imposed on imported oils. If the levy is fixed percentagewise, this allows for almost full market competition.

Although protection always results in higher internal prices to consumers, it has also an incentive value. For example, India is determined to become self-sufficient in edible oils by 1990, and so is protecting the internal producer.

Carlos Zulberti also produced an illuminating series of flow diagrams. Four systems were set out, the "Existing", an "Undesirable", an "Experimental System", and a "Desirable System". These related the flow of oilseeds and maize from the rural sector and from foreign sources (oilseeds only) either to the rural consumer or to the urban consumer. The pathways through the processes involved led to milk, poultry, eggs, packed oils, processed and packed milk, and dressed poultry were shown. I hope that these, together with the other excellent diagrams presented, will all be included in the workshop proceedings. I was especially pleased to learn today that there is to be an economics project attached to the network. More such projects are likely to follow.

Mr. Navin Popat of Oil Crop Development Limited also gave an instructive presentation. The seven priority crops of the Kenyan Government are milk, maize/beans, coffee, tea, roots, horticultural crops and wheat. In 1983/84, these accounted for 83% of the country's total produce value, and occupied 86% of the total arable land utilized. Based on the 1984 figures, Mr. Popat shown the "paper targets" for six of these crops (omitting roots) for the year 2000. The need for increased productivity stood out clearly in his figures. The areas under wheat and tea will not change. There will be a small increase in the maize area (+14%), but no increase in the area supporting livestock The tea area will increase by 33%, that under horticultural crops by 43%, and the coffee area by 80%. The productivity increases needed to achieve these targets are impressive: yields per unit area of every crop must almost double.

The population of Kenya is expected to increase from 20 million in 1984 to some 37 million in 2000, and the per capita consumption of oils and fats is also expected to rise from 5 kg to 6 kg. Although 100,000t of oils and fats sufficed in 1984, the figure needed in the year 2000 is 220,000t. Given the pressure on the land already indicated, yields must be more than double to meet the requirements.

Subsidies reducing the prices of imported oils are high: the EEC pays the exporter $480 USD/t, thus reducing the price for Kenya to about $810 USD/t. The estimated cost of subsidies on exports for 1986 is $5,500 million USD by the EEC, and $3,500 million USD by the U.S.A. At present, the cost of Malaysian palm oil (presumably unsubsidized) is about $500 USD/t, but is expected to drop again soon to $250 USD/t.

The Government of Kenya has decided that the seven priority crops listed earlier will receive even more attention, and oil crops will be added to the list because of the following reasons:

a) they save the foreign exchange.
b) some are suited to the development of marginal rural areas.
c) they are cash crops but need not compete with food crops.
d) their by-products assist the growth of the animal feed industry.
e) their import prices are highly sensitive.
f) they are managed by the private sector.

The Kenyan Government has the following goals for 1986-2000:

1. to secure food supplies.
2. to develop the rural economy.
3. to boost export earnings.
4. to conserve foreign exchange.

The Kenyan situation is probably similar to that of many African countries: some difficult years lie ahead, and the productivity of the oil crops must be improved. This is a big challenge to all of us in the network, but our work will be of great benefit to our peoples.

The Network Crops

Linseed

Linseed is an ancient oilseed crop, but the oil is not palatable and is used industrially. It is still used as a human food in some areas of Ethiopia and India. We have heard from several delegates about linseed in their home countries. Ethiopia has released four varieties, of which CI-1525 and CI-1652 have shown average yields up to 14q/ha across locations and years. Ethiopians grow 74,000 ha of the crop. Linseed is also grown for its oil in Pakistan and Bangladesh. It is also grown in several other countries as a source of fibre and industrial oil. Many people eat linseed oil unknowingly, as it may be disguised when mixed with mustard oil.

We have just received the excellent news that mutations have been obtained in Australia which change the fatty acid composition of linseed oil so that the new double mutant provides an agreeable oil for human beings. We must not be too optimistic because changes in the pathways to the synthesis of the fatty acids in the seed may well be accompanied by a premature shut-off of grain filling, or there may be other deleterious effects on yield. Let us pray that these new grain types may become a popular oilseed.

IDRC is looking carefully at the best arrangements to coordinate research on this crop as well as on niger, safflower and castor. We hope for stronger links between the scientists of Ethiopia and South Asia who are working on these crops.

