IDRC-MR93e

International Development Research Centre

MANUSCRIPT REPORTS

Oil Crops

Proceedings of a Workshop Held in Cairo, Egypt 3–8 September 1983

Editor: K.W. Riley

February 1984

CANADA

IDRC Manuscript Reports

This series includes meeting documents, internal reports, and preliminary technical documents that may later form the basis of a formal publication. Manuscript Reports are given a small distribution to a highly specialized audience.

IDRC-MR93e

OIL CROPS

PROCEEDINGS OF A WORKSHOP

HELD IN CAIRO, EGYPT

3-8 SEPTEMBER 1983

EDITOR: K.W. RILEY

FIELD CROPS RESEARCH INSTITUTE, GIZA, EGYPT, AND

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE, OTTAWA, CANADA

CONTENTS

Session 3

Country Presentations: Sudan

Session 4

Country Presentations: Ethiopia, Tanzania, Mozambique

Session 5

Country Presentations: India and Sri Lanka

Session 6

Problems and Potentials: Sesame, Groundnuts, Rapeseed and Sunflower

Session 7

Discussion Groups, Recommendations and Closing

FOREWORD

Annual oilseed crops provide an important source of energy in human diets in much of Africa and Asia, and are often consumed by those who do not have access to animal fat. In addition, oil crops often play an important role as a cash crop for small farmers.

Although research on cereals and food legumes has received increased research support in recent years, most notably from International Agricultural Research Centres, little support has been given to the oilcrops.

The objectives of the workshop were:

1. To provide a forum for oilcrop scientists to meet and exchange information on research and production in their countries.

2. To gain a better understanding of the Egyptian Oilcrops Project, through visits to experimental and production sites.

3. To discuss and make recommendations on future cooperation between oilcrop research programs.

The discussions on future cooperation helped to provide a framework for developing an oilcrops network in the region: a network which is based on cooperation among national programs.

The strength and effectiveness of the links among national programs which this workshop has fostered, will be the measure of its success.

Special thanks are extended both to the staff at the IDRC Regional Office in Cairo, and the Oil Crops Research Section of the Agricultural Research Centre at Giza who did such a fine job of organizing the workshop.

Badr El Ahmar Oilcrops Project Leader Egypt	K.W. Riley Oilcrops Technical Adviser Ethiopia

Workshop Coordinators

ABBREVIATIONS

a.i.	active ingredient
Av.	average
CIMMYT	Centro Internacional de Mejoramiento de Maíz Y Trigo
Eth. Birr	Ethiopian Birr
FAO	Food and Agriculture Organization of the United Nations
fed or feddan	0.42 ha
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
Indust.	industrial
IRRI	International Rice Research Institute
L.E.	Egyptian pound
M.T.	metric tonne
ODA	Overseas Development Administration
RH	relative humidity
SADCC	Southern African Development Coordination Conference
subsp.	subspecies
UCR	University of California, Riverside
USDA	United States Department of Agriculture

PARTICIPANTS

Egypt

Dr. Ahmed Mumtaz Aly
Director
Field Crops Research Institute
Agricultural Research Centre
Giza

Dr. Mostafa Hassan Serry
Consultant
Oil Crops Research Section
Field Crops Research Institute
Agricultural Research Centre
Giza

Dr. Badr El Ahmar
Project Leader
Oil Crops Research Section
Field Crops Research Institute
Giza

Dr. Mokhtar Metwally Satour
Plant Pathologist
Oil Crops Research Section
Plant Pathology Research Institute
Agricultural Research Centre
Giza

Dr. Nessim Riad Guirguis
Research Scientist
Oil Crops Research Section
Field Crops Research Institute
Agricultural Research Centre
Giza

Dr. Mohy El Din El Momdouh
Research Scientist
Oil Crops Research Section
Field Crops Research Institute
Agricultural Research Centre
Giza

Mr. Gordon Potts
Program Officer, Economics
Agriculture, Food and Nutrition Sciences
IDRC, Box 14 Orman
Dokki-Giza, Cairo

Sudan

Dr. Hassan M. Ishag
Oilcrops Project Leader
Agriculture Research Corporation
P.O. Box 126
Wad Medani

Dr. Abdel Moniem Beshir El Ahmadi
Groundnut Breeder
Plant Breeding Section
Gezera Research Station
P.O. Box 126
Wad Medani

Dr. Hussein Elgizouli Osman
Senior Sesame Breeder
Kenana Research Station
Abu Nahama

Ethiopia

Dr. Hiruy Belayneh
Highland Oilcrop Team Leader
Institute of Agricultural Research
P.O. Box 2003
Addis Ababa

Mr. Yebio Wolde Mariam
Lowland Oilcrop Team Leader
Institute of Agricultural Research
Melka Werer Research Station
P.O. Box 2003
Addis Ababa

Mr. Solomon Eshete
Sunflower Coordinator
Institute of Agricultural Research
P.O. Box 6
Awassa

Dr. Ken Riley
Oilcrops Network Advisor
Institute of Agricultural Research
P.O. Box 2003
Addis Ababa

Tanzania

Dr. Andrew Doto
Breeder/Senior Lecturer
Department of Crop Science
Faculty of Agriculture
University of Dar es Salaam
Sub P.O. Chuo Kikuu
Morogoro

Mozambique

Dr. A. Dunstan Malithano
Adviser, Groundnut Improvement Project
Universidade Eduardo Mondlane
Caixa Postal 257
Maputo

Malawi

Dr. S.N. Nigam
Groundnut Breeder
ICRISAT Regional Groundnut Program for Southern Africa
Chitedzi Research Station
Private Bag 63
Lilongwe

India

Dr. S. Thangevelu
Breeder (Oilseeds)
Regional Research Station
Tamil Nadu Agricultural University
Vriddhachalam, Tamil Nadu
606-001

Dr. S.M. Sharma
Niger/Sesame Coordinator, ICAR
Jawaharlal Nehru Agricultural University
Jabalpur, Madhya Pradesh
482-002

Canada

Dr. R.K. Downey
Head, Oilseeds Section
Agriculture Canada Research Station
107 Science Crescent, Saskatoon
S7N 0X2

Dr. Walter Dedio
Sunflower Breeder
Agriculture Canada Research Station
P.O. Box 3001
Morden, Manitoba, ROG 1J0

U.S.A.

Dr. D.M. Yermanos
Professor of Genetics
Department of Botany and Plant Science
University of California, Riverside
California, 92521

England

Dr. Hugh Doggett
Senior Scientific Adviser
55 Scotton St.
Wye, Kent
TN25 5BU

INVITED OBSERVERS

Tanzania

Mr. David Lamboll
Sunflower Agronomist
Oilseeds Research Project
Suluti Experimental Station
P.O. Box 355
Songea

Egypt

Dr. Abdelwahab Ahmed E. Ghobashi
Research Scientist
Flat 14, 15 Seddeek Shayboub St.
Sedi Beshir, Alexandria

OPENING SESSION

CHAIRMAN: BADR EL AHMAR

Opening Address

H.E. Yousif Wally[1]

I would like to welcome all participants of this oil-crops workshop to Cairo.

At present, oil crop production in Egypt falls far short of meeting our domestic requirement.

Cottonseed is the main source for edible oils in Egypt in addition to some quantities of soybeans. The production ranges from 115,000 to 120,000 M.T. of oil annually (representing about 25-30% of our needs).

The total domestic needs are estimated as 1,070,000 M.T. by year 2000. This clearly indicates the importance of increasing and improvement of the oilseed crops production.

The oil crops grown in Egypt are sesame, peanuts, and sunflower in about 100,000 feddans and are used as food crops rather than for oil extraction. About 30-35% of our peanuts (10,000-15,000 M.T.) are exported. Sesame production is about 12,000-15,000 M.T. (30% of our needs)and is used mainly in the manufacture of Halawa. Both crops could not be used - at least in the near future - for oil extraction because of their high prices, i.e., L.E.390/ton for peanuts and L.E.660/ton for sesame.

Great emphasis has to be given to sunflower for oil industry due to its adaptability to various environmental conditions.

Rapeseed is newly introduced as a winter crop oil and is still in an experimental stage. Preliminary results are encouraging.

Production gap in oil crops could be illustrated as follows:

Season	Oil Production (M.T.)	Oil Consumption (M.T.)	Production Gap (M.T.)	% Self Sufficient
1981/82	115,000	429,000	314,000	26.8
1986/87	120,000	637,000	517,000	18.8

Hope you have a good and fruitful discussion to exchange points of view to solve the problem of edible oil shortage in our countries.

Thank you.

[1]Minister of Agriculture, Egypt.

Welcoming Address

Ahmed Mumtaz Ali[1]

I would like to welcome all of you to share with us the first Oilseeds Workshop to be held in Cairo in cooperation between the International Development Research Centre and the Field Crops Research Institute, Agricultural Research Centre, Ministry of Agriculture, Egypt.

Egypt currently produces only about one fourth of its requirements of edible oils of plant origin. Therefore, the main target of our research staff in the Oil Crops Research Section is to increase the production of the edible oil crops. The oil-bearing seeds which we shall be dealing with are: Groundnut, Sunflower, Sesame, Rapeseed and Linseed.

From our point of view, the major constraints to production and research related to the above mentioned oil crops are as follows:

In Groundnut Production

One of the major factors which limits farm yields of groundnut may be land preparation. The method currently used by farmers is most likely reducing yields by inhibiting normal flower and pod formation and may be increasing the incidence of diseases. The long growing season required for the groundnut (145-150 days) is also a barrier. The return per unit area per unit of time is lower than for several other crops.

In Sunflower Production

The greatest barrier to increased acreage of sunflower is the apparent low yield potential of the currently available varieties. Stalk and head diseases are also reported to be limiting farm yields.

In Sesame Production

Sesame is an important food crop for direct consumption but it is used only to a limited extent for oil. Low yield potential is the major constraint to sesame production. In crop sequence, it competes with cotton, maize, and sorghum. Therefore, high yielding early maturity varieties are recommended.

---

[1]Director, Field Crops Research Institute, Agricultural Research Centre, Giza, Egypt.

In Rapeseed Production

Rapeseed is newly introduced as a winter oil crop and is still in an experimental stage. Varieties free of erucic acid would be required with follow up work on production practices. In addition, their adaptability to newly reclaimed lands from the economic point of view needs to be studied.

In Linseed Production

Poor weed control, delayed harvest and ineffective seed production reduce yield potential. Fibre quality of the straw is especially sensitive to delayed harvest.

Finally, I should like to take this opportunity to thank the IDRC for supporting the research activities to improve the oilseed production.

My best wishes to you to have a successful workshop with effective recommendations needed to improve and increase oilseed production in Egypt.

Thank you.

Welcoming Note

F. Kishk[1]

On behalf of the International Development Research Centre of Canada, I extend to you a very warm welcome and wish you a successful workshop and a pleasant stay in Cairo.

You are about to start your serious scientific discussions and exchange of ideas on a very important subject: oilseed crop production. Since its inception in 1970, the International Development Research Centre (IDRC) has recognized that with the exception of soybean in North America and cotton as a fibre crop, oilseeds have been sadly neglected by researchers and those who plan agricultural policy throughout the developing world. This was despite the fact that there is a serious shortage of edible vegetable oils in many countries of Asia, Africa and the Near East.

In addition to their nutritionally superior oil content, all oilseeds are valuable sources of protein which in nutrient composition is complementary to the major cereals of subsistence. Due to the high cost of animal protein, most developing countries populations depend mainly on starchy foods and thus they are liable to protein and fat deficiencies.

Food legumes and oilseeds thus play an important role in balancing the diets of most people in the world, but unfortunately the production of both has not kept pace with demand and human need. In India, a typical example of many developing countries, the per-capita consumption of fats and oils is estimated at 25-30g per day, which is far short of the recommended allowance of 50-60g per day per person. In Egypt, production of edible oils accounts for not more than 25% of consumption.

These shortages have forced governments to compensate by importation of expensive vegetable oils causing a great burden on their limited resources and hampering their efforts for development.

Earlier research efforts on oilseed crops have been limited by financial resources and lack of qualified researchers. Given the amount of research carried out on major cereals, it is not surprising that world cereal production is increasing much more rapidly than the production of pulses and oilseeds. In fact, available statistics indicate that during the past 20 years, per capita pulse and oilseed production in Asia and Africa has declined while cereal consumption has increased. This suggests that the nutritional quality of the diet of the poorest is deteriorating. This situation prompted IDRC to become actively engaged in supporting the national research programs dealing with pulses and oilseed.

[1]Regional Director, IDRC, P.O. Box 14, Orman Giza, Cairo, Egypt.

In addition, the IDRC, which is a founding member of the Consultative Group on International Agricultural Research (CGIAR), has supported the establishment of International Agricultural Research Centres (IARCs) in the developing world such as CIMMYT in Mexico and ICRISAT in India, IRRI in the Phillipines and ICARDA in the Middle East. These specialized centres of excellence as well as providing support for the national research programs have contributed significantly to agricultural research in the developing world. Food legumes were one of those crops to benefit from these international centres. Oilseed crops, however, were not as fortunate. With the exception of groundnuts handled by ICRISAT in India, oilseed crops do not receive any support from the international centres at present. To correct for this situation, IDRC has been systematically developing a network of oilseed research projects within the national research programs of several countries. A total of 14 active projects now receives IDRC funding and technical input. Those projects unite in their common interest and related technological theme to strengthen the national programs by the experience of others and to maintain communication and cooperation among different projects. Workshops are organized whereby scientists from the different projects meet, share their experiences and research results and plan future actions. The workshop you are now attending, which was supported by His Excellency the Minister of Agriculture and Food Security of Egypt and generously hosted by the Egyptian Agricultural Research Centre, is the first of a hopefully continuous process of exchanging ideas, communication and planning together. There are lessons that we can all share and benefit from and I hope you take your time to establish a mechanism which ensures that those lessons are shared.

Again, I welcome you all and wish to thank H.E. the Minister of Agriculture who has been always a strong supporter of research and the ARC and Ministry personnel who made this meeting possible.

Thank you.

SESSION 2

COUNTRY PRESENTATIONS

EGYPT

CHAIRMAN: HIRUY BELAYNEH RAPPORTEUR: S.N. NIGAM

Oil Crops in Egypt

M. Serry[1]

There is a shortage of edible vegetable oils in Egypt. Cotton seed is the major domestic source of oil in addition to small quantities of soybeans, both being currently the only crops that are utilized for oil extraction. Total annual seed devoted for crushing is about 700,000 M.T.; of which 600,000 come from cotton and 100,000 from soybeans. These quantities produce 115,000-120,000 M.T. of processed oil, representing 25-30% of the country's needs.

Other oil crops in Egypt (1981-82)

Crop	Area (fed)	Yield (kg/fed)	Production (M.T.)
Peanuts	28690	859	24645
Sesame	43440	424	18420
Sunflower	14280	778	11110

Present Status of Oil Crops

The oil bearing seeds grown in Egypt include sesame, peanuts, and sunflower occupying all together about 86,000 feddans. These oilseed crops are food crops, as they are not utilized for oil extraction purposes. Though these crops are grown on small areas, they are high-income cash crops and could be of major economic importance, should their areas be expanded.

In this respect, about 30-35% of the peanut production is exported, and almost all sesame produced is used in the manufacture of halawa, whereas sunflower after being salted and roasted is used for direct consumption.

Safflower and castor are grown on scattered negligible areas, while rapeseed is still in the experimental stage, being a newly introduced crop.

Constraints Encountered

The improvement of national production is confronted with various constraints:

[1]Senior Consultant to Oil Crops Research Section, Agricultural Research Centre, Giza, Egypt.

- Competition of other cash crops together with scarcity of agricultural land.

- The increase of production costs due to severe shortage of hand labour and high labour wages. This has been associated with improper field operations.

- Lack of farm machinery appropriate for the prevailing small-holdings.

- Yield fluctuations as affected by the different diseases and infestations.

- Lack of oil mills for sunflower expansion.

Research Activities and Studies

Basic research studies dealing with the agro-technique practices along with the improvement of the commercial varieties have been undertaken in the old lands as well as in the new reclaimed lands and include:

- Introduction of breeding material to be evaluated under our conditions in different agro-ecological regions.

- Establishment of field trials to find out the appropriate plant density, major and minor elements and water requirements.

- Production of certified seed needed to cover 30% of the area cultivated by the crop.

- Isolation and identification of causal organisms responsible for yield losses.

Based upon the results accomplished, recommendations are given to the growers.

Future Prospects of Oil Crops

The amounts of vegetable edible oils needed in the country up to year 2000 are:

536,000	M.T.	in 1985
685,000	"	in 1990
840,000	"	in 1995
1,070,000	"	in 2000

(on the basis of 16 kg/ capita/year, and a population of 66 million).

This represents an increase of 11% annually.

Accordingly, it is a must to increase the oilseed production at least to keep the gap between consumption and production at the same level, i.e., 25-30%.

In this connection, great emphasis must be given to sunflower and rapeseed as oil crops, because of their adaptability to various environmental conditions, early maturity, superiority to other oil crops in terms of total yield of oil per unit area.

Continuous cropping is the general rule all over the country through the application of crop rotation systems of particular sequences of crops. The ultimate result of these systems is very high cropping intensity. There are almost two crops a year in the same field, giving a cropping index of 2.0 (or 200%) on an overall national level. In view of the ever-increasing demand for agricultural products and the fact that vertical growth cannot cope with the domestic demand and export requirements, government policies have been designed to further increase the cropping intensity. This involves intercropping and relay intercropping that represent the multiple cropping system. Experimental trials have indicated the feasibility of this system with regard to certain crops.

Again, due to the intensified cropping system being practiced, there is no place in the present existing rotation of the valley and the delta for nontraditional or new crops to be cultivated.

Therefore, the future prospect will be apparently in the new lands, and fortunately research work proved the success of the oil crops in these lands, especially sunflower and rape.

In this respect, the projected area that will be reclaimed up to year 2000 is estimated at 2.8 million feddans, of which 900,000 will be cultivated with oilseed crops.

It seems necessary as the new lands are of class III or IV, to improve the soil fertility and increase the organic matter. This would be followed by a proper crop rotation system including such crops as clover, rape, and legumes as winter crops. For summer, peanuts, sunflower and forage legumes. The crop rotation system could be designed according to the projected area.

In addition, the five year plan 1983-87 included the cultivation of sunflower in about 100,000 feddans.

Marketing is a limiting factor for the establishment of a new crop. Therefore, production and marketing (at reasonable prices) must develop simultaneously. Construction of new oil mills is needed for the extraction of sunflower oil and would satisfy the target of both industry and animal raising if the by-products were used as feed.

Attention must be given to strengthen the collaboration between research and extension by the implementation of demonstration programs to secure the transfer of new techniques, comments and information to the growers.

The Oilcrops Project in Egypt

Badr El Ahmar[1]

There is a shortage of edible vegetable oils in Egypt. Cottonseed is the major domestic source of oil in addition to small quantities of soybean. The total annual edible oil production represents 25-30% of the national needs. The difference between local production and annual domestic needs (70-75%) is imported.

Other oil crops (sesame, peanut and sunflower) are food crops as they are not utilized for oil extraction.

Realising the importance of the oilseed crop, the Ministry of Agriculture, Arab Republic of Egypt, requested the assistance of IDRC to support a comprehensive research program to improve these crops. The IDRC approved in October 1978 a grant to enable the Field Crops Research Institute to undertake the program.

Specifically, the project was to:

(a) Develop oilseed cultivars suitable for the different agro-ecological regions of Egypt.

(b) Develop appropriate agronomic practices for high productivity.

(c) Test and evaluate the breeding material of the different oil crops in terms of yield potential, disease resistance, and seed characteristics.

Phase I

Sesame

- 20 on farm trials were conducted under proper cultural practices on growers' fields in the main producing areas of sesame in Upper Egypt. Results obtained, on across locations mean, revealed an increase of 39% in yield.
- Advanced yield trials indicated consistent superiority of the three strains H38-2, H60-3 and H61-(1-5) in yield performance (ranging from 7% to 20%) over the commercial variety GIZA 25.
- Screening breeding material under artificial infection with the fungi causing wilt disease resulted in obtaining tolerant or resistant lines.

[1] Project Leader, Oil Crops Section, Agricultural Research Center Giza, Egypt.

Sunflower

- Initiation of composite population (gene pool).

- Improvement of Mayak Strain (medium late maturing and high oil content) has been achieved where an increase of 2-5% in oil content was obtained over the original seed stock (38%).

- Yield tests showed an increased yielding potential in some introduced hybrids and/or open pollinated strains of 10-20% in addition to oil content higher than the check Mayak. These hybrids are Sunbred 212, Sorem 82 and open pollinated lines are Tuscania, Ala and Imiata.

Rapeseed

- It has been found that location affects the performance of rapeseed plants, where most of the tested material performed better at Sakha, Nubaria and Elserw than at Giza (Middle Egypt) or in Upper Egypt. This indicated that the crop performs better in the northern zones of the country.

- Promising strains were tested in yield trials, and the variety Cressor 95C was top yielder. This line also has good seed quality.

Research activities in Phase II include:

(a) To continue the development of new higher yielding varieties of sesame, sunflower, rape and peanuts; promising strains of the advanced yield trials will be tested under both station and farm conditions.

(b) Continuation of breeding for disease resistance or tolerance.

(c) To continue adaptation studies of sesame, rape and sunflower in the non-traditional area (new reclaimed lands) where preliminary results obtained in Phase I were promising.

(d) To undertake agronomic studies to improve the productivity of oilseed in terms of seed yield and oil with great emphasis in new lands.

(e) To explore the potential of introduced strains under the environmental conditions of the new lands.

Horizontal Agricultural Expansion Through Multiple Cropping System

Limited land resources represent a major constraint to the horizontal agricultural expansion, whereas irrigation water in adequate quantities is available all year round.

Under these conditions, continuous cropping is the general rule all over the country through the application of crop rotation systems.

Different systems of intensive cropping will be tested:

- Sequential cropping of
  Sunflower - rice

- Intercropping of
  Soybean with sesame (unbranched)
  Soybean with short season - sunflower
  Sesame (unbranched) - sugarcane

Further studies are needed to find the optimal multiple cropping system.

Major Diseases of Certain Oil Crops in Egypt

Mokhtar M. Satour[1]

Peanuts

Over the past few years, since the early seventies, stem and pod rot diseases have caused considerable damage in some peanut growing areas. Losses in yield and quality, estimated at a range of 30-90%, have been a major limitation to exportation.

In accordance with the research program, summary of the results obtained are illustrated in the following manner:

Isolation and identification of the causal organisms responsible for stem and pod rot diseases.

Selected fields in eleven governorates were surveyed for peanut diseases.

(a) Stem rot is a minor problem in Egypt; in severe infection it does not exceed 8%. Fungi associated with this disease are more than 21 fungal genera. The most prevalent are:

Aspergillus spp. (56.6%), *Fusarium* spp. (44.4%), *Rhizoctonia solani* (27.5%), *Penicillium* spp. (25.5%), *Pythium* spp. (12.5%) and *Rhizopus* spp. (12.5%).

(b) Mature pods, during harvesting exhibited severe infection, pod breakdown, ranging from 19.4% to 78.3%. Fungi associated with pod breakdown were similar to those isolated from peanut stems. However, differences were in their prevalence, with:

Fusarium spp. 65.5%, *Aspergillus* spp. 43.3%, *Rhizoctonia solani* 32.4%, *Penicillium* spp. 25%, *Botryodiplodia* sp. 15% and *Rhizopus* spp. 14.2%

(c) New pathogens were isolated from rotted seedlings and cankers including:

Acremonium crotocinigenum, *Myrothecium verrularia*, *Ulocladium botrytis*, *Neocosmospora vasinfecta*, *Melanospora* sp., *Acrophialophora*, *Botryodiplodia*, *Cephalosporium*, *Choanophora*, *Verticillium*, in addition to a new species of *Pythium*, *P. middletonii* and unknown species of *Sclerotium*, with red sclerotium.