Sesame

Professor Ashri has given us an excellent introduction to sesame. Statistics show that 99.9% of the crop is grown in the developing world with a mean yield of some 350 kg/ha. Dr. Ashri drew attention to a uniculm determinate type with a uniform, short ripening period. This had been produced as a mutant in an IDRC supported project. The few capsules with a short ripening period should minimize any problem of shattering. Dr. Ashri has emphasized the lack of improved sesame varieties, the importance of diseases and pests in reducing yields, and the value of germplasm collection and evaluation.

It is salutary to look at sesame yields. China averages 768 kg/ha on 900,000 ha; Africa 345 kg/ha on 800,000 ha; and India 224 kg/ha on 2.24 million hectares.

In China, the sesame area grew by 35% between 1980 and 1985, and the mean yield doubled to 660 kg/ha. Consumption is now increasing rapidly. The crop is a good precursor to cereals. It may be grown in narrow beds, sometimes with irrigation, at a fairly close spacing of 150,000 - 250,000 plants/ha. Sesame is fertilized with N & P, and sprayed with potash and boron. "Tip pruning" is practised resulting in larger capsules and bigger seeds. Crop rotation over 2-3 years is practised because soil-borne diseases can be serious. Pesticide sprays are used. Good drainage helps to control Phytophthora blight, and the varieties used are resistant to fusarium wilt and to stem necrosis. Bulk yields were quoted as follows:

Area	Yield	Area	Yield
2000 ha	1440 kg/ha	1800 ha	1000 kg/ha
5300 ha	1000 kg/ha	2400 ha	1260 kg/ha

Dr. Ashri reported that some Koreans grow the crop using a vinyl sheet mulch to control weeds. The mean yield in Korea was quoted as 562 kg/ha. One contribution to this workshop from Ethiopia reported an unweeded yield of 240 kg/ha, a single weeding yield of 970 kg/ha, and frequent weeding yield of 1030 kg/ha. It would seem that well managed sesame is a profitable crop.

Unfortunately, in many parts of the developing world, the crop receives few inputs and little care. The yields quoted in the papers presented seldom made encouraging reading. The typical figure was 200-400 kg/ha. India quoted a figure of 80 kg/ha in 1950-51, which has now risen to 220 kg/ha over 2.24 million ha. Mean state yields vary from 52 to 750 kg/ha. Average yields in the Sudan fluctuate between 126 and 292 kg/ha over annual areas of 830,000-1,097,000 ha. Sri Lanka has a mean yield of 525 kg/ha on 35,000 ha over 8 seasons (Yala and Maha). Progress is being made, but much more remains to be done.

Sunflower

This crop has the advantage over sesame in that it is new to Africa and South Asia, and so does not suffer from generations of fixed altitudes and traditional practices.

Dr. Walter Dedio in his lead paper set out the rapid progress made in N.America in sunflower imporvement during the past 20 years. He drew attention to the hybrids of the 894 type, yielding over 2000 kg/ha of seed, and 1000 kg/ha of oil. Some of the newer hybrids are as much as 20 days earlier than 894. Dr. Dedio also mentioned the Bird Resistant Synthetics (BRS) in N.America, which do suffer less from bird damage than the normal types.

Breeding for disease resistance has been very successful. Dr. Dedio emphasised the value of synthetics, and noted that many varieties have been selected for self-compatibility, so they were of little use in synthetics until they had been converted by crossing to a self-incompatible type, followed by selection.

Zambia reported some good synthetics yielding 1000-1100 kg/ha of seed with oil contents of 35% or over and labelled with CCA numbers. The hybrids (CH numbers) are yielding 1300-1700 kg/ha with oil contents from 38 to almost 40%. Zambia produced 45,000 mt of sunflower seed in 1972, with current production of around 30,000 mt., mostly grown by small-scale farmers.

In Tanzania, the Zambian synthetic CCA 75 gave a mean yield of 1440 kg/ha across 5 locations, and CCA 85 some 1225 kg/ha. There are good varieties, but the amount of seed purchased from growers declined from 18,000 mt in 1979/80 to 4,000 mt in 1983/84. This rose a little to 10,000 mt in 1985/86. This reflects the agricultural problems which the country has been facing.

Sunflower production in Kenya has increased steadily from 1800t in 1982 to 21,000t in 1987/88 occupying 0.004% of the current arable land. High quality seeds of locally tested disease resistant and high yielding hybrids are distributed to farmers. The number of large-scale farmers is steadily increasing from 700 in 1982/83 to 20,500 in 1987/88. During the same period, the number of large-scale farmers declined from 11,000 to 500. The Kenya Seed Company multiplies much of the seed by using lines developed in the National Plant Breeding Station at Njoro.