Survey and identification of nematodes associated with root and pod rot

Eight genera of nematodes were isolated and identified:

Meliodogyne, *Pratylenchus*, *Cremonemoides*, *Tylenchus*, *Tylenchorhynchus*, *Rotylenchus*, *Rotylenchulus* and *Radopholos*.

The first two genera are more prevalent, where, *Meliodogyne* increased infection of stems in the presence of *R. solani* or *S. rolfsii* and *Pratylenchus* favoured *Fusarium* infection.

Disease Control

Chemicals

Seed treatment with Benlate, Topsin and Vitavax-captan, decreased stem rot consistently but to various degrees, whereas fungicides used in seed treatment either failed to decrease pod rot severity or increased it.

Brasicol-75, as a foliar application, had reduced the pod rot infection from 79%-46% (externally) and from 88% to 61% internally.

Soil treatment with different fungicides, gave contradictory results, and the untreated check exhibited the least disease severity.

Other than merely fungicides application, contribute to the performance of the diseases. These factors involve mainly:

- Soil heterogeneity occurring at various sites;
- Variable inoculum densities of soil-borne fungi; and
- Variable soil moisture content as influenced by irrigation frequency and status of soil water table depth.

Biological

A preliminary investigation of biological control in 1982 at Ismailia Province pitted the saprophytic fungus *Trichoderma herzianum* against the causative fungi of pod rot disease.

The results had indicated a significant effect of this fungus, where a remarkable decrease in disease incidence was obtained together with an increase in yield of 22%.

Proper agro-techniques

Nitrogenous fertilizers - No differential response was observed in plants fertilized with nitrogen (ammonium sulfate; ammonium nitrate and urea).

Irrigation frequency - Irrigation schedule at 10 days' interval in sandy soil resulted in a marked decline of rotted pods as compared with 4 and 6 days' intervals:

Irrigation Frequency	% Rotted Pods	
	Range	$\bar{X}$
4 days	76-56	63
6 days	77-62	69
10 days	47-39	42

At a location where soils are loamy clay of high water holding capacity, irrigation intervals of 8,10 and 12 days resulted in heavy losses:

- For all treatments, percentage of diseased pods was 100.

- Diseased kernels were extremely high. Mean data of treatments are all comparable, being in the range of 74.8% to 87.7%.

Sesame

Sesame is liable to attack by root, stem-rot and wilt diseases. The most prevalent causal organisms are: *Rhizoctonia solani*, *Sclerotium bataticola (Macrophomina phaseoli)*, *Fusarium oxysporum* and *Phytophthora parasitica*. Environmental conditions and cultural practices are of major importance and may contribute much to the variable severity of the different diseases, where the rate of infection ranges from 0 to 100%. Also the causative organisms may vary.

Attempts have been made to control the wilt disease through development and planting of tolerant varieties and the improvement of cultural practices with great emphasis on irrigation, chemical and biological control. Seed treatments with fungicides, Vitavax-Captan, proved to be effective in controlling seedling diseases.

Almost all sesame strains are susceptible to wilt diseases under field conditions, although their reactions vary. Thus, 112 sesame strains were tested in the nursery under artificial infection by a mixture of the four fungi commonly causing wilt; the commercial variety Giza 25, tolerant to wilt and root rot diseases, and four highly susceptible strains were checks, i.e. Margo, Local-8, H 89-9 and NA-328. It was found that 38% of the tested lines and cultivars were completely susceptible whereas 62%showed tolerance. Out of these, 14 strains were completely free from the disease. Giza 25 was in the range of 76-100% for tolerance (visually) and 40% anatomically.

Inheritance studies of the disease reaction gave contradictory results. In one cross, susceptibility was dominant over tolerance to *Rhizoctonia* and *Sclerotium* and was controlled by 2-3 pairs of alleles. On the other hand, tolerance was dominant to susceptibility in four crosses and was controlled by one or two pairs of alleles.

Sunflower

Sunflower is the known host of more than 35 infectious microorganisms, mostly fungi, which may under certain climatic conditions reduce the yield and quality significantly.

The principal fungal and nematode diseases affecting this crop in Egypt are:

1. Rust - *Puccinia helianthi*,
2. Verticillium wilt - *Verticillium dahliae*,
3. White rot - *Sclerotinia sclerotiorum*,
4. Charcoal rot - *Macrophomina phaseoli*, (*Sclerotium bataticola*),
5. Head rot, soft rot - *Rhizopus arrhizus*,
   hard rot - *Trichothecium roseum*,
6. Leaf spot - *Alternaria alternata*, *Helminthosporium rostrata*, *Curvularia lanata*,
7. Powdery mildew - *Erysiphe cichracearum*,
8. Southern blight *Sclerotium rolfsii*,
9. Root rot and wilt - *Fusarium oxysporum*, *F. solani*, *Pythium* sp., *Rhizoctonia solani*,
10. Root-knot nematode - *Meloidogyne* spp.,
11. Reniform nematode - *Rotylenchulus reniformis*,
12. Lesion nematode - *Pratylenchus* spp.,
13. Stunt nematode - *Tylenchorhynchus* spp.

A new disease, probably caused by a bacterium, is under investigation. This disease is very destructive to the plant.

Safflower

Safflower is reportedly susceptible to 20 or more known diseases. The results of field survey in different localities of Egypt show the major diseases include:

1. Rust - *Puccinia carthami*,
2. White rot - *Sclerotinia sclerotiorum*,
3. Root and stem rots - *Phytophthora drechsleri*, *Macrophomina phaseoli*, *Fusarium* spp., *Rhizoctonia solani*,
4. Leaf spot - *Alternaria* sp.,
5. Several by nematodes- *Meloidogyne*, *Heliocotylenchus*, *Heterodera*, *Pratylenchus* and *Rotylenchulus*

Available varieties and lines are under evaluation, with respect to disease resistance. Chemical control methods for these fungal pathogens are also under investigation.

Production of Flax

M. El Farouk and Ahmed Mumtaz Ali[1]

The most important fibre crop, other than cotton, which can be grown in Egypt is flax (*Linum usitatissimum L.*).

Flax plays an important role in the present policy for agricultural development in Egypt. It is a versatile crop which contributes many products including fibres, seeds and even shives extracted from the stems. Half of the fibre production is planned to be exported while the other half could be consumed locally for manufacturing of linen and twines. Also, flax oil is one of the oldest commercial oils used in food as well as a drying oil. It is still one of the most important oils used in the paint and varnish industry. Linseed oil is consumed locally but the cake is mainly exported for its high return of hard currency. Generally, Egypt produces about 1.6% and 0.35% of total world production of flax fibre and seeds respectively.

The acreage allotted to flax in Egypt is, however, limited, being only 37106 feddans (1982/83 season); because of the shortage in the main winter crops such as wheat, the area allotted to flax in Egyptian cropping will probably not be increased for the time being. Thus, increasing the production of flax, at present, will have to be achieved by use of high yielding varieties or improvements in cultural practices i.e. row spacing and plant population.

Flax seed contains from 32-44% oil which has an iodine number of 160 to 195 and is used partly as an edible stuff but mainly in the manufacture of paints, oil cloth and printer's ink. Linseed oil meal, produced as a by-product, is either granulated or ground for livestock and poultry feed.

The dried flax stem contains about 20% of fibre by weight, with 10 to 15% long fibre. The actual yield, however, varies according to the quality of the straw and the way in which the fibre is obtained.

The optimum climate for flax is a cold weather saturated with humidity during its growing season, with a light rainfall at somewhat regular intervals. Such rainfall should be neither heavy nor continuous. Any unexpected change in the weather such as a sudden heat wave has a destructive effect on the flax crop. In flax-growing areas, the minimum temperature during the growing season is about 50°F and the maximum temperature is about 100°F.

---

[1]Research Scientist, Fibre Crops Research Section, and Director Agriculture Research Centre, respectively, Giza, Egypt.

Soil-type not only affects the yield of the crop, but also influences to a great extent the quality of fibre in the straw. Actually, the ideal soil for flax is a medium textured soil that is homogenous and that is free of salts and weeds, with good drainage and a suitable percentage of calcium and organic matter.

Cultivation Practices

Fibre flax must be sown at a rate of 2500 seeds per square meter to give single and thin stemmed plants. In contrast, oil flax must be sown at only 1000 to 1300 seeds per square meter in order to allow the branching of plants.

In Egypt, for the best results, flax should be sown from the middle of October till the middle of November. Any delay in the date of sowing will undoubtedly be at the expense of the crop. In Europe, flax is considered as a summer crop.

The most up-to-date method for sowing of flax is with a drilling machine devised specifically to sow the seeds in straight rows at equal distances and suitable regular depths. The idea is that this approach will ensure that the plants are uniform. Manual broadcasting is a primitive method which is common in Egypt.

Flax should not be cultivated twice in the same plot of land before the lapse of at least three to four years. This procedure, if followed, will increase the output and help to protect the plants from weeds and diseases.

The applying of appropriate fertilizers at the suitable time and in the required quantities needed for the plant is one of the most essential factors that produces a high output. For this purpose, it is advisable that we should analyse the soil in order that we may know its requirements of fertilizers. Medium quality land should be supplied with 20-30 kg of nitrogen per acre. The amount should be given equally before the first and second watering.

Flax in Egypt requires 4-5 waterings during the season of its growth, excluding the one given at the time of sowing. The number of waterings should be less in rainy regions, and more than that in light soils.

It goes without saying that the economic value of flax straw and seed diminishes if the plants grow in the presence of weeds. Plants will inevitably become weak. Any weeds that appear should be removed so as not to damage the crop. The MCPA is used nowadays with success as weed control in flax fields.

Harvesting the crop at the appropriate time is one of the main elements that help to obtain good quality of fibres and abundant seeds. Pulling should take place immediately after the appearance of maturity signs (complete formation of capsules and fall of leaves from the lower part of the stem). Delaying pulling will cause harm to the fibre and loss of the derge quantity of seeds. Pulling can take place either by machine constructed for this purpose or in the early morning by experienced workers trained for this operation.

De-seeding should take place by special machines instead of the old way of beating the stalks on a stone. This latter process causes breakage of stems and loss of some seeds.

Retting

Retting is a process to dissolve and eliminate the pectin which binds the fibres to the woody parts of the stems and to eliminate the thin wall-tissues surrounding the fibres by damping or soaking the stems in water in retting tanks. In other words, retting is the process by which the bast bundles of fibres are made free from the cellular tissues surrounding them by the combined action of the bacteria which are present in the straw. With the addition of moisture, the bast bundles of fibre will eventually be readily separated from the bark and woody core of the stalks and from the fibre bundle itself.

To ensure proper retting, the temperature of the retting water must be from 28-38°C, and the acidity should be from 6-7pH, while the ratio of straw to water should be 1:3. In this case, the period for retting should range from 5-7 days.

Breaking

The object of breaking is to simplify the job of separating the wood from the fibre. The essential part is the breaking of the woody portions of the stems into fine pieces called "shives" by breaking machines.

Scutching

In scutching, one beats the fibres by hand on a notched vertical post with a rod called a hammer or by feeding the broken strands of fibre through a paddle-scutching wheel to remove the woody parts or shives from the strands, leaving as much of the fibre unbroken as possible.

In some scutching mills in Egypt, there are modern electric machines which combine breaking and scutching in one continuous operation. This machine, called a Turbine , operates on the same principle as separate breakers and scutchers and obviously results in higher productivity with lower labour costs than when the work is done on separate machines. This operation gives long fibre and separates tow and shives as waste.

Flax Yield

The following scheme is the production of flax from one feddan (4200 m^2) in Egypt.

	Weight (kg)	Percent
Straw	2750	100
After retting:		
long fibre	294	10.70
tow	147	5.35
waste fibre	122	4.47
shives	1405	51.10
retting loss	782	28.38
Seed	600	100
After extraction:		
linseed oil	199	33.20
linseed cake	396	66.00
loss	5	.80

Flax Varieties

Flax varieties grown in Egypt are:-

1. Giza 4

   Egyptian variety, released since 1948, by the Fibre Crops Research Section, Field Crops Research Insititute, Agricultural Research Centre. It is selected from a cross between two local varieties Giza pupple and Giza oil. It is high yielding in fibre and seed. At present time, it covers nearly 40% of the whole flax area.

2. Giza 5

   A dual purpose variety, released by the Fibre Crops Research Section, Field Crops Research Institute, Agricultural Research Centre. It is selected from a cross between Giza 4 and Precenderia, an introduction from Argentina. The grower and scutcher prefer it for its high seed yield, fibre content and resistance to flax rust. At present time, it covers nearly 50% of the whole acreage under flax in Egypt.

3. Giza 6

   A dual purpose variety, released by the Fibre Crops Research Section, Field Crops Research Institute, Agricultural Research Centre. It is selected from a cross between Giza 4 and Maroc, an introduction from Hungary. It is high yielding in fibre and of high oil content. At present time, it covers nearly 10% of the whole flax area.

Improvement of Peanuts and Sesame in Egypt

Badr El Ahmar and Mohy D. El Momdouh[1]

Peanut

Peanut (*Arachis hypogaea L.*) is one of the most important crops in Egypt, as a cash crop for the farmers and as a crop for export.

The area cultivated with peanut during the 3-year period 1980-1982 amounted to 2800 feddans producing 2900 M.T. of unshelled peanuts with a mean of 859kg/feddan. The most important areas of production are the Eastern Delta (Ismailia) and Sharkia provinces) and Middle Egypt (Giza province) where about 85% of the total area is cultivated. The crop is used as a food crop, where 30-35% of the production is exported (10-15 thousands M.T.), and the remaining is consumed domestically.

Peanut grown in Egypt is of the semi-spreading type, large podded with two seeds per pod. The commercial variety Giza 4 is widely grown in the country. It is a large podded, two seeded, with a growing season of 150 days, and is tolerant to stem and pod diseases. The improvement program for peanut is directed to increasing the yield and quality of the crop through:

- Evaluation of introduced and local strains for yield and disease resistance to provide adequate information for further breeding studies.

- Conducting yield trials to indicate the most promising strains. Only those exhibiting satisfactory performance will be tested for disease reaction under controlled conditions of artificial infection in the disease nursery with the most prevalent fungi: *Fusarium oxysporum Rhizoctonia solani* and *Sclerotium bataticola*.

- Undertaking a crossing program to develop new high yielding lines.

- Conducting a series of experimental trials to determine the best cultural practices to obtain the highest yield: Gypsum application, macro and micro-element application, and bacterium inoculum.

- Establishment of demonstration fields under proper cultural practices in cooperation with the extension department.

[1] Project Leader and Research Scientist respectively, Oilcrops Research Section, Field Crops Research Institute, Agricultural Research Centre, Giza, Egypt.

Evaluation of Genetic Material

The breeding nursery includes 100 entries, which belong to the following three types of growth:

(a) erect
(b) semi-prostrate, and
(c) prostrate.

Preliminary and advanced trials were conducted for yield potential. These trials were carried out in three locations representing different soil types and ecological conditions: South Tahrir, Ismailia and Giza.

Table 1 indicates that some entries exceeded the commercial variety Giza 4. The entries Local 235, Local 262, Local 382 and Local 383 were higher in yield as well as for economic characteristics in terms of percent of exportable crop, 100-pod weight, 100-seed weight and shelling percentage. Yield increase was ranging between 11.61% and 45.42%, compared with Giza 4.

Crosses were carried out between Giza 4 and some high yielding entries: (Local 235, I. 322 and Local 262).

Cultural Practices Studies

These studies aim to investigate the effect of:

- Bacterium inoculation.

- Macro and micro elements application.

- Gypsum application.

Data indicated the response of peanuts to bacterium inoculum in co-operation with the Microbiology Department. Different bacterial races with local and imported carriers were applied and gave good results with regard to yield and quality.

Application of macro and micro elements indicated yield response. The highest yield was obtained with N-P-K in a rate of 30-30-24 kg/fed.

Application of micro elements (Zinc, Manganese and Iron) as a soil treatment and foliar application in a rate of 60 g/fed of each element at flowering caused yield increase. The most pronounced was for Zn and Mn, being 119 and 118%, respectively (Table 2).

Trials conducted to reveal the effect of gypsum application in rates of 500, 750 and 1000 kg/fed., applied at sowing, at flowering or half the amount at each time. Results of Table 3 indicated that the highest yield was obtained for 1000 kg/fed. Splitting the amount of gypsum gave the best results.

Table 1. Yield and economic characteristics of some new selected peanut entries in 1982 season.

Entries	Yield/fed* (kg)	Economic Characteristics			
		(%) Accepted Exportable Crop	(g) 100-pod Weight	(g) 100-seed Weight	(%) Shelling
Local 235	1286	76.0	240	87.4	89.1
Local 262	1182	74.8	248	79.3	86.4
Local 382	1429	77.6	193	76.0	86.2
Local 383	1540	71.9	218	82.8	86.9
Giza 4(com. Var.)	1059	62.0	190	74.2	69.9

Table 2. Efect of some minor elements on yield, 1981. (kg/fed of unshelled peanuts)

Application Method	Element						
	Check	Zn	Mn	Fe	B	Mean	Index
Check	1060						100
Soil treatment		1401	1138	1040	1150	1182	112
Foliar application		1112	1353	1138	1163	1192	113
Mean		1257	1246	1089	1157	1187	
Index	100	119	118	103	109	112	

Table 3. Effect of gypsum application on yield of groundnuts at two locations in 1981.

Time of Application	Rate (kg/fed)	Yield (kg/fed Unshelled)		
		Ismailia	Sharkia	Mean
(a) at sowing	500	1500	2017	1759
	750	1575	2325	1950
	1000	1538	2609	2074
	Mean	1538	2317	1928
(b) at flowering	500	1575	2138	1857
	750	1508	1968	1738
	1000	1575	2477	2026
	Mean	1553	2194	1874
(c) 50% at sowing and	500	1650	2178	1914
50% at flowering	750	1631	2120	1876
	1000	1575	2793	2184
	Mean	1619	2364	1991
Location Means		1570	2292	1931
CV %		6.32	11.36	

<u>Means of Applications</u>

a = 1928

b = 1874

c = 1991

<u>Means of Rates</u>

500 = 1843

750 = 1855

1000 = 2095

Demonstration Fields

Proper agro-techniques were applied in peanut growers' fields through an intensified extension program at Ismailia, Sharkia and Giza governorates:-

- Soil analysis was carried out to determine the requirements needed of major and micro-nutrients. Accordingly, N-P-K were applied in rates 30-30-24 kg/fed. Foliar application of zinc, manganese and iron at a rate of 60 grams of each element.

- Application of proper land preparation and recommended cultural practices with great emphasis on irrigation frequency.

The overall average increase of yield was 450 kg/fed. at Ismailia, 616 kg at Sharkia and 1200 kg at Giza, compared with adjacent fields. The increase is equal to L.E. 133, 205 and 400 in these provinces, respectively.

Mechanized Production of Peanuts

A preliminary study was carried out on newly reclaimed calcareous sandy area at Wadi-El-Mullak, Ismailia governorate under a system of sprinkler irrigation. Two ploughing methods were applied with different row-spacings. Mold board plough increased yield by 15%. Plant spacing of 60 x 20 cm gave higher yield. In another trial mechanical harvest was applied in Ismailia governorate in small holdings which indicated the economic significance and feasibility of mechanical harvest in terms of time and cost criteria. Due to the high costs of hand labour, mechanical harvest could save L.E. 13-23 of production costs (Table 4).

Table 4. A comparison between hand and mechanical harvest of peanuts (Ismailia - 1981)

Field Operations	Harvest (h)	
	Hand	Mechanical
Time consumed	72	4
Digging	10-15	6
Threshing	15-20	6
Total cost (L.E.)	25-35	12

Sesame

Sesame (*Sesamum indium L.*) is an important industrial and food crop. About 80-90% of its production is used in manufacturing the popular sweetened food halawa and the remainder covers the bakery and confectionery needs.

The area under sesame cultivation is estimated at 43500 feddans (1982 season), about 25% in Lower Egypt and 75% in Upper Egypt, with an average yield of 424 kg /feddan.

The local sesame varieties belong to the bicarpellatum subspecies, with 1 or 3 pods/leaf axil, branched and dehiscent. Seed colour ranges from light brown to white. The commercial variety Giza 25 covers about 70% of the cultivated area and is characterized by a high yielding ability, early maturity (100-110 days), profuse branching, single pods per axil and white seed. Although this variety has a high degree of resistance to wilt, in some cases the yield is greatly decreased due to severe attack of wilt diseases caused mainly by the soil-borne fungi *Rhizoctonia solani*, *Sclerotium bataticola*, *Fusarium oxysporum* and *Phytophthora parasitica*.

Sesame improvement is carried out.

Evaluation of Breeding Material

The breeding nursery at Giza Research Station includes 336 strains tested for yield performance. Data are recorded for: Days to flowering, growth cycle, plant height and yield.

Crossing Program

28 new crosses were done between Giza 25, Local 96, H38-2, N.A. 432, 413, 114, B.24 and B 32 which are characterised by high yield potential, short growing season, and/or three capsules per leaf axil, and/or tolerant to wilt diseases.

Disease Nursery

26 genotypes were planted in the disease nursery at Giza Research Station under artificial infection with the causal organisms of root-rot wilt diseases: *Rhizoctonia solani*, *Sclerotium bataticola* and *Fusarium oxysporum* to find out a source of resistance or tolerance. Inoculum of a complex of the three fungi was added to the soil at planting time. Irrigation was practiced at 7 day intervals.

At harvest, the number of visually healthy plants was recorded: 38% of the total material was completely susceptible whereas 62% was tolerant. Testing the roots of the tolerant strains indicated that only 42.3% of the tolerant strains were completely free of the disease. These strains will be further tested and if any of them gives good results, it can be used as a source of resistance in crossing programs.

Yield Trials

14 yield trials were conducted including 120 strains under four stages of test (Table 5). Results indicated that some of the tested lines outyielded the commercial variety Giza 25. As shown in Table 6, the four top yielding strains: N.A. 270, N.A. 301, N.A. 301-1 and B 1 outyielded the commercial variety Giza 25 with an average of 58.2 - 86.7%. These entries will be further tested in yield trials as well as in the disease nursery to determine their resistance to diseases.

Package Trials

12 package trials were established in Upper Egypt (Asiout, Sohag and Quena governorates) where appropriate agro-techniques and recommended practices were applied.

From this trial, it was indicated that on across location mean, package trial fields gave a remarkable increase in yield that has passed up that of adjacent fields by 165 kg/fed., equivalent to L.E. 98.

This confirms the impact of close relationship between research and extension in transferring the new approaches and techniques to the growers.

Table 5. Summary of results on sesame yield trials (1981 season).

Stage of Testing	No. of Tested Entries	No. of Top Yielding Strains	Range of Yield Increase Compared with Giza 25 (%)
D (Advanced)	12	3	5-21
C	15	6	12-20
B	21	8	25-50
A (Branched)	44	10	10-60
A (Non-branched)	28	12	15-45

Table 6. Miniature sesame yield trial (Advanced Stage) of the top yielding strains.

Entries	*Mean Yield (kg/fed.)	Percentage of Check (Giza 25)
N.A. 270	351.6	170.8
N.A. 301	360.9	175.4
N.A. 310-1	384.3	186.7
B_1 (Local hybrid)	325.5	158.2
Giza 25 (commercial var)	205.8	100.0

*Mean of 4 locations representing: Eastern Delta, Middle and Upper Egypt.

Sunflower Research Program in Egypt

Badr A. El Ahmar and Nessim R. Guirguis[1]

Great emphasis has been given to sunflower over the past 12 years with regard to varietal and agro-technique improvement as a new source for edible oil.

The following table illustrates the area, average yield per feddan and total production during the last 12 years.

Period	Area Cultivated (Feddans)	Kg/fed	Total Production (M.T.)
1970-72	27640	719	19873
1973-75	17180	627	10771
1976-78	15650	700	10955
1979-81	14020	766	10739
1982	15970	805	12856

Data of the above table show that the area in 1982 had been reduced by 45% as compared with the 3 year period 1970-1972, whereas, the average yield/feddan had increased by 12%. This could be attributed to the fluctuation of market prices from one season to another.

Most of the area under sunflower is located in Middle Egypt (about 80% with 20% distributed in Northern and Western Delta).

Large seeded types are used, and the seed produced is consumed directly after being roasted and salted.

Research Activities

Breeding Studies

- Develop suitable cultivars for the different agro-ecological regions of Egypt which would be characterized by:

  - high yield of seed and oil,
  - short duration,
  - tolerant to salinity and drought,
  - tolerant or resistant to disease and orabanche.

[1]Project Leader and Research Scientist respectively, Oil Crops Research Section, Agricultural Research Centre, Giza, Egypt.

Cultural Practices

- To develop appropriate agronomic practices for high productivity with emphasis on the minor elements and weed control.

- Intercropping and relay intercropping studies to increase the cropping intensity with regard to yield performance and net return per unit area.

Diseases

Screening for disease reaction under normal field conditions and artificial infection with the causal organism of the most prevalent diseases.

Results

In accordance with the plan of work designed for sunflower improvement, achievements include:

- Initiation of a synthetic population with a high oil content ranging from 40-45% together with high yield of seed.

- Improvement of the Miak strain for early maturity and high oil content. In this respect, an increase of 2-5% in oil content was obtained.

- Evaluation of breeding material (introduced) on station fields under different ecological regions of the country was undertaken where the following plant and seed characteristics were recorded: Plant height, stem and head diameter, head bending, head shape, days to maturity, seed yield per plant, oil content, husk percentage and disease reaction.

  Data showed wide range of genotype difference among these characters that offer a large scope for various breeding purposes.

- Yield tests were conducted on station fields at Sakha and Sids Research Stations to study the yield potential of the introduced entries along with Giza 1 and Miak as checks. These entries included hybrids and open pollinated varieties together with those of International Sunflower Network.

  The following table illustrates the number of entries and yield trials conducted in 1982 season.

Test	No. of Locations	No. of Entries
a. European and American hybrids and varieties	2	18
b. O.P. and hybrids	2	24
c. 1st International trial	1	18
d. 2nd " "	1	18
e. Romanian and Yugoslavian hybrids	1	16

Data showed the superiority of some entries in yield potential over the check as presented in the following table:

Test	No. of Superior Entries	Range of Increase in Yield	
		Kg	%
a	1	52	5
b	8	187-333	18-32
c	1	58	6
d	5	95-260	12-94
e	10	276-887	55-275

Mean location yields in these tests ranged from 752 kg/fed at Sakha to 1112 kg/fed at Sids.

- According to the studies dealing with the improvement of agro-techniques, the following recommendations are given to the growers:

  - date of planting - March - April
  - plant density - 23000 plant/fed (69x30 cm)
  - fertilizer rate and date of application - 30 kg N/feddan ($\frac{1}{2}$ at sowing + $\frac{1}{2}$ 30 days later)
    30 kg P_2O_5/feddan (during land preparation)
  - irrigation frequency - 6-7 waterings (at 15 day intervals).

- The sunflower plants are liable to attack by a number of fungal diseases; charcoal and head rot diseases are of major importance in the northern regions of the country. In this respect under natural field conditions, the number of infested plants was recorded for these diseases on the tested material of the breeding nurseries at Sakha and Nubaria Research Stations.

The Expansion of Sunflower Production

There is no place in the present existing rotation of the valley and the Delta for non-traditional or new crops to be cultivated due to the intensified cropping system being practiced.

The future prospect of this crop will be apparently in the new lands and fortunately research work proved its success in the calcareous soils which represent a great part of our lands especially in the Western Delta.

In addition to its high oil content which amounts about 45% in the improved varieties, the production of this crop would be most important for animal raising as its meal is of high nutritional value.

As the crop is essentially cross pollinated by insects, it is most necessary to set up adequate number of honey-bee hives in the sunflower field. This would obviously increase the economic importance of sunflower.

Improvement of sunflower production in the new reclaimed lands at Marriout and Northern Tahreer area had been achieved, where an average yield of 700 kg/fed was obtained in 1981 compared with 250 kg in 1980 and 50 kg in 1979.

Need for Additional Research

Broad lines of further work needed on sunflower are:

- Development of superior varieties in terms of seed yield and oil.
- Development of superior production package.
- Testing and adaptation of mechanized production.
- Effect of different methods of irrigation prevailing in the new reclaimed lands on yield and disease incidence.

The Future of Rapeseed as an Oil Crop in Egypt*

Badr El Ahmar[1]

As earlier mentioned, substantial increases in oil production in Egypt are required to maintain or increase self sufficiency above the existing level of 25-30%. Sunflower and rapeseed have been found to be the most suitable oil crops which can be grown on newly reclaimed calcareous soils and hold potential for increasing domestic oil production.

Initial work on rapeseed started in 1973, with the introduction of both winter and summer rapeseed lines from Germany. Plantings were carried out in Northern and Middle areas of the Nile Delta, as well as in Middle and Upper Egypt. Winter types did not perform well in any area, while summer types appeared promising in the Northern and Middle Delta areas. A large number of lines have been introduced from Czechoslovakia, France, Sweden, England, Canada and Denmark and tested on calcareous and saline soils. Lines were grouped into 3 maturity classes: Early-120 to 130 days; medium-140 to 160 days, and late-more than 170 days. The early maturing lines have been found to escape damage from aphids (*Aphis pseudo-brassica*).

Yield trials carried out on the Eastern and Western parts of the Nile Delta over 3 years have shown the superiority of the variety Cressor 95C, which produced a mean seed yield of 2470 kg/ha. This was 14 to 20% higher than 3 other varieties being tested. Moreover, oil content was highest (41.5%), the erucic acid level in the oil was low (0.7%), and the glucosinolate level (7.75 mg/g) was lower in Cressor 95C than in other varieties.

A seeding rate study which compared rates from 8.4 to 33.6 kg/ha showed that a rate of 25.2 kg/ha gave the highest yields followed by the 16.4 kg/ha rate. These results were consistent at two locations.

Fertilizer experiments were carried out at 2 locations (Sakha and Nubaria) over two seasons (1978/79 and 1979/80). In both years, highest yields were recorded when the highest rates of both N (96 kg/ha) and P_2O_5 (72 kg/ha) were applied. Response due to the high rate of nitrogen ranged from 163 to 186 percent over the unfertilized control, while the high rate of phosphorus produced a response of 126% in 1978/79 and 332% in 1979/80.

---

*Summary of a paper scheduled for presentation, but not read at the workshop.

[1]Project Leader, Oilcrops Research Section, Agricultural Research Centre, Giza, Egypt.

Discussion: Country Presentations, Egypt

Six papers covering Egyptian oil crop research + production were given as reproduced above. An additional paper entitled "The future of rapeseed as an oil crop in Egypt", by Badr El Ahmar is summarized here but was not read at the workshop.

General Discussion

The Egyptian scientists were asked if groundnuts and sesame would be used for oil extraction in the future. Participants were informed that these two crops would continue to be food crops in Egypt due to their demand for the purpose, and due to the shortage in production to meet existing food and export needs. It was also felt that Egyptian consumers might not like the taste of groundnut oil, and finally that oil extracted from sesame and groundnut would be prohibitively expensive, given the existing prices of these crops.

The information was given that flax oil is used as an edible oil in certain areas of the region.

Increasing oil production in Egypt could be brought about by a number of strategies: The most important is through an expansion of oil crops onto new lands. Since these new soils will not be as productive as soils of existing cultivated lands, a strong multidisciplinary approach is required to achieve success. Another approach is through increasing cropping intensity (the number of crops grown on a piece of land per year), but since cropping intensity in the country is already 200%, scope is limited to boost this figure further. A third strategy is to use intercropping such as sugarcane-sesame, sesame-soybean, sunflower-rice etc., to increase the output per unit area of land.

The question was raised that since the main objective is to increase overall production and per capita availability, does it matter whether groundnuts + sesame were used as an oil or as a food crop? The answer was that breeding objectives for use as an oil crop were different from those of improving a food crop.

The information was given that Egypt was fortunate enough to have no insect pest problems in oil crops.

Discussion on Groundnuts

A thorough discussion on the gypsum application experiment revealed that the soil pH in Egypt ranges from 7.5 to 10.5 but that a soil nutrient analysis had not been carried out prior to the experiment. Since earlier experiments on gypsum had shown a positive response, it was not considered necessary to include an untreated control in the experiment. The Egyptian scientists felt that calcium was not washed out of the soil by irrigation; nevertheless, they felt that a split application was better than a single application at planting. The higher gypsum response at

Sharkia compared to Ismailia was reported to be due to differences in soil types and cultural conditions.

Some participants felt that fertilizer nitrogen applied at the rate of 30kg N/feddan was rather high for groundnuts. This rate was established in earlier experiments where 30 kg N/feddan was found better than inoculating with rhizobia Egyptian scientists were interested in obtaining new and efficient rhizobia strains, which might fix more nitrogen under Egyptian conditions.

Groundnut rust was reported to be absent in Egypt. Leaf spot could be a problem if the crop were planted late. The Egyptian groundnut crop was reported to be completely free of aflatoxin contamination. However, some doubts were raised.

The origin of the local groundnut lines used in the experiments was from selection within the landraces existing in Egypt.

Mechanical harvesting versus hand harvesting was also discussed. Participants were informed that the harvesting trial was initiated in cooperation with a private company. The problem reported was the cutting of vines by the thresher. Fodder is valued highly by the farmers and after threshing, the vines must be baked before they can be sold in the market. It was pointed out that a machine which combines digging and picking operations could be used and would result in the availability of green fodder. On the future of mechanisation, the group was informed that large farmers will need mechanisation. Questions were raised on the very high figures reported for shelling percentage (up to 89.1%). The group was informed that these figures were based on the selected sample of mature pods.

Discussion on Sesame

A question was raised on the ability of sesame to establish itself in an intercropping situation. In reply, it was stated that for the first 10-15 days, sesame requires frequent irrigation; the interval could then be prolonged and irrigation stopped at physiological maturity. The requirement for water at establishment of the crop was stated to be low.

It was commented that the yields reported from yield trials were sometimes lower than the national average yields (424 kg/ha).

It was explained that the mean of percent yield increase in Table 5 (see "Groundnut and Sesame in Egypt") was based on 12 locations, while in Table 6, this figure was based on 4 locations, resulting in 2 different figures.

Trials on farmers' fields were planned jointly by scientists and extension workers, with the operations carried out by the farmers, under supervision from experts. Although the adoption of the package resulted in an increase of 165 kg/feddan, the relative importance of the different components going into this package had not been examined separately.

In screening for resistance to wilt in sesame, staff induced disease in plants by adding the wilt-producing fungi to the soil every year. Phyllody was reported to be unimportant in Egypt. A new method of controlling many soil-borne fungi and of killing weed seeds in the soil was described by the Egyptian Pathologist. This involved mulching and irrigating the soil, then covering with a polythene sheet for eight weeks during the summer. The increased temperature under the sheets kills the weeds and fungi, and provides control for several years. The Egyptian Pathologist requested the participants to help in compiling lists of insects and diseases of oil crops in the different countries.

The origin of the sesame lines with NA (new arrival) numbers was stated to be from the USA.

Discussion on Sunflower

A clarification was sought on the applicability of the recommendation of the package of practices in sunflower growing areas on both old and new lands in Egypt. The group was informed that the package of practices was similar in both areas. On new soils, a starter dose of fertilizer was required, whereas on old soils, fertilizer was added at the time of thinning. A split dose of phosphorus was found better than a single application.

On bird damage in sunflower, desirability of goose neck type was expressed and the group was informed that work to incorporate this character is being vigorously pursued.

On the requirement of bee hives, one of the participants gave the information that there is a self fertilizing variety which does not require bees to set seed. Egyptian scientists were not aware of this and requested further information on the variety. The hybrids and populations under test in Egypt were reported to have 50-60% self pollination.

Considering the total area under sunflower and its production, question was raised as to how crushing plants would come up to make it a successful oil crop. The group was informed that low prices were presently fixed by the government for sunflower and the hope was expressed that if government fixed the prices at remunerative level, area under sunflower would increase substantially.

Discussion on Rapeseed

The comment was made that the optimum reported seed rate (18 kg/ha) for rapeseed was rather high compared with Ethiopia and Canada. It was replied that thinning is generally carried out after emergence.

Session 3

Country Presentations

Sudan

Chairman: Badr El Ahmar | Rapporteur: D. Yermanos

Groundnut Production in Irrigated Areas of the Sudan - Prospects and Constraints

Hassan Ishag[1]

Groundnut is an important export crop for the Sudan. It contributed about 18.6% of the total export value, whereas Sesame contributed about 9.9% in 1981-82 season.

Total area planted has increased from 327,300ha in 1964 to 826,000ha in 1974. Seventeen to twenty five percent is under irrigation, and this produces about 75% of the total production. The acreage under irrigation provides a stabilizing effect on groundnut production, which is not present in other groundnut producing areas in the world with the exception of the United States where the tendency is to increase areas under irrigation (Hammons, 1980).

Up to 1965, there was a wrong belief that the heavy clay soils of central clay plain are not suited for groundnut production (Ishag and Said, 1982).

Detailed and intensive research showed that the potential pod yield is about 6.7t/ha(Ishag, 1982 a). Many factors contribute to this high yield (El Ahmin, Ishag, and Burhan, 1983).

The climate of the irrigated areas is semi-arid with abundant sunshine and a solar radiation of 548 Cal/Cm²/day. The rainy season is from May to October with the heaviest rainfall during July - August. Average temperatures vary from 33°c in May to 23°c in January (AOAD, 1974).

In the irrigated schemes, three types of rotations are practiced. Four course rotation, cotton-wheat-groundnut/sorghum-fallow in the Gezira; three course i.e. cotton-wheat-groundnut/sorghum in the Managil; and two course i.e. cotton-groundnuts in the Rahad and Suki. It is expected that the yield of groundnuts will be decreased with shorter rotations mainly because of loss in soil fertility.

---

[1]Oilseeds Project Leader, Agricultural Research Corporation, P.O. Box 126, Wad Medani, Sudan.

Some Research Findings

The highest pod yield was obtained when the land was disc ploughed at the depth of 20cm followed by harrowing or disc ploughing at the same depth followed by rotovation (Ishag et al 1980).

Ridging only had resulted in unfavourable soil physical conditions and consequently fewer pods per plant.

Early sowings i.e. April-June increase both pod and hay yields. However, delaying sowing date to September decreased pod yield by about 53% for Virginia types and 70% for Spanish types (Ishag, 1965).

One of the most critical factors limiting yield in irrigated areas is the sparse plant population. Ishag (1970) reported that highest pod yield for semi-spreading types was 60cm between ridges, 15cm between plant holes and two seeds per hole, while for bunch types the highest pod yield was obtained with 40cm between ridges, 15cm between plant holes and two seeds per hole.

MH383 outyielded all other cultivars in all seasons and in all sites. Ishag (1982b) reported that this cultivar exhibits drought tolerance.

Newly introduced cultivars from USA, i.e. NC17, Florigiant and Florunner proved to be low yielding for Gezira environment. They are poorly nodulated, sensitive to delay in sowing and highly susceptible to termite damage.

Weeds reduce the pod yield of groundnuts by about 80% (Ishag, 1971). Too frequent hand weedings were found to reduce yields mainly because of the disturbance of pegs. Two hand weedings i.e. 30 and 60 days from sowing were enough to achieve high pod yield.

The pre-emergence herbicides Ronstar (Oxadizon) at a rate of 0.45-0.60kg a.i per feddan and Balan (Benefin) at a rate of 0.60kg a.i. per feddan were found to be effective in controlling weeds.

Total water requirement for groundnuts in the irrigated Gezira was found to be 486-597mm (Ishag et al 1983). Seventy five percent of water depletion was from the upper 20cm. Plants in the sparse population were more sensitive to water stress than plants in the dense population.

The time of harvesting is critical, as it affects both quality and quantity of the pods. Too early harvesting causes the shrivelling of kernels. Lifting groundnuts late results in higher pod losses (68%) with no increase in yield. Late harvest subjects the pods to termite damage which encourages aflatoxin contamination.

IDRC Project on Groundnuts

Many experiments are carried out in irrigated groundnuts to find out the appropriate cultural practices and cultivars to suit the climate and soils of central clay plains. Two experiments, on crop sequence and nutrition of groundnuts, are showing promising results:

Crop Sequence

Crop immediately preceding groundnut can affect yield and quality. Eleven treatments were included in the crop sequence experiment. The establishment of Groundnuts was the best if it was preceded by Safflower, Sunflower, Fallow and Maize (Germination percent ranges from 80-95%) followed by cotton (long staple and short staple), sorghum (50-60% germination). Soil physical conditions and growth of groundnuts were seriously affected when the previous crop was Pigeon peas, Lubia *(Dolochis lablab)*, Phillipean *(Phaseolus trilobus)* or groundnuts. The experiment is still going on and the yield and yield components will be reported later.

Nitrogen and Phosphorus

Groundnuts are a soil depleting crop and require a considerable amount of nutrients for high yields. Martin (1965) reported that for every ton of unshelled pods and one ton of hay, 40-47kg of N, 7.5-8kg of P_2O_5, 16-22 of K_2O 9-14kg of CaO and 10-12kg of MgO were removed.

Phosphorus increases nodulation and results in earlier formation of gynophores. The rate of nitrogen fixation per weight and the increase in uptake of other nutrients due to increased root activity might be due to the application of phosphorus.

Constraints

With the high potential yield of groundnuts in irrigated areas, the gap between the yield obtained by the research stations and the farmer is indeed very big. The package of production technology should be tested on farmers' fields.

The Sudanese farmer is reluctant to adopt the high production technology not because of his ignorance, but mainly because of bad marketing system and unavailability of infrastructure facilities.

Detailed and intensive research is needed in agricultural machinery, irrigation, effect of mid and late weeds, insect pests and aflatoxin.

References

AOAD (Arab Organization for Agricultural Development) (1974) Agro-climatological study in the Arab countries, AOAD, Khartoum Sudan.

El Ahmin, E.M., Ishag, H.M. and Burhan, H.O. (1983). Important factors affecting the yield of groundnuts in the Sudan, *(Arachis hypogaea L.)*, Zeitschrift für Angewandte Zoologie No. 1.

Hammons, R.O. (1980) Research and extension inputs resulting in high yields of groundnuts in the USA. In Proceedings of international workshop on groundnuts pp33-39 ICRISAT.

Ishag, H.M. (1965) The effect of sowing date on growth and yield of groundnuts in the Gezira. African Soils 10:509-520.

Ishag, H.M. (1970) Growth and yield of irrigated groundnuts *(Arachis hypogaea L.)* at different spacings in the Sudan Gezira. 1-Flowering and yield components. Journal of Agricultural Science, Cambridge. 77:237-242.

Ishag, H.M. (1971) Weed control in irrigated groundnuts *(Arachis hypogaea L.)* in the Sudan Gezira. Journal of Agricultural Science, Cambridge 77:237-242.

Ishag, H.M. (1982a) Groundnut production in the Gezira Environment In Groundnut production and intra African trade (Gambia) African Groundnut Council. (A symposium)

Ishag, H.M.,Said, M.B., Osman, A.K. and Mohmoud, T. (1980) Land preparation and phosphorus requirement of groundnut. Annual Report Gezira Research Station.

Ishag, H.M. and Said, M.B. (1982) Groundnut production in the Vertisols of the Gezira, achievements and problems. 5th International Soil Classification Workshop. Khartoum

Ishag, H.M. (1982b)The influence of irrigation frequency on growth and yield of groundnuts *(Arachis hypogaea L.)* under arid conditions. Journal of Agricultural Science,Cambridge 99:305-310.

Ishag, H.M., Fadl, O.A.A., Adam, H.S. and Osman A.K. (1983) Growth and Water requirements of groundnuts (*Arachis hypogaea)* in irrigated Gezira. Submitted to "Experimental" Agriculture.

Selection of Groundnut Cultivars for Rainfed Western Sudan

A. Beshir El Ahmadi[1]

Rainfed groundnut production in Sudan is mainly in the Western regions of Kordofan and Darfur. It is an important cash crop and a major source of edible oil. In 1979-81, the area under groundnut was stable at about 0.8million hectares and yields average 680kg per hectare. The crop is grown by small farmers in undulating stabilized sand dunes of low fertility, known locally as "qoz". Crop production is mainly south of the 400mm isohyet. Annual rainfall varies from less than 300mm in the north to over 800mm in the south. The rainy season extends from June or July to September with monthly coefficients of variation ranging from 25 to 100%(9).

Agricultural research services on a continuous basis were almost lacking. The situation is being rectified and an ambitious project, Western Sudan Agricultural Research Project, is in progress.

Barberton, an introduced early maturing upright bunch cultivar (*Arachis hypogaea subsp. fastigiata*), predominates and has almost replaced the runner late maturing alternately branched (*A. hypogaea subsp. hypogaea*) types that used to be grown. One of the earliest attempts to select cultivars for Western Sudan was conducted as part of the United Nations Special Fund Project: "Land use and rural development research project for Kordofan"(21). The results showed the superior performance of Barberton which was in general production at the time.

Desirable Cultivar Attributes

In what follows, characters that are important as selection objectives will be discussed. These can be grouped into: (a) adaptation characters and (b) quality attributes.

Adaptation characters

1. Drought resistance

Drought is the most important factor reducing yield in the major production area of Western Sudan although leaf spot diseases and termites may also contribute to yield reduction.

There seems to be some disagreement about the terminology of drought resistance. Kramer (15) considered the term "drought resistance" unsatisfactory and ambiguous and preferred to replace it with "drought tolerance"

[1]Groundnut Breeder, Plant Breeding Section, Gezira Research Station, P.O. Box 126, Wad Medani, Sudan.

while Levitt (16)believes that a physical concept of stress should be accepted by biologists. Using Levitt's terminology, drought resistance may be a result of avoidance (e.g. through earliness) or tolerance i.e. the capacity of the protoplasm to survive dehydration.

The subject of water relations in groundnut was reviewed recently by Boote et al (4). Groundnut is most sensitive to water deficits during the period of pod formation, and drought results in a reduction in pod number. Peg penetration and elongation, pod expansion and photosynthesis are also reduced. After a full fruit load is set, water deficit during seed growth and maturation terminates growth of younger fruits, resulting in aborted and shrivelled seeds. Other effects of drought on groundnut include low grading quality, low germination and more susceptibility to colonization by the aflatoxin-producing *Aspergillus flavus* group fungi.

The literature on morphological and physiological adaptations of plants to water stress and the associated possible screening techniques is voluminous. However, it seems that the empirical approach of selection under drought for absolute performance or performance under stress relative to that under normal conditions will be followed by breeders especially when possibilities for a multidisciplinary approach are lacking. An aid to the empirical approach is the line source sprinkler irrigation (12) which provides a stress gradient.

In developing drought-resistant groundnut cultivars for Western Africa, scientists at the Research Institute for Oils and Oilseeds (I.R.H.O.) and the National Center for Agronomic Research (C.N.R.A.) studied:

1 - Germination at high usmotic concentrations.