Ethiopia has an active testing and improvement program developing synthetics with emphasis on resistance to downy mildew. Yields across four locations in 1985/86 showed that SNTHE NHS 25 averaged 2,600 kg/ha on unfertilized land. Country statistics for sunflower areas and yields are not available.

Sunflower was introduced to India in the nineteen seventies, and the area increased steadily to about 700,000 ha in 1983-84. This year (1987-88) the area is believed to be one million hectares. Yields rose to about 530 kg/ha in 1980-82, then declined slightly to about 450 kg/ha in 1983-84, but were back over 500 kg/ha in 1984-85. These are encouraging figures for all tropical sunflower producing countries.

Sunflower spread slowly in Pakistan from 1965 to 1985. Then there was a rapid increase to 10,000 ha in 1986 and 48,000 ha in 1987. Mean yields were quoted as 890 and 780 kg/ha, respectively, which were perhaps unexpectedly high.

Areas under sunflower in Nepal, Bangladesh, and the Philippines were not reported.

The Comparison Between Sesame and Sunflower

One contrast between sesame and sunflower was mentioned by a delegate from Zambia this morning: sunflower is popular with the private sector as there is money to be made in the production of hybrid seed and the crop is easy to handle. As an imported new crop, it was known to require inputs and to respond to good treatment. There lies the contrast between the two crops: sesame is a traditional crop: farmers have always lived with it, and have fixed conservative altitudes to the way it is grown. They are too familiar with it and they take it for granted. The use of inputs to grow sesame goes against tradition. The situation is improving, but research and the improvement of sesame varieties need to be coupled with incentives and advice to the farmer. The activities of "UFUTA" in Kenya should be watched with care. It could well be that the offer of a good cash price paid promptly for the crop, coupled with a little advice, encouragement and good seed, will prove to be an essential activity operated in line with the research work, encouraging people to grow the crop. The papers and group discussions have made it possible to identify research priorities. I suggest that a few "UFUTA" type operations need to be opened up to encourage the farmer to put more into the crop. This will also encourage the researchers as they see the farmers adopting their varieties and results, which they now actually pay them to use. It would be worth trying a few "UFUTA" schemes in line with the research efforts - if interested businessmen can be persuaded to do this. We might then see Dr. Ashri's determinate types in the fields of our countries sooner than we think.

Today, we have heard summaries of the papers presented, and also of the group discussions. I will not add further to these, except reminding you of the innovations that have been reported:

1. The formation of more subnetworks.
2. The SPAAR initiative on small project support.
3. The FAO/UNDP sesame project.
4. The addition of an economics component to the network, and the recognition of the need for small-scale, local oilseed expelling and refining.
5. The developed mutants, changing the fatty acid balance in linseed grains.

Lastly, let me draw attention to the need for an ox-drawn seeder expressed by a delegate from Zambia. A seeder is essential if mechanized, ox-drawn weeders are to be introduced. These are very useful tools. Many seeders have been tried, but a cheap machine that does a good job is not still available to the farmer at a low cost. This is a need deserving more attention.

Finally, I would like to thank you for inviting me to attend this workshop, which has been well organized and managed. We are grateful to our Kenyan hosts and to Dr. Abbas Omran.

It has given me much pleasure to see many old friends, and to listen to the presentations. I urge you to continue and strengthen your efforts which can be of a great importance to oilseed growers everywhere.

May God bless you in all your research activities, in your jobs, and in your families and homes.

FIELD TRIP

- The field trip was organised on the last day of the workshop, 29^{th} January 1988 and took the group to the Eastern side of the Rift Valley in Central Kenya.
- The host during the trip was Oil Crop Development Ltd of P.O. Box 2657 Nakuru, Kenya, a leading promoter of Oil Crops in Kenya.
- The trip took the participants through various agricultural eco-zones of the country.
- The trip covered approximately 500 km.
- The delegates visited a joint sunflower trial plot belonging to National Plant Breeding Station, Njoro, Kenya Seed Company and Oil Crop Development Ltd. It was explained to the delegates how the three institutions have cooperated in promotion of sunflower production in Kenya.
- The delegates were informed that the sunflower oil crop scheme has 80,000 small scale holders spread mainly in the marginal areas of the country. The delegates visited a few of these farmers on their fields.
- The delegates were informed that the organisation of the sunflower promotion with so many small holders is a big exercise and its success is dependant on the cooperation of the farmers, produce buyers, government extension research service, Kenya Seed Company and Oil Crop Development Ltd.
- It was explained to the delegates how the Oil Crop Development uses the computer to organize data into useful information to enhance better understanding and development of an appropriate promotion approach.