2 - Relative growth rate of young plants grown in pots.

3 - Heat resistance of young plants.

4 - Relative transpiration rate.

5 - Water potential of leaflets.

Early (55-437), medium (57-422, 73-33) and late maturing (59-127) cultivars were developed (3, 10).

2. Earliness

Earliness is the most important mechanism by which groundnut varieties may escape drought. Cultivars of *A. hypogaea subsp. fastigiata* are short maturing and are thus adapted to short season environments.

Because of the indeterminate fruiting nature of groundnut, determination of maturity would require examination of pods for signs of maturity. Methodology in this regard has been reviewed recently by Sanders et al (20). Boote (5) proposed uniform growth descriptions for groundnut based on visually observable vegetative (V) and reproductive (R) events. His results with Starr and Florunner indicate that days to first bloom (R1) may not always be correlated with harvest maturity (R8) since both cultivars started flowering at the same time but Starr reached R8 about ten days earlier than Florunner. Although cultivars of *A. hypogaea subsp. fastigiata* are in general short maturing, variation among cultivars in this character exists. Chico is a very early maturing cultivar being used as a source for earliness in Oklahoma (14) and ICRISAT.

Quality attributes

1. Resistance to infection by *Aspergillus flavus* and aflatoxin formation.

   This is an important factor primarily affecting exports. Development of resistant cultivars is one of several other methods that could be followed in controlling this worldwide problem.

   Mixon and Rogers (17), using a laboratory technique conducive to optimum fungal growth, identified two accessions, P.I.337409 and P-I.337394F as having a high degree of resistance to fungal colonization. Bartz et al (1,2) using a modification of the method of Mixon and Rogers identified a resistant breeding line UF71513 (UF734022). The drought resistant cultivars 73-30 and 55-437 were reported by Zambettakis et al (24) as also having resistance. J-11, a commercially grown Spanish cultivar in India, was also found to be resistant according to tests at ICRISAT.

   Mixon and Rogers (18) found that colonization of P.I.337394F increased with storage time, with increase in storage temperature and at 20% adjusted seed moisture. Also Wilson et al (22) found that both resistant and susceptible genotypes accumulate appreciable levels of aflatoxin after 9-10 days' storage at 23-26°C and 87-95% RH. Recently, Davidson et al (7) reported that the newly released resistant cultivar "Sunbelt" had no advantage over Florunner in reducing levels of *A. flavus* and subsequent aflatoxin contamination under field conditions. Zambettakis et al (24) found no significant correlation between the results of artificial inoculation and natural infection in the field, but, in general, varieties least sensitive to infection in the laboratory test had low natural contamination. After more testing Zambettakis et al (25) reported that the correlation between the laboratory test and natural contamination was significant in five out of seven cases. They concluded that selection among hybrid progenies based on artificial inoculation of seed will result in production of varieties less sensitive to contamination by *A. flavus*.

Diener et al (8) expressed the view that the problem is complicated by the fact that the fungus is not an aggressive plant pathogen but a saprophyte that may become a weak pathogen under conditions of stress.

2. High oil content

Most of the locally consumed groundnut is used for oil extraction. Previous oil analysis in Sudan indicated that, as a group, varieties of subsp. fastigiata had higher oil content than those of the subsp. hypogaea. This, however, does not seem to be the case in the United States (13).

Several workers in the United States reported results of oil analysis in groundnut. Cherry (6) evaluated 37 wild species and 21 cultivars for oil content. Oil percentage varied from 46.5 to 63.1 in the wild species and from 43.6 to 55.5 for the cultivars. Pancholy et al (19) analysed 77 cultivars for oil, total protein and amino acid composition. Oil content varied from 42.0 to 55.2%. Hammons (11) reported the results of oil and protein analysis on 30 cultivars and breeding lines. Oil content ranged from 45.6 to 55.4%. The variability in oil yield, especially in the wild species led Wynne and Gregory (23) to express the view that oil content in groundnuts can be increased, perhaps dramatically.

The predominant fatty acids in groundnut oil are oleic and linoleic acids. A high proportion of the latter is believed to decrease the shelf life of oil because of the development of oxidative rancidity. Cultivars of the subsp. fastigiata appear to have higher proportions of linoleic acid than cultivars of the subspecies hypogaea.

The Current Selection Program

Although groundnut breeding in Sudan is conducted at the Gezira Research Station, at Wad Medani, the program attempts to meet the cultivar needs of other regions as far as feasible. The program in its present location started in 1980 and is based on variety introduction and hybridization.

This season, one advanced trial comprising 18 cultivars of the subsp. fastigiata mainly of U.S. origin is being conducted at four locations in Western Sudan. Another trial with 22 entries mainly from ICRISAT is being conducted at two locations. Forty new selections and cultivars are in a preliminary evaluation stage at Medani. Selected entries from the two advanced trials will be further tested as a uniform rainfed trial. Ideally, this last stage in the testing should be conducted at three locations in each region representing the low, medium and high rainfall areas. Because of transport problems, a location representing the medium rainfall areas was not included in the tests of this season. When repeated over years, these trials will yield information on the genotypes best adapted to the region.

Hybridization is viewed as a long term reliable source of variation. However, for several years to come, testing introduced material will remain a major activity.

One set of crosses involved cultivars and selection with early maturity (Chico, Pronto), drought tolerance (55-437, 73-30, 73-33, 59-127), sequential branching, runner growth habit (e.g. ICG 720 and ICG 121), etc.

The argument for the development of sequential runner rests on a basic difference between groundnut and other crops in relation to utilization of soil moisture. In groundnut, the subterranean fruits require moisture to enhance calcium absorption. When the fruit load is concentrated around the tap root as in cultivars of the subsp. fastigiata, then both fruits and the upper part of the root system will be drawing water from a restricted soil volume. Cultivars of the Valencia type produce a succession of fruiting branches in the first five or six nodes in the cotyledonary and other n + 1 branches. If such branches were diageotropic, then the fruit load would be spread over a wider area, allowing utilization of moisture that would have been lost to evaporation or percolation. Prostrate growth habit should be coupled with synchronous flowering, early maturity, and drought tolerance. One objection to this plant type would be the increased difficulty in harvest.

Another set of crosses involves accessions resistant to colonization by *A. flavus*. Because of the difficulties discussed earlier, it was envisaged that selection for resistance in segregating populations involving resistant x susceptible cultivars would be difficult. Selection is practised among progenies derived from pairwise crosses and a three-way cross involving the three resistant accessions P.I.337409, P.I. 337394F and UF 734022. Toalson, reported to have pods resistant to fungal penetration was also crossed with P.I. 337409. Selection is for improved yield and pod type. There is also the possibility that segregants with improved resistance may be obtained.

Starting this season, the International Groundnut Aspergillus Flavus Nursery will be grown at Gezira Research Station by the groundnut pathologist.

No significant steps were taken to initiate a program for the development of varieties with high oil content. Some basic requirements for such a program need to be secured first.

Finally, we anticipate that efforts to develop groundnut cultivars for Western Sudan will be enhanced by activities of the new ICRISAT Sahelian Center.

References

1. Bartz, J.A., A.J. Norden, J.C.La Prade and T.J. Demuynk. 1976. Tolerance to colonization by A. flavus found in certain peanut *(A. hypogaea)* breeding lines and cultivars. Proc. Amerc. Peanut Res. Educ. Assoc. 8: 94 (Abstr.).

2. ________, _________, __________, . 1980. Seed tolerance in peanuts *(Arachis hypogaea L.)* to members of the A. flavus group fungi. Peanut Sci. 5:53-56.

3. Bockelle-Morvan, A., J. Gautrean, J.C. Mortreul and O. Roussel 1974. Results obtained with drought-resistant groundnut varieties in West Africa. Oleagineux 29:309-314.

4. Boote, K.J., J.R. Stansell, A.M. Schubert and J.F. Stone 1982. Irrigation, water use and water relations. pp 164 - 205. In Peanut Science and Technology. H.E. Pattee and C.T. Young edits.

5. _______, 1982. Growth stages of peanut *(Arachis hypogaea L.)* Peanut Sci. 9: 35-39.

6. Cherry, J.P. Potential sources of peanut seed protein and oil in the genus Arachis. J. Agric. Food Chem. 25:186-193.

7. Davidson Jr., J.I., R.A. Hill, R.J. Cole, A.C. Mixon and R.J. Henning. 1982. Field performance of two peanut cultivars relative to resistance to invasion by A. flavus and subsequent aflatoxin contamination. Proc. Amer. Peanut Res. Educ. Soc. 14:74 (Abstr.).

8. Diener, U.L., R.E. Pettit and R.J. Cole. 1982. Aflatoxins and other mycotoxins in peanuts. pp.486-519. In Peanut Science and Technology. H.E. Pattee and C.T. Young edits. Amer. Peanut Res. Educ. Soc.

9. El Tom, M.A. 1975. The rains of the Sudan. "Mechanism and Distribution", Khartoum University Press, Khartoum.

10. Gautreau, J., B. Garet and J.C. Mauboussin. 1980. The 73-33, a new variety of Senegalese groundnut adapted to drought, English summary. Oleagineux 35:154.

11. Hammons, R.O. 1981. Peanut varieties: Potential for fuel oil. Amer. Peanut Res. Educ. Soc. 13: 12-20.

12. Hanks, R.J., J. Keller, V.P. Rasmussen, and D.G. Wilson. 1976. Line source sprinkler for continuous variable irrigation - crop production studies. Soil Sci. Soc. Am. J. 40: 426-429.

13. Higgins, B.B. 1957. Relation of breeding and varieties to quality for specific uses. Proc. National Peanut Res. Conf. 13-20.

14. Kirby, J.S. and D.J. Banks 1980. Methods of breeding for early maturity. Proc. Amer. Peanut Res. Educ. Sci. 12: 47 (Abstr.).

15. Kramer, P.A. 1980. Drought stress and the origin of adaptations pp. 7-20. In N.C. Turner and P.J. Kramer edits. Adaptation of plants to water and high temperature stress. John Wiley and Sons.

16. Levitt, J. Stress terminology. pp. 437-439. In N.C. Turner and P.J. Kramer edits. Adaptation of plants to water high temperature stress. John Wiley and Sons.

17. Mixon, A.C. and K.M. Rogers. 1973. Peanut accessions resistant to seed infection by *Aspergillus flavus* Agron. J. 65: 560-562.

18. _______, _______. 1975. Factors affecting A. flavus link ex Fr. colonization of resistant and susceptible genotypes of *A. hypogaea L.* Peanut Sci: 2: 78-22.

19. Pancholy, S.K,. R. Sepulveda, and Shaik M.M. Basha 1980. Oil, total protein and amino acid composition of 77 peanut lines and cultivars. Proc. Amer. Peanut Res. Educ. Soc. 12: 13-22.

20. Sanders, T.H., A.M. Schubert, and H.E. Pattee. 1982. Post harvest physiology and methodologies for estimating maturity. pp. 624-654. In Peanut Science and Technology H.E. Pattee and C.T. Young edits. Amer. Peanut Res. Educ. Soc.

21. Tsangarakis C.Z. and P.A. Gerakis 1969. Groundnut variety introduction and breeding objectives in the sandy rainlands of the Sudan. African soils 14: 75-83.

22. Wilson, D.M., A.C. Mixon and J.M. Troeger. 1977. Aflatoxin contamination of peanuts resistant to seed invation by A. flavus phytopathology 67: 922-924.

23. Wynne, J.C. and W.C. Gregory 1981. Peanut Breeding. Advances in Agron. 34: 39-71.

24. Zambettakis, C., A. Bockelee-Morvan, F. Waliyar and J. Rossion 1977. Varietal differences in groundnut sensitivity to contamination by A. flavus in the field and in artificial conditions. Oleagineux 32: 377-385 (Fr. with Eng. Summary).

25. ______, __________, _________, ________, 1981. Results of four years of research on resistance of groundnut varieties to A. flavus. Oleagineux 36: 383-385.

The Status of Sesame Research and Production In The Rainlands of the Sudan

Hussein Elgizouli Osman[1]

Sesame (*Sesamum indicum L.*) is grown mainly in the tropics and subtropics i.e. between 25°N and 25°S. However, the crop is grown up to 40°N in China, Russia and up to 35°S in South America. At present, the main sesame producers are India, Sudan, Burma and China (Table 1).

In the Sudan, sesame is raised entirely under rainfed conditions (500-800mm per annum). An area of about 0.8 million hectares, yielding only about 0.2 million tons, is allotted annually to the crop.

Factors Limiting Sesame Production In The Sudan

Traditional Seeding Practices

In most of the rainfed areas (the traditional sector) the farmer cleans the land from sorghum debris, broadcasts seed (about mid-June) and covers it lightly with superficial hand hoeing. In many cases, seeds are left uncovered.

In the semi-mechanized schemes, the land is harrowed once or twice with a wide level disc harrow/seed drill during late June or early July - usually after early weed emergence. With the latest harrowing, seed is usually hand broadcasted with labourers sitting atop the seed drill. Less often the drill is used for sowing, but with the hoe's lower end freed from the supports to broadcast the seed, defeating the purpose of the drill.

Suitable Sesame Cultivars

All of the sesame grown is of the dehiscent type and therefore, hand harvesting of the crop creates a high labour requirement within a very short harvesting season. It is becoming more and more difficult to secure the necessary farm labour force to hand harvest an area of 0.80 million hectares of sesame. This often intensifies the competition among growers to secure labour and results in higher harvesting wages.

[1]Sesame Breeder, Kenana Research Station, Abu Nahama, Sudan.

Planting Time

The planting date of sesame is dependent on the initiation of the rainy season. Hence, growers often miss the optimum sowing date (about mid-June to mid-July), fail to carry out effective weed control, and suffer losses during harvesting. Dry spells during flowering or capsule filling limit the yields in some years.

Weed Control

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

Drainage

Sesame is very sensitive to excess moisture. Hence, lack of proper drainage system in sesame fields causes major reduction in yield in areas where rain water stands for extended periods of time.

Pests and Diseases

The main potential pests in the sesame fields are the sesame webworm (*Antigastra catalaunalis*) and the sesame seed bug (*Aphanus sordidus*). Although many diseases such as Phyllody, leaf curl, *Cercospora* and leaf spot, root rot, stem rot, bacterial blight were observed in sesame fields, bacterial leaf spot (locally known as 'Marad ed Dam') caused by *Xanthomonas sesami* is still the most serious potential disease that threatens sesame production in the Sudan.

Research

Agronomy research in the past was directed towards some of the basic aspects of sesame production and recommendations were put out for the growers regarding: land preparation, date of planting, seed rates, spacing, seed treatment and crop sequences. It has not been possible to come up with recommendations about fertilization, chemical weed control and mechanical harvesting.

Plant breeding research was directed towards the purification of the land varieties, their classification in terms of seed colour and evaluation in different testing sites. Six local sesame strains known as A/1/2, A/1/5, A/1/6, A/1/10 (all white-seeded), A/5/13 and A/4/9 (both brown-seeded) were released to the rainfed farmers. Further, a large number of introduction was evaluated and used in a large number of crosses to incorporate short internodes, three capsules per leaf axile, eight locules, long capsules and indehiscent capsule in the local cultivars. Many strains having different character combinations of these characters were selected and tested together with the local cultivars in different sites in the rainfed areas of the Sudan. Unfortunately, nothing was achieved and none of the introductions or strains retained from their crosses with the local cultivar outyielded A/1/10 and/or A/5/13 (the controls).

Data presented in Tables 2 and 3 summarize the results of the national sesame trials conducted in the Plant Breeding Section at Kenana Research Station in the period 1967-1982. The data clearly indicate that, although many of the strains evaluated had stable yield (i.e. having a regression coefficient (b) close to 1 and a standard deviation (sd^2), close to zero), none of them outstandingly outyielded A/1/10 and/or A/5/13 at any of the locations. Such unpaying efforts leave the sesame breeder in the Sudan with a difficult question - where next?

Agricultural engineering research was directed towards mechanical seeding and harvesting of the crop. Many binders were evaluated but none of them proved to be satisfactory. More recently, a system that involves direct combine of the crop by using a special header attachment was introduced from the University of California, Riverside, and evaluated. Finalization of this system awaits financial support and the involvement of more countries.

Table 1: Area, Yield and production of Sesame in major producing countries in 1981*.

	Area (1000 ha)	Yield (kg/ha)	Production (1000 MT)
India	2500	200	500
Sudan	830	241	200
Burma	763	212	162
China	742	540	401
Nigeria	235	311	73
Mexico	150	569	86
Uganda	133	346	46
Syria	66	954	63
Ethiopia	61	574	35
Afghanistan	50	800	40
Venezuela	50	600	30
World	1573	292	459

* FAO Production Year Book, Volume 35, FAO, Rome, 1982.

Table 2: Entry mean yields ($\bar{x}$), b values for yields on environmental index, mean square deviations (sd^2) for the NSVT in thirteen environments in the period 1967-1975.

Entry	$\bar{x}$ (kg/plot)*	b ± sb	sd^2
A/1/9	1.18	1.11 ± 0.08	0.03
A/2/1	0.98	0.96 ± 0.08	0.03
A/2/10	1.31	1.23 ± 0.11	0.05
A/2/15	1.31	0.88 ± 0.16	0.11
A/3/8	1.06	0.81 ± 0.11	0.06
A/4/4	1.25	0.97 ± 0.09	0.04
A/4/10	1.23	1.22 ± 0.07	0.02
A/5/9	1.35	0.99 ± 0.15	0.09
A/5/18	1.07	1.08 ± 0.13	0.08
C.31/1	1.11	0.85 ± 0.13	0.08
C.31/3	1.17	0.87 ± 0.15	0.11
A/1/10	1.09	0.91 ± 0.11	0.05
A/5/13	1.23	1.11 ± 0.18	0.14
Mean ($\bar{x}$)	1.18	1.00 ± 0.12	0.07

*Yield per ha = Yield per plot x 238

Table 3: Entry mean yield ($\bar{x}$), b values for yield on environmental index, mean square deviations (sd^2) and mean anthesis for SSVT-3 in eight environments in the period 1979-1982

Entry	$\bar{x}$ (kg/plot)	b ± sb	sd^2	Mean Anthesis
UCR 75116	1.55	0.80 ± 0.11	0.99	47
UCR 75399	2.13	1.14 ± 0.07	0.04	47
UCR 75403	1.63	0.87 ± 0.08	0.04	48
UCR 76197	1.95	0.99 ± 0.15	0.16	46
UCR 76198	1.93	0.80 ± 0.07	0.04	47
UCR 76400	1.98	1.14 ± 0.08	0.04	49
UCR 76418	1.66	0.87 ± 0.09	0.06	49
UCR 770192	2.10	1.00 ± 0.08	0.04	44
C.56/5	1.78	1.11 ± 0.07	0.03	55
A/1/10	2.01	1.28 ± 0.10	0.08	52
Mean ($\bar{x}$)	1.87	1.00 ± 0.09	0.06	48

Discussion: Country Presentation, Sudan

Irrigated Groundnuts

The irrigated groundnut crop, which accounts for 17-25% of the groundnut production in the Sudan, comes from the central clay plain. In these areas, longer rotations, which include a year of fallow, have been found to produce high yields of groundnuts. The sequence of crops in the rotation has also been found to be important. Timely land preparation is another factor in obtaining high yields, as this allows the crop to be planted at the correct time. Farmers usually have very low plant populations - an average of only 20,000 plants per feddan, while the recommended population is 92,000 plants per feddan. All these factors contribute to farmers yields being much lower than research yields.

The cultivar MH383 is both high yielding and resistant to Cercospora leaf spot.

Groundnut harvest is by hand, because mechanical groundnut pickers do not work well in heavy soils. Up to 70% of the yields can be lost, especially the larger pods which do not lift easily from the heavy soils. A mechanical harvester needs to be developed which can lift the nuts in heavy soils.

Rainfed Groundnuts

Insects, especially white grubs, cause more yield loss than do diseases in rainfed areas. Cercospora leaf spots, however, can become prevalent after heavy rains. Groundnut rust also occurs.

The bunch type of groundnut has now replaced the runner types in Western Sudan. Bunch types are earlier and easier to harvest.

There are different mechanisms of drought tolerance which are effective for the irrigated and the rainfed crops.

The production of edible oil in the Sudan is surplus to the domestic needs. This surplus is exported.

Sesame

Sesame production has declined in Sudan in recent years. Increasing yield levels must be the first priority of the sesame improvement program. Application of fertilizer is not effective in increasing yields in rainfed areas. In fact, nowhere in the world is there much yield response in sesame from nitrogen fertilizer application.

Mexico and China are reported to have the highest yields in the world, because sesame is grown partially under irrigation in those countries.

In Sudan, the ideal spacing for sesame has been found to be 60cm between rows and 7cm between plants, using a seed rate of 2kg/ha.

Sesame and sorghum are often grown in rotation; however, a cotton and sesame rotation has been banned because of problems of pest buildup.

Maintaining sesame collections is a problem, as rejuvenation is needed every two years. Further collections of Sudanese land races of sesame are required.

The mechanical harvester being developed could harvest dehiscent types if they were first desiccated. The machine has pans under the cutting bars, so that the seed is not lost during cutting.

The oil content of brown seeded lines is generally higher than that with white seeds. There is a price differential for white seed.

The origin of sesame lines named "UCR" is California while those prefixed with "A" come from Sudan.

Good resistance to bacterial blight has been found in sesame.

SESSION 4

COUNTRY PRESENTATIONS

ETHIOPIA, TANZANIA AND MOZAMBIQUE

CHAIRMAN: R. PATHIRANA

RAPPORTEUR: W. DEDIO

Highland Oil Crops Production and Research in Ethiopia

Hiruy Belayneh[1]

Ethiopia has a total geographic area of over 122 million hectares with a population of about 33 million. About 84 million hectares of the land are considered fit for agricultural production, out of which cultivated (crop) land totals 13 million hectares. The country lies mostly between 9° and 18° North and between 34° and 48° East.

The economy of Ethiopia is primarily based on agriculture, and 85 to 90% of its population is dependent on agriculture.

Ethiopia has a wide range of climatic zones and soil types, providing ecological conditions suited to the cultivation of many and various crops. Though cereals are the most important field crops in the country, oil crops and pulses are fast becoming of equal importance. In the country, oil crops supply the basic fat in the diet of the majority of the population. They also provide the feed stock for a number of agro-industrial products. In addition, oil crops have an important place in Ethiopia's export commodities.

The oil crops currently in production in the country are noug, rapeseed/mustard, linseed, sunflower, sesame, groundnut, safflower and castor bean. The four oil crops grown at high altitudes in Ethiopia, which are considered to be highland oil crops (cool season crops), are noug *(Guizotia) abyssinica)*, linseed *(Linum usitatissimum)*, the brassicas including true rapeseed *(Brassica napus)* and Ethiopian mustard *(Brassica carinata)* and sunflower *(Helianthus annuus)*. Noug and linseed together occupy 70% of the total land area under oil crops.

The production of oilseed still depends to a very large extent on both human and animal power. These crops are generally sown (boradcasted) by hand and grown on a minimum tillage basis. Fertilizer and insecticide are seldom used. The farmers seldom weed their oil crops. As a result yields are low. More recent seed yield estimates show 300-500 kg/ha for noug, 200-400 kg/ha for linseed and 400-500 kg/ha for mustard.

There is a serious shortage of edible oil in the country with annual availability averaging only 1.03 liters per person. The existing oil mills operate well below capacity. It is hoped that

[1]Project Leader, Highland Oil Crops Improvement Project, IAR P.O.Box 2003, Addis Ababa, Ethiopia.

the recent research and extension approaches and the government effort to increase production will improve the situation.

Review of Research

The overall objective of the Highland Oil Crops Improvement Project is to develop high yielding stable cultivars with the necessary package of practices required for sustained high yields. There is also a growing interest to improve the quality of mustard and linseed with regard to nutrition, which is receiving some attention.

The research programs fall into three sections:

(a) The improvement of the two indigenous oil crops (noug and linseed), having available a wide range of variability and wealth of unutilized indigenous germplasm.

(b) The improvement and popularization of the *Brassica* oilseed crops, of which there is also a wide range of indigenous germplasm.

(c) The improvement and popularization of the introduced sunflower crop, of which there is probably no indigenous germplasm.

Organized research on highland oil crops started about ten years ago. Within this short period of time, some promising varieties with fairly wide adaptation and high oil content have been identified. The cultural practices were studied, and certain species (best adapted) and the optimum package for some locations established. The early research work and survey have also helped to define the problems and priorities to some extent. The problems have been identified in line with production constraints at the farmers' level; problems related to the characteristics of the oil crops; and problems at the research level:

Production constraints at the farmers' level

1. Oil crops are usually grown on marginal soils;
2. farmers seldom weed their oil crops;
3. land for oil crops is ploughed once or twice compared to three or four times for cereals;
4. farmers don't use improved varieties;
5. farmers use traditional and less productive methods of technology; and
6. poor market prices.

The characteristics of the oil crops

1. Noug

- Uneven ripening and seed shattering;
- application of fertilizer or improved management practices generally produced increased vegetative growth and lodging (this makes it difficult to adapt this crop to improved technology);
- low yielding ability (efforts to select improved varieties are difficult because of compulsory outcrossing mechanism);
- high percentage of flower sterility; and
- frost sensitivity.

2. Linseed

- Damage from diseases (wilt, pasmo, powdery mildew);
- inefficiency in water use in low rainfall areas;
- susceptibility to lodging;
- high sensitivity to frost;
- inability to respond to artificial fertilizer;
- poor competitive ability with weeds; and
- low seed yielding ability.

3. Rapeseed/Mustard

- Disease, birds and insects are draw backs to *Brassica* production;
- oil quality problem (both erucic acid and glucosinolate contents are high in *Brassica carinata*);
- shattering (rapeseed shatters more easily than mustard);
- sensitivity to waterlogging.

4. Sunflower

- Lack of insects for pollination (in some locations);
- often attacked by birds, specially when grown in small scale farms;
- damage from disease and insect pests at several sites; and
- sensitivity to waterlogging.

Problems at research level

- Lack of trained manpower; and
- Unavailability of research sites in some of the major production areas.

To solve these problems, the Highland Oil Crops Improvement Research Team was formed in 1979. The team members represent different disciplines (Breeding/Agronomy, Pathology, Entomology, Weed Science, Soil Fertility and Food Science). The research program developed and executed by the team includes:

1. Breeding/Selection

   (a) Characterization and evaluation of local and introduced materials;

   (b) hybridization and selection;

   (c) observations and Micro Trials;

   (d) high yielding varieties' evaluation in multi-location variety trials; and

   (e) variety purification, seed increase and maintenance.

2. Cultural Practice

   Agronomy/Soil Fertility trials on noug, linseed, *Brassica* and sunflower to determine the optimal packages for each oil crop, which can be utilized by farmers.

3. Crop Protection

   (a) Entomology - Survey, collection and identification of insect pests of highland oil crops.

   (b) Plant Pathology - General survey, collection and identification of diseases on highland oil crops; crop loss assessment trial due to diseases; screening for disease resistance in disease infested areas (linseed and sunflower).

   (c) Weed Science - Crop loss assessment trials due to weed competition and chemical weed control studies for linseed and sunflower.

A brief account of the results obtained on crop basis follows:

Linseed

Linseed has been a crop in Ethiopia for many centuries. In fact, Ethiopia is considered to be center of diversity for this crop.

The linseed landraces in the country are generally very short and very highly branched and used mainly for oil and as a wat prepared from crushed seed. The crop is grown above 1800 meters and performs best between 2300 and 2800 meters.

Victory is the presently recommended variety. CI 1525, CI 1650 and CI 1652 with high yielding and good disease resistance will soon be available to growers.

In general, maximum seed yields of linseed are lower than those of other oil crops such as sunflower and oilseed Brassicas. However, yields of 20q/ha have been achieved under experimental conditions at several sites (e.g.Holetta).

At several sites, the best time of planting, seeding rate and fertilizer levels for linseed have been identified through the cultural practice trials. In general, fertilizer increased seed yields only in waterlogged areas. The lack of fertilizer response in linseed in relatively fertile areas produced the recommendation that no fertilizer need be applied to linseed in those areas. Two years' results from Holetta indicate that exotic lines were less responsive to fertilizer than the locals. Higher rates of fertilizer have been observed to cause lodging in Ethiopia. Linseed has been found to be an excellent precursor for wheat, barley and tef.

Weeds - Data from three years' loss assessment study at two locations confirmed that the critical time of competition between the crop and weeds is during its early growth. At Holetta, the reduction in linseed seed yield due to weed competition was found to be as high as 81.4%. An early weeding two weeks after planting followed by a mid-season weeding is the minimum number of weedings recommended. Linuron at 1.5 and metabromuron (patoran) at 2.0kg a.i./ha showed greater selectivity in linseed and gave good yields and excellent control.

Diseases - Diseases in Ethiopia may be serious where linseed is grown in high rainfall areas or where soil is poorly drained. The main diseases are pasmo (*Septoria linicola*)wilt (*Fusarium Oxysporum* and seedling blight (*Rhizoctonia sp.*). At Holetta, linseed introductions, local collections and crosses are being screened in wilt infested soil for wilt resistance.

<u>Insect Pests</u> - From survey data of two years and earlier reports gathered, it has been established that the African Bollworm (*Heliothis armigera*) is a serious pest of linseed in many areas of Ethiopia.

<u>Noug</u>

Noug is an oil crop which originated in Ethiopia. It is the most important oil crop in the country. Approximately 50% of total vegetable oil production is from noug. Generally, noug is grown at wider range of altitude than are other oil crops. It can be grown from 1400 meters to 2600 meters, and it is better adapted to water logged conditions, low fertility and competition with weeds. Most noug is used for oil extraction, either in the home or in oil mills.

There is a large diversity of types of noug growing in different areas of Ethiopia. Efforts to select improved varieties are difficult because of the compulsory out-crossing mechanism in noug. Hence, little improvement work has been done on this indigenous material so far. There is one recommended variety called Sendafa which belongs to the longer maturing group. At present, a good breeding program is being carried out by the Holetta group and improved varieties are expected for release in the near future.

The cultural practices trials investigated planting date, seeding rate, harvesting stage and fertilizer level. Seed yield was generally influenced more by harvesting stage and planting date than by the other factors such as plant population. Early sowing towards the end of June or early July is important for yield on reasonably well drained soil. In waterlogged soils, planting can be delayed until end of August. The noug harvesting stage study found that harvesting a week to three weeks after petal drop produced the most seed yield. Application of fertilizer or "improved" field management practices generally produce increased vegetative growth and lodging but only a slight increase in seed yield. This makes it difficult to adapt this crop to improved technology. Noug is well known to be a good precursor for other crops.

Weeds - Noug is known to be an excellent competitor with weeds. The crop is important as a pioneer plant and weed killer in the crop sequence, especially at lower altitudes where it covers the soil quickly and grows up to two meters high. During early stage of growth, noug should receive at least one weeding. This crop may produce a substance that is toxic to other plants and prevent their germination and growth.

Diseases - Economic loss in noug due to disease does not usually occur. The most prevalent diseases are shot hole (*Septoria spp.*), powdery mildew (*Sphaerotheca spp.*) and stem and leaf blight.

Insect Pests - A survey of pests of highland oil crops indicated that the African Bollworm (*Heliothis armigera*) is the most serious pest on noug.

Rapeseed/Mustard

The *Brassica* production comes almost entirely from *Brassica carinata* known as Ethiopian mustard or gomenzer. *Brassica carinata* originated in Ethiopia from the natural crossing of *Brassica nigra* (Senafitch) and *Brassica oleracea* (tikil gomen). The species is widely grown only in Ethiopia by small farmers in more fertile, well drained area often close to their houses. *Brassica napus* and *Brassica campestris* were introduced into Ethiopia about 10 years ago on an experimental basis from Northern Europe and Canada. The Ethiopian mustard is grown at medium to high altitudes between 1600 and 2600 meters and used for many purposes. The uses reported by farmers were as follows: For greasing the metad before injera is baked; the leaves are boiled as a stew (gomen wat); the seeds crushed and oil extracted by stirring; seed is used as a component in spices; to make soup; and to soften leather.

Evaluation of the Ethiopian landraces has led to the release of five *Brassica carinata* varieties, named S-67, S-71, S-115, Awassa population and Dodolla-1. Target is the only released *B. napus* variety in the country. At present time, there are no released varieties of *B. campestris*. New *B. napus* varieties with low erucic acid and glucosinolate levels are being tested. A breeding program is expected to produce mustard varieties with low erucic acid and glucosinolate in a few years.

A number of cultural practices trials were carried out at cooperating stations. The factors studied were different brassica species, planting date, seeding rate and fertilizer level. Seed yield was generally influenced more by the date of planting and by NP fertilization than by differences in plant population. High yields were usually obtained from early planting. Fertilizer produced tremendous increase in seed yield at several locations. Without fertilizer, mustard (*B. carinata*) seed yields were higher than those of rapeseed (*B. napus*). At Holetta, cropping sequence studies showed that wheat or barley following rapeseed produced good grain yields.

Weeds - In the early stages of growth, rapeseed is not a good competitor with weeds. The crop should have an early weeding at about 15 days after emergence followed by mid season weeding. Although several different herbicides are used to control specific weed species in other rapeseed growing areas of the world, no herbicide is recommended in Ethiopia for the oilseed *Brassica*.

Diseases - The importance of disease in rapeseed and mustard depends on the species and on the environment during growth. In general, Ethiopian mustard is more resistant and turnip rape is more susceptible. *Alternaria brassicae*, which produces pod and leaf spot, is the most serious disease of oilseed *Brassica* in Ethiopia. Stagheads produced by downy mildew (*Peronospora parasitica*) and white rust (*Albugo candida*) are minor problems.

Insect Pests - The serious insect pests of oilseed in many growing areas of Ethiopia are cabbage aphid (*Brevicoryne brassicae*), diamond-back moth (*Plutella xylostella*), cabbage white *Pieris brassicoides* and plusia worms *Chrysodeixis acuta*.
Most pests have been controlled by cultural means and by using insecticides such as carbaryl, malathion and endosulfan against caterpillars and beetles and dimethoate, formothion and endosulfan against aphids.

Sunflower

Most sunflower varieties presently under test were recently introduced into Ethiopia. However, there are reports of sunflower being introduced and grown in Northern Ethiopia 140 years ago. The crop seems to be adapted in Ethiopia from below 1500 meters to over 2500 meters. Fairly large tracts of sunflower have been grown in recent years in three Administrative Regions. The crop is used for oil extraction.

The only variety under production at the present time is a long maturing, tall type called Russian Black. The variety often runs out of moisture or is damaged by frost before it can mature. Hesa and Pop 158 are the other two released sunflower varieties. Shorter, early maturing and high yielding varieties are badly needed.

The results of several planting date experiments with sunflower in Ethiopia have shown that late maturing varieties should be planted early, depending on the onset of the rains, to achieve a higher yield. The plant density study at a number of locations found that seed yields were generally highest at populations ranging from 44 to 53 thousand plants per hectare. Except in very defficient soils, response to added nutrient was not large.

Weeds - A crop loss assessment trial at Awassa found that an early (2-4 weeks after emergence) and mid-season weeding produced the highest yield. At the same location, Russian Black produced the highest yield with the herbicide Igran at 2.5 kg ai/ha. The most prevalent weed in this weed control trial was *Nicandra physolodes*.

Diseases - A survey of diseases of highland oil crops indicated that rust, sclerotinia wilt, leaf blight, downy mildew, alternaria and verticillium wilt were principal sunflower diseases. Crop rotation and resistant varieties are the primary control measures.

Insect Pests - Insect pests that damage sunflower in some locations include wireworm, cutworm beetles, African Bollworm, weevils, cabbage sawfly, flea beetle. Chemical control is usually recommended.

Direction of Future Research

In the past, the Highland Oil Crops Team Members in collaboration with the Plant Genetic Resource Center, have made collections of linseed, noug, mustard and sunflower. Of the 2190 highland oil crops germplasm collected locally, 924 are linseed, 650 noug, 605 Brassica and 11 sunflower. The collection and characterization of germplasm will be strengthened.

All in all, the team has 71 research projects for this season out of which 39 are on breeding, 12 on agronomy and soils, 17 on crop protection and 3 on food science. The breeding, agronomy and other activities will be continued in certain local and introduced stocks of highland oil crops. The breeding approaches are mass selection and half sib recurrent selection in noug; backcrossing in oilseed Brassica; single plant selection and pedigree method in linseed. Mass selection is also being carried out on established and newly introduced sunflower populations. A modified (rapid) method of selection has been initiated to develop narrow and broad based sunflower synthetics.

The breeding/agronomy section was able to obtain financial and material support from IDRC to promote highland oil crops' research in Ethiopia. Since crop improvement involves more than plant breeding, the project fund will be used by the other disciplines such as weed science, plant pathology, entomology, soil science and food science.

Oil crops' research in Ethiopia, even though young, has shown that considerable improvements are possible. At present, there are two main stations, 16 testing sites, and 19 extension sites actively engaged in highland oil crops research. So far some improved highland oil crops varieties have been identified. The research work has also identified some improved cultural practices for the improved varieties. Hence, we believe that Ethiopia has the research tools needed to narrow the gap between the potential and existing level of oil crops production. The main objective of the research program in the next phase would then be to provide the extension service with a package of recommendations that will increase the national average yield For that, the professional competence of the extension staff will be upgraded through seminars and training and the improved package will be demonstrated to the farmers on their fields.

Sunflower Research and Production in Ethiopia

Solomon Eshete[1]

Ethiopia has certain indigenous crops like mustard, niger (noug), linseed, and sesame. But due to low oil content and low yield per hectare of these crops, the edible oil demand of the country is not satisfied. Therefore, the introduction of a crop with good potential for oil production is required.

At present, a variety known as "Russian Black" is under production in several areas of the country, mainly on large scale farms. Even though it is not widely produced under the peasant farming system, the farmers in sunflower growing regions of the south and southeastern part of the country are using the stalks of sunflower as a source of firewood as well as oil. The yields of Russian Black vary from region to region depending on the management and agroclimatic conditions. In Awassa State Farm, the yield ranges from 10-15 q/ha; in Herero State Farm (southeast), 8-10 q/ha; and at Birr (northwest) 15-20 q/ha. The price per quintal (100kg) is 48 Eth. Birr (about US$23) at Awassa oil mills. The amount of land covered with sunflower in Ethiopia ranges from 2000 to 5000 ha.

The research program in sunflower was started at Bako and Awassa Research stations during 1965/66. Researchers in both stations have made studies using available varieties and found Russian Black to be outstanding. Trials of crop rotations, plant populations, and so on were initiated. However, due to resource limitations, the research activity on sunflower discontinued for more than five years. Since 1979, a team approach was started to alleviate the production problems and increase yield. The sunflower research team is composed of the following disciplines:

1. Breeding and agronomy
2. Pathology
3. Weed Science
4. Soil fertility
5. Entomology

The breeding program in sunflower is not yet at full strength. However, trials in screening varieties that are adapted

[1] Sunflower Coordinator, Awassa Research Station, Institute of Agricultural Research, Box 6, Awassa, Ethiopia.

to different agroclimatic conditions are expanding, covering almost ten administrative regions. In this regard, promising varieties which are superior to Russian Black are coming into the picture. In addition, a mass-selection program to improve varieties under production is made to increase the yield and maintain their uniformity.

The most important diseases of sunflower in Ethiopia include:

1. Downy mildew *(Plasmopara halstedii)*
2. Stem and head rot *(Sclerotinia sclerotiorum)*
3. Rust *(Puccinia helianthi)*
4. Alternaria *(Alternaria helianthi)*
5. Leaf blight *(Fusarium equiseti)* corda.

The relative importance of sunflower diseases varies annually with biological, climatic conditions and the farm management practices. So far the research work has concentrated on the survey of economic importance of diseases. Recent research work on control measures is mainly concentrated on screening for resistance, cultural control, and loss assessment studies.

Surveys on the weed flora of sunflower-growing areas were made for the past two years, some weeds identified and included in the weed herbarium. The most important weeds in the southern regions were identified as: *Nicandra physolodes*, *Cyprus spp.*, *Commelina benghalensis*, *Galinsoga parviflora* and *Guizotia scabra*. In the southeastern part of sunflower-growing areas *Galinsoga parviflora*, *Guizotia scabra*, *Tagatas minuta*, *Chenopodium spp.*, *Cyprus spp.* and *Amaranthus* hybrids are the dominating weeds. In addition, noxious parasitic weeds (broom rape, *Orobanchi spp.)* have been observed at a few locations.

In trials on loss assessment early and mid-season weedings proved to be the best. Chemical control trails on sunflower are in progress at Awassa Research Station.

Trials on nitrogen and phosphorus (rates of application and time/method of nitrogen application) have been conducted in the south and southeastern sunflower-growing regions of the country. Results indicate that there was not significant nitrogenous fertilizer application.

A survey on sunflower arthropod pests was made in sunflower-growing areas of the country. A sizable number of pests have been collected and identified. In the future, the survey will cover the remaining sunflower-growing regions of the country.

Birds are drawbacks to sunflower production especially in small-scale farms.

A total of 260 sunflower (*Helianthus annuus L.*) varieties has been introduced to Ethiopia. The main sources of these materials were USA, USSR, Canada, Yugoslavia, West Germany and Hungary. In addition, a germ plasm collection in the northern province was made, and a total of 11 varieties was collected during the 1982/83 crop season. These varieties are now in the preliminary observation nurseries.

Summary

Sunflower (*Helianthus annuus L.*) is a new crop in Ethiopia. However, it was introduced to the northern part of the country approximately 140 years ago as an ornamental crop.

The research on sunflower has been carried on at Bako Research Station in Western Ethiopia and at Awassa Research Station in the South. At present, one oilseed variety known as Russian Black is extensively cultivated in large state farms. But the importance of sunflower is not yet known by the Ethiopian peasant farmer. The main production constraints in sunflower are diseases like downy mildew, stem and head rot and rust as well as bird damage.

At present, the research activity is expanding throughout the country covering almost ten Administrative Regions with technical and financial support from the International Development Research Centre (IDRC). The research activities include assessment of potential sunflower-growing areas, adaptability tests, screening of varieties against diseases and pests, and breeding work.

Groundnut and Sesame in Ethiopia - History, Research, and Improvement Prospects

Yebio Wolde Mariam[1]

Groundnut

Groundnut is a relatively new crop to Ethiopia. It is found growing extensively in only two Administrative Regions of the country, namely Eritrea and Hararghe. It is mainly a peasant crop cultivated for the purpose of securing cash to cover basic household needs. In Hararghe, nearly 50% of the area occupied by groundnut is intercropped with sorghum and/or beans. But in Eritrea, it is grown mostly as a sole crop. Available evidence indicates that the crop was introduced to Eritrea before the advent of Italian concessioners in the Gash plain of Western Eritrea. The first introduction was presumably made from Sudan. Wide-scale groundnut cultivation in Eritrea, however, started in mid 1920 with the completion of Tesenei-Alighider irrigation scheme near the border of the republic of Sudan (Personal communication from A. Nastazi, 1983).

The initial plan of the Italians was to make their first acquired overseas colony self sufficient in cooking oil. This was envisaged to be accomplished through the expansion of the irrigation scheme in the Gash basin. The idea was found to be somewhat impractical and the plan was abandoned in favour of peasant cultivation. Thus, farmers were encouraged to grow groundnut for internal consumption, and gradually the crop along with sorghum attained importance in the western part of the region. The expansion of groundnut cultivation in Eritrea's western part, however, did get an impetus during the brief occupation of the province by the British who had ample experience with groundnut production in Sudan and elsewhere in their West African colonies.

In Hararghe Administrative Region, where an estimated 14,000 ha is under groundnut cultivation, the crop first appeared during the brief occupation of Ethiopia by the Italians in 1935-40. The first Italian groundnut venture started where an experimental sub-station is located. No documented evidence is available to indicate the experimental work preceding large scale production. But the establishment of an oil extracting plant at Harar city in the late 1930s shows that the venture was indeed profitable.

Peasant cultivation of groundnut in the region did not start before the evacuation of the Italians in 1940. Since then, the crop occupies major importance among the crops in the region and is a source of cash to cover basic needs of the farmers. In 1975/76 alone, a total of 114,000 quintals of unshelled nuts were produced in the region (1).

[1]Team Leader, Lowland Oil Crops Improvement Team, Melka Werer Research Station, Box 2003, Addis Ababa, Ethiopia.

Groundnut production in Ethiopia is totally done by man and animal power from land preparation to harvest. The planting method adopted by most farmers in Ethiopia is very interesting to observe. After the oxen-driven wooden plow opens the furrow, children throw seeds in the furrows at irregular spacing intervals. The exposed seeds in the furrows are then covered by another furrow parallel to the old one, made during the next turn of the plowing operation. The seeds maintain their position on the ridge that is not quite straight but good enough to allow interrow cultivation at a later stage. Besides interrow cultivation using oxen-pulled wooden plow farmers in Ethiopia put earth around groundnut plants at least once during the early stage of flowering, thus facilitating the pegs to penetrate deep into the soil and develop into good pods.

Up to the present, no improved cultivar has been supplied to the peasant. Instead local cultivars of exotic origin introduced nearly half a century ago are widely cultivated by them. Farmers in the Hararghe Administrative Region often prefer the spreading type cultivar, Sartu, which they claim is high yielding and conserves moisture. Some, though,opt for the semi-erect variety, Jumbo, which allows with less difficulty, the performance of farm operations such as weeding and hoeing. This cultivar is also very convenient to use as a companion crop with cereals. The average yield obtained using these varieties is less than 10q/ha.

Many areas in the country are found to be potentially good for raising groundnuts. The limitation of groundnut expansion as a suitable cash crop to the peasant, therefore, lies partly in research and greatly in extension work. Adaptation trials conducted during the past few years indicated that at least 5 more Administrative Regions are suitable for growing groundnut.

Past and Current Research Status

Research work on groundnut was initiated by the Institute of Agriculture Research (IAR) at Melka Were Research Station in the early 1970s with a few introductions from the USA. Soon after, more introductions were made from the USA and West Africa and tested at several locations to determine their adaptability to specific regions of the country. The adaptability test continued in areas of mid and low altitudes, high and marginal rainfall and irrigated basins for a number of years.

Through years of continuous experimentation, Shulamith, a large seeded cultivar, out-yielded most varieties tested across locations and has been released to state farms for production. The average yield of this variety under irrigated condition is between 60-70 q/ha and yield is about half as much in marginal rainfall areas. Since Shulamith is highly susceptible to leaf spots (*Cercospora arachidicola* and *Cerosporidium personatum*), it is less favoured by users. It is also susceptible to rust (*Puccinia arachidis*)a disease of considerable importance in Ethiopia.

Other promising varieties but more susceptible to groundnut diseases are NC2, Florirunner, and MC4X. The variety PI250680, although low yielding is moderately resistant to rust and leaf spot diseases. The average yield of this cultivar under experimental condition for rainfed area is 20q/ha and double that in irrigated areas.

Efforts to screen varieties resistant to diseases have been continuing in three separate locations of the country. So far, a few cultivars were found to be moderately resistant to attack by either *Cercospora* or leaf rust -- the two increasingly becoming the major factors limiting groundnut production in Ethiopia.

Experiments assessing losses caused by *Cercospora* were conducted for two consecutive seasons. These studies of leaf spot on three rainfed groundnut cultivars showed that the mean yield loss due to the disease was 62.3% in 1981/82 and 67.8% in 1982/83. The mean yield increase due to fungicides' application on three varieties namely Florirunner, Bamby and NC5 was 179%, 137%, and 182% respectively. Among the fungicides used, Benlate most effectively controlled the leaf spot disease (2).

At present, groundnut research activities in Ethiopia are slightly hampered by the introduction of an internal quarantine imposed in 1979/80 to prevent the spread of rust disease through out the country. Thus the movement of groundnut material from one locality to the other is prohibited unless thoroughly checked. for at least one season in one of the quarantine stations of IAR.

Through the cooperation of ICRISAT, over 200 breeding and germplasm materials, now partially released from quarantine observation are under study at three locations representing different agroecologic conditions. Of the materials under test, some are believed to resist rust and other groundnut diseases such as *Cercospora*. These lines are in the International Groundnut Foliar Disease Nursery. It is expected that cultivars with good combining ability i.e. potentially high yielding and disease resistant will be obtained for further study in yield trials. Breeding materials of high yielding potential received from ICRISAT at F_2 have now, through selection, reached F_5 stage. The selection method used is by bulking. This technique will continue until a fairly uniform population is achieved; thereafter the pedigree selection will be employed.

At the moment, experiments on groundnut are limited to a few locations namely Bisidimo/Babile, Arba Minch and Melka Werer. At all these locations, the National Yield Trial and Pre-National Yield Trial are conducted. After another year, varieties suitable to each region may be released for use by farmers and state farms. At Babile and Bisidimo, groundnut variety screening against diseases and chemical spray to control rust are in progress.

Alongside experimental work, a periodic survey is conducted on peasant fields to obtain basic socio-economic information and to understand the difficulties encountered by the farmers, such as pest and disease attack type of weed flora etc.

Sesame

Sesame is found growing in many regions of Ethiopia, notably the North Central and the East, either as a mixed or sole crop. It is also grown in the low lying lands of Western Ethiopia, adjacent to the Republic of Sudan. Until recently, the importance of the crop was limited for domestic use only, but increased world demand for the crop accelerated production at a fast rate. Ethiopia's export in late 1950s accounted for 9% of the world total. At this early period export amounted to 100,000 quintals of sesame seed.

The continuous and impressive increase in total world sesame demand during the 1960s triggered an increase of production in Ethiopia at the same time. In 1968-70 alone the three major sesame importing countries (Italy, Japan and the United States) obtained a little over a million quintals of sesame seed from the world market. The total export from Ethiopia to these countries at that period was 325,000 quintals, an increase of export by 220% from the previous decade (3).

In 1965-66, the total area under sesame cultivation was estimated to be 80,000 ha. By 1974 the acreage under sesame cultivation reached 160,000 ha. The sudden jump of production hectarage can be largely attributed to the steady increase of world price for sesame and modest government incentive for large and middle level farmers in the northwestern region of the country. Indeed the period covering 1965-75 can be equated to the California gold rush of 1800 in the USA where prospective farmers flocked to Setit Humera to own farms. Furthermore, the average national yield has been constantly on the increase from 3.9 q/ha in 1966 to 5.8 q/ha in 1974 (4).

Such trend of production increase was short lived. With the proclamation of land nationalization and deterioration of security in the area beginning 1975, production growth slumped and annually cropped lands shrunk by almost half. The state agencies entrusted to operate the farms in a centrally administered fashion ran into serious labour shortages during weeding and harvesting time. As a whole, the country lost the market it had earlier dominated. In 1975, Japan alone imported 330,000 quintals of sesame seed from Ethiopia. Two years later the export to Japan went down to 52,620 quintals only. By 1979 export to Japan further dwindled to 2,740 quintals of sesame seed (5).

Simultaneously, with the decline of export production, area was reduced to below the 1960 level. By the year 1978, the area under sesame cultivation was estimated to be 77,000 ha (4). At the present time, official figures indicate that the area under cultivation in the state run Setit Humera farm is less than 5000 ha.

Production Constraints

The major problems facing sesame producers in Ethiopia can be categorized into two. The first problem is that small farmers use uncertified low yielding varieties; crops suffer from diseases, pests and heavy infestation of weeds. Secondly the large scale state farms lack proper management, aggravated by shortage of labour at harvest. Since all varieties under cultivation at present shatter during maturity, mechanical harvesting is out of the question; thus an estimated 20-30% of seed is lost during stooking and manual threshing.

Generally speaking, though, the major production constraints involved in the sesame producing regions of Ethiopia are more or less common to most developing countries of the world. However, each country may have specific ones that require special attention to alleviate existing problems and accelerate production to a profitable degree.

As far as my country is concerned, there are a number of major obstacles to production increase:

1. Lack of strong supporting research programs.
2. The weak linkage that exists between research and extension.
3. Government marketing policy and lack of price incentive for the producers.
4. The attitude of the peasant who views the crop as marginal.
5. Chronic labour shortage and unenthusiastic labour force at the time of weeding and harvesting.
6. Lack of security in the major sesame-growing region of Setit Humera.

In Ethiopia, research work on sesame started as early as 1970 with major emphasis in agronomic trials. Up to the period 1980/81, 72 introduced varieties were tested at fewer than 10 different locations of the country in a variety trial. During this period, a few local collections were also made among which one outstanding variety, Kelafo, was deemed to be suitable for both irrigated and rainfed areas. In a few locations, namely Melka Werer Research Station and Setit Humera, sowing date, fertilizer and irrigation trials were also conducted.

As of 1980, however, the Institute of Agriculture Research (IAR) has devised a new approach to solve problems in the field of research by aggregating the highly diffused manpower into a team. The team approach not only saved badly needed funds for conducting research but also helped the systematic use of research personnel in the nation. At present, the Lowland Oilcrops Research Team is based at Melka Werer Research Station in the central eastern part of the Rift Valley. The station coordinates experimental work on sesame, groundnut, safflower and castor bean and dispatches planting materials and seeding instructions to regions with similar agro-ecologic conditions. The team carried out experiments in breeding/agronomy, pathology, entomology, weed science and soil science at various locations in the country. In addition, trials conceived and designed by the team are sent to various cooperating stations (i.e. outside IAR major testing sites) followed by an inspection tour by members of the team once or twice during the major cropping season of the year.

Currently, the effort of the team is geared toward collecting local germ plasm before it is irretrievably lost due to changes in land use, famine and war. So far with the collaboration of Plant Genetic Resource Center/Ethiopia (PGRC/E), 122 germ plasm have been collected from 6 administrative regions of the country. The altitude, from which the germ plasm was collected, ranges from 1000 to 1930 m above sea level. General characterization and preliminary evaluation of the local germ plasm have been completed. Selection on some of the outstanding lines is done and these are advanced into pre-national yield trial. More selections for uniformity of growth, less tendency to shatter, good number and size of capsules as well as disease resistance will continue. Exotic varieties with shattering and non shattering characteristics are also under study at Melka Werer Research Station. Promising varieties will be screened further and sent for location test. Breeding or germ plasm materials for screening pass through a number of years of rigorous observations before being ready for release.

The steps followed are:

National Yield Trial (as many sites as possible)

Pre-National Yield Trial (4-5 sites)

Advanced Observation Nursery (2-3 sites)

Preliminary Observation Nursery (1 site)

At present the team conducts sesame variety trials on the national level at different locations covering the major agro-ecologic zone of the country. The time required for varieties to be released depends on the materials under test and the condition under which the entire experimental exercise carried out. Thus, a minimum of 4 to 7 years is needed before an outstanding variety is released for users.

During the past three years of experimentation, four outstanding varieties have been identified, and one is actually distributed to the sesame specializing farming enterprise of Setit Humera

The average yield of the outstanding varieties across locations and under rainfed condition is 8q/ha. The same varieties under irrigated condition give as much as 16q/ha. The varieties T-85 and Kelafo gave a mean yield of 21q/ha for two consecutive seasons in the irrigated valley of Tendaho with an elevation of 350m above sea level. Two varieties of East African origin, that is S and E, besides being potentially high yielding are found to be moderately tolerant to bacterial blight *Pseudomonas sesami)*. Most of the local cultivars are of bushy type with moderate yielding capacity but are less susceptible to bacterial blight disease and web worm *(Antigastra catalaunalis)* attack.

At present, the breeding program is concentrating on achieving non-shattering and disease resistant lines, by crossing lines obtained from the USA and Sudan with those of Ethiopian origin or adaptation. The intention is to incorporate the desirable characters of T-85, Kelafo and E, which are high yielding and moderately resistant to bacterial blight, with the non-shattering characters of the exotic ones.

The long term objective of the team is to screen or breed varieties suitable for the different agro-ecologic zones, in particular the drought stricken areas of Ethiopia. Unfortunately, most if not all of the sesame produced in the country comes from the northern part of Ethiopia where drought conditions have threatened the lives of millions of people since the early part of the last decade. If varieties requiring less than 300mm of rain could be screened or bred, it would be ideal for such marginal and low rainfall areas of the country. The local germ plasm widely adopted by farmers, although relatively resistant to bacterial blight disease, are of long duration. Therefore, short maturing varieties to catch the early rains of winter will be screened or exchanged with regional institutions having similar conditions to the arid conditions of northern Ethiopia.

In addition, varieties suitable as a companion crop with cereals, in particular with drought resistant sorghum, will be screened so as to intensify the beneficial use of land in a given area. Deep rooted, short and non branching varieties are considered ideal for this purpose.

1. Anon. Statistical Abstract 1977. Central Statistical Office, Addis Ababa.

2. Mesfin Tesera 1983. Loss assessment due to cercospora leaf spot on rainfed groundnut. Proceedings. National Crop Improvement Conference, Addis Ababa, 1983.

3. Schmaedick G.L. 1973. Sesame seed markets, old and new IAR and Ministry of Agriculture Planning and Programing Unit, Addis Ababa.

4. Anon.1977. Preliminary survey of research production and processing oilseeds in Ethiopia. EPID Publication No. 43.

5. Kobayashi, T. 1981. Sesame seed demand and supply in Japan. In sesame: Status and Development. FAO Plant Production and Protection Paper No. 29.

6. Khidir M.O. 1981. Major problems of sesame growing in East Africa and the Near East. In Sesame: Status and Development. FAO Plant Production and Protection Paper No. 29 p.36.

Discussion: Country Presentations, Ethiopia

The three papers were read as presented above, except that individual papers were read on Sesame and Groundnuts.

General

Several Oilcrops in Ethiopia were reported to be used for "wat". Wat is an Ethiopian word for a spicy stew into which the bread (or enjera) is dipped.

The fertilizer available in Ethiopia is urea and diammonium phosphate. Recommended fertilizer rates of N and P_2O_5 can be obtained by mixing the appropriate amounts of these two fertilizers.

The African bollworm (*Heliothis armigera*) is very similar to the American bollworm, but the two are in fact different species.

The team approach in agricultural research in Ethiopia insures a multidisciplinary approach. At the annual Preview and Review meetings, the program for each team is discussed and approved. A problem in the team approach is that some scientists must be members of several teams because of manpower shortage. This means that these scientists cannot give full attention to their research programs on a particular team.

There is a College of Agriculture providing B.Sc. and M.Sc. training and three junior colleges giving agriculture diploma training. At the present time, there are M.Sc. students working on studies with soybeans, linseed, and sunflower. No students are working on the lowland crops at the present time.

Rapeseed/Mustard

In Ethiopia, high erucic acid is not of concern, as the average consumption of edible oil per person is very low, and oil from several crops are mixed together and sold on the retail market, so that the erucic acid is diluted. At the present time, an early maturing Canadian variety called Target, has been released. This variety has high erucic acid content in the oil. Rapeseed *B. napus* varieties with low erucic acid and glucosinolate content are expected to be released soon. Varieties with low erucic acid and glucosinolate levels are sought with a view to possible export of oilseed or oilcake in the future.

Noug (Niger)

As this crop is very self-incompatible, breeding is by means of mass selection and recurrent selection.

The substance which is secreted by the roots of noug has a weed-killing effect, but it is not residual in the soil.

There are two major maturity groups in noug. Highland noug takes more than 150 days to mature, while lowland noug matures in 120-130 days.

Sunflower

It was stated that the program to make synthetics (or composites) from sunflower hybrids used hybrids of similar maturity and height to develop the synthetic population.

Groundnuts

There was some surprise expressed that a groundnut rust quarantine was still in effect in Ethiopia. Although groundnut rust is known to be a wind-borne disease, the pathologists in Ethiopia were still not convinced. They have not lifted the quarantine in spite of information that Uredospores on seeds lost their viability in less than 2 months.

The high yields from Shulamith were from irrigated fields, where disease incidence is very low.

Sesame

The released variety T-85 is capable of very high yields in Ethiopia. It was noted that a variety of the same name in India was not a very high yielder.

Yields of sesame on irrigated lands were more than double those on rainfed land. The number of capsuls per plant was the yield component that contributed most ot this increase.

In large state farms, shortage of labour at harvest is the main problem. Also the cost of transporting the labour to the state farms is very high. The potential of sesame is very high in parts of Ethiopia, but mechanization on these state farms is needed.

It was mentioned that a dark seeded wild, or related species of sesame had been found in Sudan, but its oil content had not been determined.

Groundnuts and Soybeans in Tanzania Research at Morogoro

Andrew L. Doto[1]

Tanzania is basically an agricultural country where nearly 90 percent of the population earn their living by working on the land. While agriculture is the mainstay of the country, production for a number of important food crops, including oil crops has in general been outstripped by demand. The diverse range of environmental conditions prevalent in Tanzania has meant that a wide range of crops (oil crops inclusive) can be grown. Crops grown in Tanzania primarily as source of vegetable oil include groundnuts *(Arachis hypogaea)*, sunflower, *(Helianthus annuus)*, Sesame *(Sesamum indicum)*, coconuts *(Cocos nucifera)*, soybeans *(Glycine max)* and oil palms; cotton and cashewnuts are primarily grown to cater for other needs but also are raw materials for the extraction of oil. In this presentation, further details are confined to groundnuts and soybeans.

Groundnut production in Tanzania was estimated to be about 29,331 metric tons for the year 1972 (Geddes and Loursey, 1976). The figure, however, may be an underestimation. It is generally believed that groundnut production in Tanzania stands at 50,000 metric tons. It is worth nothing that a significant portion of this tonnage is grown on small scale farms where intercropping (with cereals and cassava) is a common practice. Much of the crop is also consumed locally and therefore only a small part goes through the formal markets. Groundnuts are grown in practically every region in Tanzania, although a significant portion comes from Tabore, Matwara, Kigoma and Mtwara regions.

Soybeans on the other hand are not so widely grown in the country and are currently confined to Mtwara, Morogoro and Mbeya regions. The bulk of the crop also comes from small scale farmers. Recently, soybean is becoming attractive to large scale farms as a rotation crop or as a sole crop.

The importance of agricultural research to augment production in Tanzania had been recognized as early as the beginning of the twentieth century. Soybean for example was introduced in Tanzania in 1907 and as early as 1909 varietal testing was initiated. Later in 1955, a comprehensive soybean breeding program was started in the southern part of the country at Nachingwea (Auckland, 1970). The program was completed in 1963 culminating with the development of 3H/1, 7H/101, 1H/192 as outstanding soybean lines which were later tested and recommended.

[1]Breeder/Senior Lecturer, Department of Crop Science, Faculty of Agriculture, University of Dar es Salaam, sub PO Chuo Kikuu, Morogoro, Tanzania.

Similarly, locally documented research information is available (although limited) for other oil crops. Literature on cotton research in Tanzania is extensive and world famous, particularly that done at Ukiriguru and Ilonga research station.

While research work on oil crops started early in Tanzania, lack of continuity and lack of serious funding has been apparent, particularly when compared with grain legumes. In response to the urgent research needs related to oil crops, the Oilseeds and the Pulses and Groundnuts projects were launched. The Oilseeds and the Pulses and Groundnuts projects are funded by ODA of the British Government and IDRC (Canada) respectively.

The Oilseeds project based at Naliendele in Southern Tanzania is mainly concerned with the improvement of sesame, groundnuts, cashewnuts and sunflower. On the other hand, the Pulses and Groundnuts project, based at the Faculty of Agriculture, Forestry and Veterinary Science, Morogoro, also researches on groundnuts as well as soybean, greengrams and bambarra nuts (*Voandreia subterranea*). The last two are not categorised as oil crops.

The Pulses and Groundnuts Projects

The pulses and groundnut project became effective in May, 1980 with a number of spelt out objectives:

(a) To develop high yielding groundnut varieties with high oil and protein content;

(b) To develop early maturing and late maturing varieties of groundnuts to suit the various agro-ecological zones;

(c) To develop groundnut varieties which are resistant to drought, insects and diseases, especially groundnut rossette;

(d) To develop suitable agronomic packages for groundnuts which can be utilized by farmers;

(e) To participate in the cooperative national trial and identify high yielding varieties of soybean and green gram;

(f) To undertake germ plasm collection, screening and testing of bambarra groundnut; and

(g) To assist the Faculty of Agriculture, Forestry and Veterinary Science to train graduate students at the M.Sc. level.

In order to achieve the research objectives outlined above the work at Morogoro is handled as a single item, but for the purpose of description it could be divided into:

1. Germplasm and seed increase;

2. Screening and varietal development; and

3. Testing development, evaluation and package development.

During the planning and implementation phases of each of the three areas, teamwork approach has always been encouraged. The research team at Morogoro consists of breeders, crop physiologists and crop protection specialists.

In order to speed up the work, two generations of material are raised per year. However yield trials are planned to be conducted during the wet season so as to obtain results which are close to the situation prevailing on the farmers' field.

For both crops, considerable progress has been made in identifying/developing lines with enhanced yield potential as well as possessing other desirable features.

Work on groundnuts for example had by the end of 1982 shown that the runner types were more productive than the bunch types in grain weight per plant. Twelve accessions were identified as lines with promising potential (Table 1).

Table 1: Yield per plant (g) for groundnut: 12 lines at Morogoro in 1982.

Accesssion	Other Name	Plant Type*	Yield Per Plant (g)
MGC 13**	Makambako	R	26.0
MGC 19**	Ex-Njombe	R	22.1
MGC 6	Mbeya	R	20.2
MGC 53	Ileja (Ex-Ulambia)	R	19.6
MGC 52	Ex-chimala	R	19.1
MGC 18	Dixie Runner	R	19.2
MGC 122**	PHI 200 PI 314817	B	14.5
MGC 124	1/88	B	13.8
MGC 166	NC 343	B	13.8
MGC 167	Jabulaya	B	12.8
MGC 201	Torapota PI 350680	B	12.2
MGC 116	Tifspan	B	12.1

*R and B for runner and bunch types respectively.

** Resistant to **Cercospora**, rust and groundnut rossette virus.

Following these results, a variety trial involving 25 entries was carried out at Morogoro in 1983. The trial was laid out in randomized complete block design with 4 replicates. Although full analysis has not yet been done, the variety mean values for two characters are presented (Table 2). Yields were generally low, probably due to dry conditions during the flowering/pod filling stage and to high incidence of pops. Full analysis needs to be done for the other important characters before drawing further inferences. In this trial, six lines gave numerically higher yields than the control (Natal Common).

A preliminary yield trial involving 100 lines of groundnut was also carried out at Morogoro this year. However, data from this trial has not yet been processed. During the next two years, it is planned to test the promising lines of groundnuts at many locations in the country for yield and adaptation.

Work on soybean has progressed along similar lines, although the material from the soybean hybridization stream is in a more advanced stage than that for groundnuts (now in F_1 stage). Apart from developing soybean lines with high yield potential, early maturity and acceptable plant height, emphasis has also been towards evolving some highly promiscuous varieties. It is thought that such promiscuous lines would be able to effectively symbiose with native soil rhizobia, thus reducing the dependence on chemical N fertilizer.

This year some 18 entries were evaluated in a randomized complete block design with 4 replications at Morogoro. Results are as indicated in table 3 where the first 14 entries on the list are F_8 lines emerging from the Bossier x 1H192 cross. The cross had earlier been effected in order to develop promiscuous improved lines. Other work on soybeans is documented elsewhere (Ayiseni, 1982; Doto and Chowdhury, 1983; Doto 1983).

While these results are encouraging, the promising lines need further testing in the potential soybean areas before final recommendations are made. It is also interesting to note that among the introductions, Orba has given consistently high yields at Morogoro for the last three years. Thus apart from paying special attention to the promising advanced F_8 lines, Orba should also be included among the lines for extensive testing.

Table 2: Grain yield per plot (g per 3.3 m^2) and days to maturity for 25 groundnut accessions grown at Morogoro.

Accession	Other Name	Yield (g)	Days to Maturity
MGC 129	1/30	397.8*	87.0
MGC 96	Starr	368.3	87.0
MGC 201	Tarapoto PI 350680	325.3	88.0
MGC 28	NC 343	330.2	103.0
MGC 110	1/69	340.2	85.0
MGC 124	1/88	336.6	87.8
MGC 19	Ex-Njombe	252.4	105.5
MGC 18	Dixie Runner	301.5	106.0
MGC 53	Ileje (Ex-Ulambia)	258.9	106.0
MGC 52	Ex-chimala	276.7	106.5
MGC 6	Mbeya	359.4	105.0
MGC 13	Makambako	217.2	104.5
MGC 167	Jabulaya	298.6	87.3
MGC 10	Karanga Kubwa	159.0	105.5
MGC 88	Comet	352.3	87.0
MGC 8	Ex-chunya	298.8	106.5
MGC 213	Spanhoma	405.2*	88.0
MGC 121	Spancross	328.5	87.0
MGC 71	Virginia 72R	290.4	105.0
MGC 106	2/108	120.6	85.0
MGC 126	KH 149 A	255.6	91.0
MGC 64	Tamnut-74	434.4*	87.3
MGC 50	Mamboleo	341.0	87.3
MGC 184	Natal common check	342.3	87.0
MGC 81	1/94	327.4	87.3
$S\bar{x}$		54.23	0.29

*Top three accessions for yield.

Table 3: Mean grain yield (kg/ha), number of days to maturity and plant height (cm) for 18 soybean lines grown at Morogoro.

Line	Grain Yield	Days to Maturity	Plant Height
L5 R, P2	3033.2	87.5	44.6
L5 R, P2	2188.3	86.8	44.2
L1 R3 P2	5630.5*	86.8	48.0
L1 R3 P2	2784.5	85.5	42.3
L5 R3 P1	3510.1	87.3	48.3
L5 R3 P1	3757.1*	84.5	43.2
L5 R3 P1	3200.6	85.5	43.2
L13 R2 P3	2387.8	86.8	41.8
L5 R2 P3	3681.4*	87.5	47.0
L7 R2 P3	2826.3	86.0	46.8
L3 R3 P1	3224.2	85.8	45.2
Unknown	2995.5	84.8	40.6
L1 R3 P1	2727.3	86.8	40.1
L5 R1 P2	2442.3	86.5	44.3
Bossier	2870.3	88.0	28.9
1H/192	1639.6	114.0	81.5
Orba	3611.9	85.8	44.5
Hardee L.S.	2479.5	105.0	40.0
$S\bar{x}$	190.3	0.63	2.79

*Top three lines for grain yield.

According to the initial program schedule, the year 1983 should have seen multilocation trials for both groundnuts and soybeans. However, this has not been the case. Again, up until now research activities have been confined to varietal development. We are still committed to launch the multilocation trials (jointly with our sister team at the oilseeds project, Naliendele) at the onset of the rains in November this year. We also now think that the appropriate stage has come for serious work to develop suitable agronomic packages.

Acknowledgements

Although I have taken liberty to highlight some of the oil crops research activities at Morogoro, I should first register my sincere gratitude to the entire research team at Morogoro. I should in particular like to mention Dr. B. Ndunguru, Professor C.L. Keswani, Dr. Z. Maningu, Miss M. Quentin, Dr. A.Mphuru and Professor M.S. Chowdhury for the significant role they have so far made in this joint venture.

The work reported would not have been possible without the cooperation and devotion of the field staff, to them I am thankful.

The author and the research team are deeply indebted to IDRC for the generous financial support received.

References

1. Auckland, A.K. (1970). Soybean Improvement in East Africa. In Leaky C.L.A. (ed.). Crop Improvement in East Africa. Commonwealth Agricultural Bureaux, England pp. 131-155.

2. Ayiseni A.R. (1982). Yield Component Interrelations and Heritability estimates in soybean (Glycine max (L) Merrill). M.Sc. Thesis, University of Dar-es-Salaam.

3. Doto, A.L. (1983) Search for improved variety in Tanzania. Paper to be presented at the First International Symposium on Soybean in Tropical and subtropical cropping systems. September 26 - October 1, 1983. Tsukuba, Japan.

4. Doto, A.L. and Chowdhury, M.S. (1983). Breeding soybeans to Exploit Native Rhizobia. Paper presented at the 5th International Symposium on Nitrogen Fixation, August 28 - September 3, 1983, Netherlands.

Discussion: Country Presentation - Tanzania

Groundnuts

Although runner types of groundnuts yield more per plant, it was stressed that this was not necessarily true on a yield per unit area basis.

It may be misleading to include both runner types and bunch types in a trial using the same plant population. Bunch types should be planted at a higher plant population than are runner types.

There was some doubt that combined resistance to three diseases i.e. leaf spots, rust and rosette could be found so readily in one line. The reply was that there could be some escapes, but lower disease prevalence had been found at Morogoro, to all 3 diseases in the 3 lines mentioned in Table 1.

Further multilocation testing has been hampered by the lack of continuity of staff at many of the agricultural research stations.

The most convenient marker for physiological maturity in groundnuts is the darkening of veins on the inner surface of the shells; however, there are other ways of determining maturity which are more laborious.

Soybeans

Both introduced and local types of soybeans were tested in the Project.

Hybridization of soybeans is carried out by emasculating in the evening and pollinating the following morning, or by pollinating immediately after emasculating. The former method is preferred, but success rate is low.

The most convenient indicator of maturity in soybean is the change of colour of the leaves and start of defoliation.

Groundnut Improvement Through Problem Oriented Research

A.D. Malithano and K.V. Ramanaiah[1]

Summary

Groundnut *(Arachis hypogaea L.)* is one of the most relished and most extensively grown grain legumes in Mozambique. Two distinct types of groundnuts may be identified: the long-season spreading types grown in the north and the short-season erect types adapted to the south of the country, respectively. The crop is almost exclusively grown by small farmers at a subsistence level either in a pure stand or intercropped with other staples on small plots of land. Yields are very low due to the traditional system of farming and unimproved crop husbandry. In recent years, production has declined due to lack of seed and adverse weather conditions.

Research has focused on improving the cultural practices aimed at reducing the major yield-reducing factors through timely sowing, plant density, fertilizer application, control of pests and diseases. Major advances have been made in selecting, from local landraces, promising pure lines and bulks which are evaluated together with exotic varieties. Promising research results have been obtained and superior varieties have been recommended for commercial production. The transfer of appropriate technology to the farmers is implemented through on-farm experimentation.

Background

Groundnuts are an important food and cash crop in Southern Africa grown, with the exception of Lesotho, in all the member countries of the Southern African Development Coordination Conference (SADCC). They are produced mainly by small-scale farmers.

Yields are generally low and average about 500kg/ha, although experimental yields of over 4,000kg/ha have been obtained in Malawi (Sibale and Kisyombe. 1980), with over twice this yield under irrigation in Zimbabwe (Hildebrand, 1980).

The potential for groundnuts production in the region, both as a rainfed and irrigated crop, is enormous. Presently, there are several constraints to successful groundnut production; although common to the whole region, in Mozambique they may be itemised as follows:

---

[1]Groundnut Project Advisor and Agronomist, respectively, IDRC-UEM, Faculty of Agriculture and Forestry, Box 257, Maputo, Mozambique.

(a) Poor cultural practices - These originate from a lack of extension services and a generally impoverished and poorly equipped rural population, whose only implement is the hoe. The consequences are late land preparation, late planting, poor weed control and low plant density because farmers have to wait for the rains before they can start cultivations and the speed of their activities is governed by their own hand efforts.

(b) Low soil fertility - The practice of shifting cultivation, together with a use of the lighter, more easily worked soils, both characteristic of these poor farming communities, means that cultivated soils are low in nutrients. In the higher rainfall areas of North Mozambique, calcium is short, whilst the lighter soils of the South are deficient in zinc and phosphorus.

(c) Irregular rainfall - Given the irregular rainfall pattern of South Mozambique and the occurrence in some years of severe drought conditions, successful cropping will only be achieved through good cultural practice, improved varieties and pest and disease control.

(d) Unimproved landraces - Improved varieties suitable for local conditions have not been developed and thus do not exist for multiplication and distribution to growers. Past practices in the colonial area whereby unsuitable and untested seed was indiscriminately introduced has resulted in the genetic erosion of local genotype and the introduced varieties have now degenerated.

(e) Lack of marketing opportunities - The absence of any marketing organization means that there is no facility for distributing improved seed, advising on better cultivation methods and providing an incentive for the grower to improve and increase production. Thus, most production is consumed locally and even the oil extraction plants that have been built remain under utilized.

(f) Potential for the future - Mozambique has a total population of 12.6 million people, of whom nearly half grow groundnuts. In the national development plan of the Government of Mozambique, it was decided that groundnuts were an important food crop as well as a source of edible oil for which the country is not yet self-sufficient. It was further decided that attention to groundnut production should be given to the small-scale farmers, who produce the bulk of the crop and to do so by employing, as efficiently as possible, simple agricultural technology.

Farm cooperatives should also be encouraged and receive technical assistance; as well, state and private sectors should be involved in groundnut production.

Production Methods

Groundnuts are grown all over the country but mainly along the coastal zone of the northern provinces of Nampula, Zambezia and Cabo Delgado and southern provinces of Inhambane, Gaza and Maputo (Malithano, 1980).

The crop forms part of an unimproved, traditional, shifting cultivation system where the only implement is the hand hoe. It is often interplanted with cassava, maize, sorghum and millet. Under such conditions, yields are generally low, varying from 200 to 500kg/ha although up to 1 t/ha is obtained from pure stand crops. The necessity to secure the staple cereal crop, be it maize, sorghum or millet, tends to relegate groundnut production to second place with consequent late planting and weeding. Seed shortages, more marked in recent years, mean that planting rate can be from 80kg/ha to as low as 40kg/ha. As with other crops in Mozambique, groundnuts are planted on the flat and with no soil-conservation measures being used. Erosion often follows, particularly in the North where the rains are heaviy.

Late harvesting, due to competing requirements of other crops and lack of any mechanical aids, means that aflotoxins may develop. Where non-dormant short season varieties are grown (as in the south), germination before harvest may occur.

Groundnut production methods in the South differ from those in the North. In the South, short season erect landraces and other varieties are grown. The most commonly grown being Bebiano Branco and Bebiano Encarnado. Other varieties which are grown are Valencia and Natal Common. These varieties mature in 100-120 days and are grown twice a year. The first growing season is from July to November and the second from December to April. The date of planting is influenced by the on-set of the rains. Disease occurs less often on the first crop than on the second, which is usually attacked by rosette virus, rust and leaf spot. The first season crop yields are higher than those for second season crops, but problems of aflotoxins and germination in the pod are quite serious because the crop matures during the wet season. Drying of the first crop is also extremely difficult; hence the second season crop is usually reserved for seed (the percentage of germination is higher). The risk of complete losses in the second season crop is higher because of high disease prevalence and failure of the rains.

During the first season, groundnuts are grown as a pure crop, whereas in the second season they are intercropped.

In the South, the rainfall pattern is very erratic and risk of drought is very high. The southern groundnut-growing areas have an annual rainfall of about 750mm, with the potential evapotranspiration of 120mm, although in places rainfall is less and not evenly distributed, making it uneconomic to grow groundnuts. Even so, they are grown wherever there are suitable light soils.

In the North, where rains are regular and prolonged, long season prostrate and dormant landraces and varieties are grown. The prevalence of diseases such as rosette, rust and leaf spots is similar to the South, but rosette was considered to be more serious in the North than in the South. For this reason, a long season variety, Senegal, was introduced from Senegal and is found to be resistant to rosette. Other introductions from Senegal, such as 57-422 and RMP 12, are high yielding and are being recommended for commercial production. In the North, only one crop per year is grown and planting takes place in November and December. The yields are higher than in the South, the long season varieties giving high yields if they are allowed to express their full potential. The northern red loam soils where groundnuts are grown are usually more fertile than the sandy and light southern soils although leaching of soil nutrients is high in the North due to heavy rainfall, which also causes soil erosion.

Present Research and Results

The Faculty of Agronomy and Forestry, Universidade Eduardo Mondlane, was given full responsibility by the Ministry of Agriculture through the National Institute of Agricultural Research (INIA) to carry out all national research on groundnuts. This is known as the Groundnut Improvement Project and is based at the University.

The Project, which started in 1980, is financially supported by the International Development Research Centre (IDRC), Canada. The Government of the people's Republic of Mozambique also contributes, in kind, towards its running costs. Previous to IDRC support, basic research on groundnuts had already been initiated, in the form of village surveys, germ plasm collection, multiplication, identification and conservation. Agronomic trials were conducted in the South and later extended to the North of the country.

The project is primarily aimed at solving the basic problems facing small-scale farmers, cooperatives and state farms who produce groundnuts and other crops. The Project reveals that yields of crops are generally low because of poor and unimproved cultivation practices. Much effort has been directed toward conducting simple experiments at different sites and in different agro-ecological zones. These experiments ensure that results obtained are directly applicable to these different zones.

One of the important aspects of the Project is to understand the farmers' situation through village surveys. Some detailed information about groundnut production in the southern part of the country has been obtained, but in depth studies need to be conducted in the north as well. The farmer gives back information on the applicability to him of results obtained under his conditions. This approach helps the Project to formulate research priorities and methodology e.g. intercropping of groundnuts with maize can be improved in many ways if there is understanding of the farmer's practice and the reason why he is doing it. In some cases, the observations made by the farmer may not give direct understanding of the problem but they may help us plan our research. For example, although farmers express the decline in yield of groundnuts in many ways, our detailed studies of soil showed that plant nutrients such as phosphorus, zinc, and calcium were deficient.

The Project has benefited very much from the information obtained from the farmer and so lessened the effort needed in obtaining the same kind of information through experiments. The research presented in this paper is a result of intimate relationship between the farmer and the Project.

The Project has over 350 different acquisitions of groundnuts and these are evaluated in three stages:rapid screening, variety yield trials and advanced-generation yield trials.

(a) Rapid screening of the germplasm - This is achieved through preliminary observation nursery of small plots of 4 lines and 5m long with two replicates. Bebiano Branco, a local variety, is used as a check. A multi-location preliminary observation nursery is recommended because some acquisitions perform differently in different locations. For example material from Senegal is excellent in the North, but inferior in the South.

(b) Variety yield trials - The entries that performed well in the preliminary observation nursery are further tested in replicated multi-location variety trials. Depending on the quantity of seed, some varieties were evaluated directly in variety yield trials without fertilizers, as this is how they are normally grown. In such trials, varieties 57-422 and RPM 12 were found to yield best in the north (Table 1) and Bebiano Branco, Valencia and Virginia R26 in the South. The varieties were susceptible to diseases, but yield was not appreciably decreased, so these varieties were considered to be superior (Malithano et al, 1983).

Table 1: Yield of unshelled groundnuts at Namialo, 1981 (North).

Variety	Yield (kg/ha)	Duncan Test (0.05)
57-422 X	3611	a
Florunner	3333	ab
RPM-12 X	3259	ab
Early Runner	2963	abc
59-127 X	2796	bcd
69-101	2333	cd
N apalala	2278	cd
Manipintar	2206	d
Senegal X	1556	e
Local	1500	e

Table 2: Effect of zinc on Groundnut yield at Nhacoongo, 1981

Treatment	Yield (kg/ha)
T_1	673
T_2	1234
T_3	984
T_4	1491

T_1 - Control

T_2 - 20kg of N/ha and 40kg of $P_2 0_5$/ha

T_3 - 50 kg of Zn So_4/ha

T_4 - 50kg of Zn So_4/ha + 20kg of N/ha and 40kg of $P_2 0_5$/ha.

(c) <u>Advanced-generation yield trials</u> - Varieties that have shown promise in variety yield trials are further evaluated under farming system approval, and tested under different levels of fertilizer. At Umbeluzi Agricultural Research Station, fertilizer did not increase yields because soil fertility is high. In a trial at Nhacoongo late planting and rosette virus masked any fertilizer response.

Trials to assess response to zinc phosphate and superphosphate were conducted at Nhacoongo Agricultural Research Station and at the Zonas Verdes in southern Mozambique where the soils are deficient in zinc and phosphorus. A marked difference in yield between the control and the treated plots (Table 2) was found in the Nhacoongo trial. Highest yields came when zinc sulfate was applied in combination with single superphosphate and ammonium sulfate (Table 2).

On farm trials were also conducted at cooperatives in collaboration with farmers. They were advised on technical aspects and provided with fertilizer but did all operations themselves. In some cases, they were given varieties for the trial; otherwise they planted their own seed. Only one variable was introduced at a time (e.g. fertilizer) so that there were no interacting factors to confuse the farmer. Ten sites were selected and 40kg/ha of P_2O_5. The soils were sandy loam, low in nitrogen and phosphorus, but high in potassium and with neutral pH. Yields in treated plots were significantly higher than in the control (Table 3). Farmers also saw residual effect of phosphate fertilizer. These results were very convincing to farmers and helped the project to win their confidence. The sites were also used for educational purposes. Undergraduate students of the Faculty of Agriculture thus got into touch with farmers and saw the effect of improved farm practices both on yields and on farmers' enthusiasm toward improvement. The experiment also helped national technicians acquaint themselves with the use of on-farm trials.

The most important aspect of this experiment was that it convinced the administrators of the Zonas Verdes on how small quantities of fertilizer could increase the yield of groundnuts.

Farmers generally plant groundnuts rather late, and plant density is always less than optimum. Preliminary experiments at several sites in the South showed that planting groundnuts at the right time and at a high density gave an increase of 100% in yield. In the South, planting

Table 3: Effect of phosphorus on groundnut yields at Zonas Verdes, 1982.

Site No.	Yield (kg/ha) Control	Treated (40 kg P_2O_5)
1	1000	3600
2	900	3500
3	1200	4000
4	200	1000
5	80	900
6	900	3600
7	1500	3500
8	2000	3800
9	1000	3400
10	900	1900

groundnuts early from the second week of July up to the end of September gave the highest yields. These plantings escaped diseases such as rosette,leaf spots and rust. Insect attack such as Spodoptera was light. In the North, the recommended period of planting is mid-November. The date of planting will be affected by the onset of the rains. Late planting in the months of October-November is always associated with diseases and insect attack, and low yields result.

Plant density of erect varieties of 330,000 plants/ha at a spacing of 30cm x 10cm gave higher yields than low plant density of 220,000 plants/ha at a spacing of 45cm x 10cm. The aphid population was low when plant density was high.

Gains Realized by the Farmers

The Project works closely with farmers, in studying and trying to understand their problems and their limiting factors. This helps greatly when the time comes to advise on improved technology since farmers are already convinced that the work of the Project is of direct relevance to them. An intimate relationship between the Project and the farmers has been established by researchers' interaction with them in their homes and on their farms, working closely with them during land preparation, planting and harvesting.
The link between the farmers and the project has also brought the students and staff members of the Faculty into contact with the farmers for the first time.

Students are exposed to the problems they will eventually face after the completion of their studies. This has created an awareness by Faculty of Agronomy of how they can help small farmers, and, with the initiative of the Project a nucleus of an agricultural extension service has been initiated. The Project, together with the members of staff and students, has prepared written information sheets on agriculture that are aimed at helping the small farmer. This information is broadcast by radio and soon the technical advice will be taped on video cassettes for use as visual aids. Considering that, in Mozambique, there are no extension services for farmers, the mass media program initiated by the project is of great significance to the country and of direct benefit to the farmers.

When the better performing varieties have been multiplied and distributed, farmers will benefit from planting them through increased yields. Further, the recommended planting of short-season varieties of groundnuts in the South and long-season varieties in the North fits with the differences of climates in these agroecological zones.

On farm trials, we have demonstrated that even small quantities of fertilizers in soils deficient in mineral nutrients increase the yield of groundnuts considerably. As certain fertilizers can be made locally in Mozambique, their use is an economic proposition.

The research station experimental results have shown that early planting and high plant density give higher yields. This information is being transmitted to the farmers this growing season (1983/84) through on farm trials.

Collection and conservation of groundnut germ plasm, though not of immediate benefit to the farmers, is of great importance for the future. A gene bank has been made for the storage of the local and exotic groundnut germ plasm. Recent droughts, especially during 1982-83, have eliminated groundnut populations in some areas and genotypes in others thus narrowing the genetic bases.

The germ plasm now being conserved by the Project was collected before these severe droughts and thus has been saved from extinction.

The Project does not only carry out research on groundnuts, it also trains farmers by working with them in a farming system approach that includes testing of technology. This training is now being expanded to include both theoretical and practical aspects of groundnut production. In this respect, farmers will be trained on their farms on matters of a practical nature and at the Faculty of Agriculture on theoretical aspects of groundnut production. They will also be invited to take part in seminars organized for them, for farm managers and agricultural administrators.

Although the Project started its work only 3 years ago, its contribution to groundnut production is being felt and appreciated by both the farmers and the government officials. The government officials are now encouraging and supporting the work of the Project after seeing its positive aspects and the contribution it has made, in such a short time, to groundnut research in Mozambique. The farmers also feel that the Project cares for them and they can depend on it for technical advice and services. The confidence that the farmers have placed in the Project is a big achievement and is in itself evidence that the farmers are benefiting from this research.

Direction of Future Work

The research work now in progress is under constant review and modification. With time, solutions to the problems the farmers now facing will be found, but new problems will emerge which will require different approaches. Thus, the development of future work is in a dynamic state.

It is important to understand the cultural and sociological background of the farmer and the agro-ecological conditions under which he grows his crops.

For this reason, the work on village surveys which has already been started will be continued so as to understand the constraints to and economics of improved technology where-ever it is introduced.

There is need to collect local germplasm country-wide and especially in the South where genetic erosion of groundnut is quite pronounced. Introductions of groundnut varieties from other countries will also be continued. The germplasm will then be evaluated in respect to yield potential, disease resistance and other agronomic characters. Medium-term cold room facilities are now available for the conservation of the germplasm.

Research will be conducted to develop a package of practices such as improved varieties in combination with fertilizer application, date of planting, control of diseases and mixed cropping, through manipulation of planting date and plant density. Based on the research results obtained, adaptive trials on farmers' fields, cooperatives and state farms will be conducted and field verification trials will be carried out in different agroclimatic zones.

The disease and pest situation is much different in the farmers' field to that on research stations where, for instance, rosette and rust are more severe. Groundnuts on the farmers' field suffer from an unusual disease they call ulombe. It occurs in patches during spells of dry weather, but after rain the plants recover. There is therefore need for a pathologist to look into these problems.

Nitrogen deficiency, characterized by poor vegetative growth of groundnuts, pale green leaves and poor nodulation was observed in the coarse sandy soils at Macia in southern Mozambique. Experiments on inoculation of seed with rhizobia will be conducted in these soils. Benefits to farmers of biological nitrogen are important since they cannot afford to buy mineral nitrogen fertilizers.

Farmers grow landraces and mixtures of different types of groundnuts. These different populations have different reactions to diseases and drought. There is therefore a great utility in growing such mixtures. Multi-line varieties composed of agronomically similar, but genetically dissimilar, pure lines have been proposed by Browning and Frey (1969). Development of multi-line varieties is in line with the farmers' practices. Such varieties will be more easily accepted by the farmers and their characteristics maintained than varieties originating from a single pure line which will be blended by the farmer in order to satisfy his needs. Therefore, breeding methods should aim at developing varieties with a high frequency of genes for yield without impairing the genetic variability of the variety.

There is need to develop seed multiplication technology so that large quantities of seed of good quality can be multiplied as quickly as possible; there is great scarcity of seed in the country. The project, in collaboration with the National Seed Company, is giving technical advice on purification, multiplication and conservation of varieties.

In order to alleviate the drudgery of farming, development of simple animal-drawn implements for ploughing, planting, weeding and harvesting groundnuts will contribute to increased yields. Draught animals should be properly trained at centres strategically located in the country. Home-made tools involving very little investment and which farmers can repair themselves will be most appropriate.

Concluding Remarks

Experience so far has confirmed the advantage of using what is called the holistic or whole system approach, so that problems are seen from the sociological and technical standpoint.

as well as the ecological. Thus, bringing the farmer and the student technocrat into the project as early as possible is important; the latter has, in the long run, got to influence and convince the former. But the whole system approach has to go even further and look at problems of increasing food production in their ecological context too. In the work here it is obvious that permanent and large scale improvement requires the input of more motive power than the hands of men and women on the hoe. Prudence and an objective assessment of future fuel supply and price suggest animal power rather than the internal combustion engine. It seems that groundnuts would fit rather well into a mixed farming system using draught animals, not only because they fix nitrogen and enhance the oil and protein element of diets but because the dry haulms represent valuable animal fodder. The proposal of SADCC to establish regional agricultural research centres involving ICRISAT in groundnut research is therefore timely and to be encouraged and supported. They should provide the fundamental basis of well tested, appropriate varieties and a secure supply of good seed as well as a source of agronomic advice for administrators, extension workers and farmers alike.

References

1. Browning, J.A. and K.T. Frey. 1969. Multiline cultivars as a means of disease control. Annual Review of Phytopathology, 355-382.

2. Hildebrand, G.L. 1980. Groundnut production, utilization, research problems and further research needs in Zimbabwe. Proceedings of the International Workshop on Groundnuts held at the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) Patencheru PO Andhra Pradesh 502-324, India, 290-296.

3. Malithano, A.D. 1980. Groundnut production utilization, research problems and further research needs in Mozambique. Proceedings of the International Workshop on Groundnuts held at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patencheru, PO, Andhra Pradesh 502-324, India, 257-261.

4. Malithano, A.D. K.V. Ramanaiah and S.B. Chilengue 1983. Reviving groundnut production in Mozambique. Paper presented at Eastern and Southern Africa Regional Workshop on Crop Improvement, Research objectives and on-farm testing, Nairobi, Kenya.

5. Sibale, P.K., and C.T. Kisyombe 1980. Groundnut production, utilization, research problems and further research needs in Malawi. Proceeding of the International Workshop on Groundnuts held at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Patencheru PO Andhra Pradesh 502-324, India 249-253

Discussion: Country Presentation - Mozambique

The component lines in the proposed multiline variety can be distinguished by the colour of the seeds.

In the fertilizer experiment, only one type of phosphorus fertilizer (single super phosphate) is available in Mozambique. No nitrogen was applied in the phosphorus experiment (Table 3).

It is the small farmers (not the cooperative or state farms) who do not have enough seed.

In the South of Mozambique, groundnuts are used entirely as a pulse crop.

Session 5

Country Presentations

India and Sri Lanka

Chairman: D. Malithano   Rapporteur: R.K. Downey

Production and Research Achievements of Niger in India

S.M. Sharma[1]

Niger is another important oilseed crop in India grown at present in an area of about 0.6 million hectares with annual production of about 150 thousand tons. India is the chief producer of this crop. The average yield of this crop is about 240kg/ha in this country.

In India, it is chiefly cultivated in the states of Madhya Pradesh, Orissa, Maharashtra, Bihar, Karnataka, Andhra Pradesh and Gujarat. It is grown extensively as a mixed crop with various grains and pulses or as a sole crop on marginal and sub-marginal lands in tribal areas on hill tops and slopes, although this crop does best on well-drained loam soils of good depth and texture.

Although good yields are obtained in Andhra Pradesh, Orissa and Assam, they are below the national average in Madhya Pradesh, Maharashtra and Karnataka where about two-thirds area is located.

Satisfactory seed yields even under difficult conditions, high oil percentage (35-50%), less care and effort in cultivation, resistance to drought and less attack of animals, birds, insects and diseases are important features influencing local farmers for its cultivation.

The niger seed oil is good quality edible oil with pleasant nutty taste used as a cooking medium. Lower grade oils are used for soap making and as illuminant. Niger seed oil is also used as a paint oil to a limited extent. Niger seed cake is utilized for cattle feed or as manure.

Variety Improvement

Research work on niger improvement under the auspices of All India Coordinated Research Project on Oilseeds of ICAR is being carried on at Jabalpur (Madhya Pradesh). Dhule and Igatpuri (Maharashtra), Semiliguda (Orissa), Kanke (Bihar), Raichur (Karnataka) and Rastakuntubai (Andhra Pradesh). Recently, research work has also been undertaken at Udaipur (Rajasthan) and in Gujarat State.

Niger germ plasm is being collected and used at all these centres but the major work of germplasm collection, characterization and cataloging is being done by the Project Coordinator at Jabalpur. Varieties for yield, early maturity, high oil content and suitability for different growing periods have been identified and evolved for different niger growing states (Table 1).

[1]Project Coordinator, All India Coordinated Research Project on Oilseeds. Jawaharlal Nehru Agricultural University, Jabalpur MP, India 482-004.

Table 1: Suitable varieties for niger growing states.

State	Variety	Duration (Days)	Oil (%)	Average Yield (kg/ha)
Madhya Pradesh	Ootacamund	110	42	500
	No. 5	105	40	450
Andhra Pradesh	Grandagudal local	95	39	570
Karnataka	No. 71	95	41	500
Maharashtra	IGP-76	110-125	40	500
	N 12-3	110	40	450
Orissa	IGP-76	110-125	40	500
	Ootacamund	110	42	500
Bihar	N-5	118	35	450
	Ootacamund	110	42	500

Extensive hybridization programs are conducted at all the centres. Work on building up composites and development of synthetic varieties has also been taken up. Inbred lines are being developed. Population improvement through recurrent selection is in progress at Jabalpur.

Self incompatibility is known in this crop. However, the genetics of incompatibility as yet are not clear. Genetics of incompatibility and seed setting are being studied.

These varieties have an average yield potential of about 5q/ha. Varieties having higher yield potential and higher oil content viz. RCR-18 from Raichur and IGP-72 from Igatpuri have been developed.

Niger crop is grown alone or mixed with bajra (pearl millet), ragi (finger millet), castor, groundnut or pulses or as a pure crop in kharif (rain) season.

Seed and sowing - 6 to 8kg seed per hectare should be sown in rows 30cm apart. The seed should be treated with thiram at the rate of 3g/kg seed prior to sowing. Thinning should be done to maintain plants 15cm apart within the rows about 2 weeks after sowing.

Fertilizer - The crop should be given a basal dose of 10kg N + 20kg P_2O_5 + 10kg K_2O per hectare followed by top dressing with 10kg N/ha about 30-35 days after sowing.

Weed control - Weeding should be done at the time of thinning after about 15 days of sowing. If necessary, second weeding should be done before top dressing. In Karnataka inter-culturing 2-3 times with bullock drawn hoe is practiced.

Recently dodder (cascuta) has been found to infest the crop. If the seed has been obtained from the place when this parasite is known to occur, it is desirable to separate the cascuta seed before sowing. Application of chloraprophom weedicide as granular formulation at the rate of 4kg/ha to the surface of moist soil 6 days after sowing effectively controls cascuta.

Irrigation - The crop is mainly grown as a rainfed crop during kharif season. However, during long dry spells, irrigation increases the yield to a considerable extent. During rabi (post-rainy) season, it is recommended to apply 3 irrigations at 10, 30 and 55 days after sowing which coincide with germination, vegetative growth and flowering stages.

Plant protection measures - The crop should be protected against major insect pests and diseases by adopting recommended control measures (Table 2).

Table 2: Recommended control measures for important diseases and pests of niger.

Name of the Disease/Pest	Control Measures
Leaf spot (*Alternaria sp.*)	2 sprays with 0.3% zoneb
Powdery mildew (*Oidium sp.*)	2 sprays with 0.3% solution of wettable sulfur - one at first signs of disease, the other 15 days later
Root rot (*Rhizoctonia bataticola*)	Seed treatment with 0.3% thiram
Niger caterpillar (*Perigea capensis*) Cutworm (*Agrotis ypsilon*)	Both the pests are controlled by spraying 800g carbaryl 50 WP in 600 litres of water per hectare.

Harvesting - Harvesting is done when the leaves dry up and the head turns black. The plants are cut with sickles and stacked in a threshing yard for a week or so. Then they are beaten with sticks to separate the seeds.

Inter cropping - Intercropping of niger either with groundnut or with sunflower is profitable. Niger with sunflower (1:1) intercropping has been found to improve the seed filling of sunflower heads due to increased bee population. Growing chick-pea as an intercrop with niger is more profitable than growing other pulses as intercrops with niger in rabi season in Karnataka.

The crop is presently grown in marginal and sub-marginal lands without fertilizer or as a mixed crop, where main emphasis for cultural requirements is given to the main crop. If the crop is grown under good growing conditions, it is more profitable than many other crops. Moreover, it is the main source of edible oil to most of the tribal people in many parts of the country.

At present, the niger varieties have low yield potential. Efforts are being made to develop high yielding varieties and synthetics and composites of higher yield potential and varieties responsive to better management practices.

Problems

1. Niger varieties have low yield potential. Intensive efforts should be made to breed varieties with higher yield potential so that the crop becomes more remunerative and farmers get incentive to pay more attention to its management. Hybridization program should be intensified and synthetics and composites of higher yield potential should be developed.

2. The present varieties are based on narrow germplasm. Every effort should be made to collect germplasm from all parts of the country and abroad.

3. At the scientists' level, basic information on the plant characteristics is lacking. Studies on genotype-environment interaction, quantitative components of yield, heritability of different characters and pollinating agents should be done.

4. The crop is essentially a cross pollinated one due to self-incompatibility; studies on the nature of self-incompatibility and seed setting should be done.

5. Improved agronomy of the crop for different agro-climatic regions should be worked out and a package of practices should be developed.

6. Impact of improved varieties and improved agronomic practices should be demonstrated so that farmers are convinced of the yield potential and profitability of this crop.

7. Availability of seed is a problem particularly in tribal areas. Production, procurement and distribution of seed should be taken up on a top priority basis.

Crop Improvement Strategies in Sesame in Tamilnadu (India)

S. Thangevelu[1]

Sesame is a crop of the developing countries and in fact it is a small farmers' crop requiring hand labour. Sesame is being grown in 65 countries of the world between 40° N and 40° S latitudes. The annual world production is about two million metric tons. From 65 countries, 24 in Asia, 21 in Africa, 15 in Central and South America and 5 in Europe. India is the world's major producer with a third- of world's acreage and approximately a quarter of total global production (2 million tons). Other major sesame growing countries are Burma, China and Sudan (Table 1).

India imports about one million tons of vegetable oil per annum spending valuable foreign exchange worth Rs. 10,000/ million (1000 million dollars). So the immediate task is to bridge the gap between production and demand.

Tamilnadu is one of the seven major sesame producing states in India with annual production of about 60,000 tons of seeds from an area of 182,000 ha. It is situated in much the same latitude as Venezuela, Guyana, Surinam, Sudan, and Nigeria. The plant materials and research results produced in Tamilnadu might be useful in the other countries of the semi-arid tropics.

The major sesame growing states in India are Uttar Pradesh (30%), Rajasthan, Madhya Pradesh, Tamilnadu, Maharashtra, Andhra Pradesh, Karnataka and Gujarat (Table 2). The average seed yield in Tamilnadu is 332kg/ha as against the average yield of 221kg/ha for India.

More than 75% of the production is used for edible oil extraction. The sesame oil is also being used in the manufacture of fragrant and scented oils, margarine, toilets etc. besides being used directly as edible oil. The cake is used as cattle feed especially for milk cattle.

Cultivation

Sesame is mostly grown under rainfed condition as a marginal crop on poor and marginal lands with poor management. The duration of the crop varies from 65 to 140 days. The seed colour also varies from ivory white to deep black.

---

[1]Breeder (Oilseeds), Regional Research Station, TNAU, Vriddhachalam, Tamilnadu, India 606-001.

Table 1: Area, production and yield of major sesame growing countries of the world.

Countries	Area (1000 ha)	Production (1000 tons)	1978-79 Yield (kg/ha)
Asia			
India	2441	489	211
China	952	381	400
Burma	606	111	189
Korea	70	32	457
Bangladesh	56	31	554
Afghanistan	50	36	720
Turkey	48	26	542
Syria	40	20	506
Pakistan	34	12	360
Sri Lanka	26	12	461
Thailand	28	22	786
Total	4296	1208	281
Africa			
Sudan	879	267	304
Algeria	230	70	305
Uganda	140	50	357
Ethiopia	70	40	571
Total	1613	528	327
North America			
Mexico	244	134	549
Others	32	30	647
Total	275	164	598
South America			
Venezuela	110	56	509
Others	31	17	527
Total	141	73	518
Europe	7	1	203
World	6332	1974	312

Table 2: Area, production and yield (kg/ha) of major sesame growing states of India.

State	Area (1000 ha)	Production (1000 tons)	1978-79 Yield (kg/ha)
Uttar Pradesh	635.3	87.0	118
Rajasthan	432.2	75.1	178
Madhya Pradesh	247.1	29.5	119
Tamilnadu	182.1	60.5	332
Maharashtra	173.3	52.1	291
Andhra Pradesh	164.6	23.0	140
Karnataka	118.2	48.8	413
Gujarat	101.5	30.4	300
Others	296.5	113.3	
India	2441.0	439.7	221

The sowing seasons are as follows:

Season	Planting Time	Harvest Time	Water Source	% of Area
Rainy	June-July	Sept-Oct.	Rainfed	70
Mid-rainy	Aug.-Sept.	Nov.-Dec.	Rainfed	20
Winter	Oct.-Nov.	Jan.-Feb.	Rainfed	1
Summer	Jan.-March	April-May	Irrigated	9

In Tamilnadu, sesame is being planted during three seasons -- two seasons under rainfed conditions and one under irrigated condition. The first main crop is sown during June-July under rainfed condition with southwest monsoon rains. During winter season (Oct.-Nov.), it is raised as a second crop after the harvest of groundnut, sorghum, pennisetum, etc. under rainfed condition. During Jan.-March, sesame is being planted in rice-fallow fields of deltoic region under irrigated conditions and under lift irrigated condition.

Long (120 days) and medium duration (85-90 days) sesame varieties are being cultivated during rainy and winter seasons, while medium duration varieties are grown during summer season.

Sesame is cultivated on a variety of soils varying from sandy-loam to heavy clay. Mostly seed is broadcast, except in Gujarat and Maharashtra where it is sown as a row crop. Sesame is sown as pure crop as well as mixed crop with cotton, groundnut, pigeon pea, pennisetum, sorghum, etc.

Immediately, on receipt of rains, the lands are prepared and the soil brought to fine tilth. During the subsequent rains, the seeds are broadcast and covered by a country plough. Normally no fertilizer application is practiced by any farmer especially for the rainfed crop. The irrigated crop might be fertilized wherever resources are available. Except weeding, no cultural operations are being undertaken. Even plant protection measures are not adopted. The crop is harvested just before its full maturity to avoid its shattering in the field; it is then staked in stooks for ripening. The ripened capsules are dried and seeds collected.

Research

Research programs of crop improvement of sesame were undertaken very early in India and about 40 varieties have been developed so far for different regions of the country by the different research centres. In Tamilnadu alone, 9 varieties have been developed. However, these varieties are not resistant to major pests and diseases. So the production could not be stabilized or increased substantially. Moreover, these varieties were developed only from local land varieties with limited genetic variability by pureline, mass selection and pedigree breeding methods.

Objectives of research programs are:

1. Development of higher yielding varieties under two duration groups of sesame (120 days and 90 days).
2. Improvement of the yield levels of the existing varieties as the present yields are only up to 500kg/ha.
3. Breeding varieties suitable for different seasons.
4. Developing varieties suitable for all the seasons.
5. Infusing resistance to stress conditions like drought.
6. Developing resistant varieties to major pests: shoot webber, gall midge etc.
7. Infusing resistance to diseases like powdery mildew. bacterial blight, phyllody and wilt.
8. Developing several branched, less-branched and non-branched varieties suitable for different farming situations.
9. Developing suitable management practices to obtain the highest yields even under stress conditions.

Achievements to date are considerable. Nine varieties were released for general cultivation -- two long-duration and seven medium duration. Among these varieties, TMV 3 is popular and is being planted under rainfed conditions, and TMV 4 is favoured for summer planting.

Now totally 1950 germplasm types have been collected and maintained for evaluation and documentation.

Even though the farmers are not applying any fertilizer for sesame, the experiments we have conducted indicate that application of the N-P-K fertilizers would be useful in increasing the yield:

	N	P_2O_5 (kg/ha)	K
Rainfed	23	13	13
Irrigated	35	23	23

Suitable plant protection schedules have been worked out to control the major pests and diseases.

The release of improved varieties and adoption of improved farming techniques by the farmers have resulted in increased production by 15%. Now there are separate seed producing and certification agencies to help the farmers.

A simple clay technique developed for selfing to maintain the genetic purity of the variety and another simpler technique for emasculation for hybridization have paved the way for development of hybrids in sesame. A number of hybrids have also been produced and they are under evaluation.

After the implementation of the IDRC Project on Sesame in Tamilnadu, a large number of high yielding cultures have been developed. One culture VS2 with 20% increased yield is under adaptive research trials in the farmers' holdings.

Two cultures VS16 and VS80 with 30% increment are under multilocation testing in different Research Centres of Tamilnadu. Forty seven types are under advanced yield evaluation trials while 691 cultures are under preliminary testing trials.

Besides the above, 13 hybrids with increased yield potential up to 90% have been developed and are under testing.

The strategy in future includes:

1. Collection and evaluation of a large amount of germ plasm from different countries and wider geographical areas.

2. Development of less-branched and non-branched types suitable for different farming situations.

3. Improving the yield potential of the existing varieties and stabilizing the production.

4. Developing short duration varieties for relay cropping and mixed cropping condition.

5. Infusing resistance in the existing varieties for major pests: shoot webber, gall midge.

6. Resistance to diseases: powdery mildew, bacterial blight, wilt and phyllody.

7. Resistance to environmental stress like drought.

8. Uniform maturity or determinate habit.

9. Developing an ideal plant type.

10. Improving the harvest index.

11. Developing non-stattering capsuled varieties suitable for mechanical harvest.

12. Developing varieties suitable for different seasons.

13. Developing varieties suitable for all seasons.

14. Exploitation of heterosis by developing hybrids.

15. Potential to respond to higher inputs.

16. Increasing the existing genetic variability by induced mutation and different breeding programs.

To achieve the above objectives, the following breeding techniques are being followed:

- Pure line and mass selection for the direct improvement of non-uniform plant populations.

- Pedigree breeding and selection to evolve superior genotypes.

- Bulk population breeding.

- Backcross breeding to transfer specific desirable characters.

- Population improvement to make use of high rates of outcrossing and male sterility.

- Production of synthetic varieties. The feasibility of using increased rates of outcrossing, to evolve synthetics should be explored

- Production of hybrid varieties.

- Mutation breeding. Apart from providing variation in plant material, mutation induction can also be a useful means to improve already superior genotypes in a particular respect, such as plant architecture, maturity time or disease and pest resistance.

- Composite crosses to create a wide spectrum of genetic variation by manual means or by use of male sterility.

References

Anon. (1980, 1981, 1982) Annual progress reports of IDRC Project on Sesame in Tamilnadu.

Ashri, A. (1980) Increased genetic variability for sesame improvement by hybridization and induced mutation - status and improvement proceeding of expert consultation, FAO, Rome, Italy.

Desai, N.D. and S.N. Goyal (1980) - Major problems of growing sesame in India and South East Asia - Sesame - Ibid.

Thangavelu, S. (1980) - Intensification of Research on Sesame in Tamilnadu, India - Ibid.

______________ (1982) - Sesame - Information note, FAO No. 1, Rome, Italy.

Discussion: Country Presentation - India

Niger

It was established that niger and noug are in fact same crop although in Ethiopia the crop is grown on heavy waterlogged soils, while in India the crop occupies thin soils primarily on slopes and hill tops. It was also reported that Indian niger has a seed size of about 3g/1000 seeds and the crop is usually sown at the onset of the monsoons (June-July).

It was made clear that the breeding objectives for niger were to develop improved plant types and varieties for both the marginal lands as well as good soils. It is also planned to develop a system of pedigree seed production in India which would permit the seed to be produced in the area of adaptation, but on private niger growing farms rather than state farms. Such a program would have to rely on isolation by time of flowering rather than by distance to ensure production of pure seed.

It was clarified that the yield figures reported by Dr. Sharma were for plots harvested from poor soils located on state farms. It was suggested that since this crop is grown as a green manure crop in West Germany and following crops do very well in both India and Ethiopia, niger may have some nitrogen fixing capability.

Sesame

Dr. Thangevelu noted that the plant characteristics, most closely associated with sesame yield, were the number of capsules per plant and the number of seeds per capsule. However, the most important factor in increasing farm yield was considered to be improved cultivation practices followed by improved varieties. He felt the most successful method of getting the improved cultivation practices accepted would be to promote the improved variety and cultural practices as a total package.

Considerable interest was shown in the possibilities for sesame hybrids from male steriles (MS). The Indian researchers had failed to recover MS plants from seed stocks obtained. Dr. Yermanos indicated that seed stocks of the male sterile are now available. Concern was expressed that producers in developing nations could not afford to purchase hybrid seed, together with the fertilizer and other inputs needed to obtain the potential returns. There appeared to be a general consensus, based on experience with corn and sorghum that if the yield advantage was sufficiently large (25-30%) and stable, producers would indeed welcome hybrid sesame. It was noted that hybrids had given yield increases up to 98% but that on the average a 25-30% yield increase for sesame could be expected with a seed cost of about 15US$ per kg. If growers wished to use precision seeders with the hybrid seed, then seeding rates as low as 0.5kg/ac could be used successfully.

Oil Seeds Improvement in Sri Lanka

R. Pathirana, P.J.A. Wijewichrama, W.S.R.M.R. Ananda[1]
and S.J.B.A. Jayasekera[2]

Coconut is the single largest traditional source of edible oil in Sri Lanka. It occupies 440,000ha in the wet and intermediate zones of the low and mid country. It plays an important role in the foreign exchange earnings of the country with approximately 45% of the production being exported. With the increase in population, it has been projected that without a significant increase in the production of coconuts, the surplus available for export would be considerably reduced. However, during the recent past, the construction of industrial complexes and the development of tourism in the coastal plains where coconut is the major agricultural crop have reduced its area of production. Therefore, the need to increase the production of other edible oils is obvious.

The wet zone and part of the intermediate zone have been planted to the three major plantation crops of the country - tea, rubber and coconut. Therefore, the potential area for the increase of production of annual field crops lies in the dry zone and the drier parts of the low country intermediate zone. The traditional oilseeds grown in these areas include sesame, groundnuts, castor and mustard. About 15% of the cooking oil consumed in Sri Lanka comes from sesame. Groundnut is grown for roasting and confectionery purposes. However, a few oil expeller plants for groundnuts are already operating in the country. Mustard is used as a condiment. The area, production and the yield of the two major oilseed crops - sesame and groundnuts are presented in Table 1.According to these figures, the production of sesame has increased almost three fold during the period from 1971 to 1981. The groundnut production has doubled during this period. The sharp increase in sesame production is explained by the more or less stable prices for sesame received by farmers after Sri Lanka's entering the export trade of this product since late seventies.

Table 1: Area, production and yield of major oilseeds in Sri Lanka. (Source: Department of Agriculture, Division of Economics).

Year	Sesame			Groundnut		
	Area '000 ha	Production '000 MT	Yield kg/ha	Area '000 ha	Production '000 MT	Yield kg/ha
1971-75	9.5	4.8	505	6.5	6.5	1000
1975/76	18.8	8.5	452	6.6	6.0	909
1977/78	16.8	9.8	583	8.2	7.4	902
1979/80	31.1	23.2	746	9.4	13.8	1468
1980/81	24.8	13.8	557	11.9	14.2	1193

[1]Agricultural Research Centre, Angunakilapelessa, Sri Lanka.
[2]Agricultural Research Centre, Maha Illuppallama, Sri Lanka

Cultivation

Sesame has been grown for thousands of years in the dry zone of Sri Lanka as a "chena" (shifting cultivation) crop. Due to the increase in settlement schemes in the dry zone, particularly during the last decade or two, sesame is becoming a component of the settled farming systems.

Local cultivars adapted to different agroecological regions and seasons of cultivation are grown by the dry zone farmers. Sesame is grown mainly during the Yala (South-west monsoon) season which brings about 1/3 - 1/4 of the total annual rainfall. This season accounts for about 80% of the total annual production. In the drier parts of the country where rainfall is not reliable during the South-west monsoon, sesame is grown in the Maha (North-east monsoon) season as the main crop or immediately after rice as the second crop, using residual moisture.

Three varieties have been released for cultivation by the Department of Agriculture. MI 1 and MI 2 are branching, black seeded varieties. MI 3 is white seeded and has a non-branching stem. Although these varieties have higher yield potential and general adaptability, the majority of the farmers grow local varieties adapted to their specific conditions. The seeds are broadcast at the rate of 3-5kg/ha after land preparation, before the rains. Usually, no agrochemicals or fertilizers are used. However, due to increased cropping intensity and area, sesame crop is affected by several diseases such as *Phytophthora nicotianae* var. *parasitica*, mildew (*Oidium sp.*), *Alternaria* and phyllody. Pests common to sesame are shoot webber (*Antigastra catalaunalis*), gallfly (*Asphondylia sesami*), aphids etc.

(b) Groundnut is grown mainly in the Maha season as a rainfed crop. About 15% of the annual production is contributed by the Yala crop grown with supplementary irrigation in the rice fields or as a rainfed crop in the highlands. Groundnut is popular with the farmers of eastern Sri Lanka. Eastern groundnut belt has a longer rainy season during the northeast monsoon and therefore the runner types (*subsp. hypogaea*) with seed dormancy are grown. In other areas bunch varieties (*subsp. fastigiata*) released by the Department of Agriculture are grown.

The varieties released for cultivation are MI 1, No. 45, X-14-4-b-19-b (all with pink testa and two seeded pod) and Red Spanish (with three seeded pod and red testa). Although Red Spanish is lower in yield than the rest of the recommended cultivars, it is grown widely due to consumer preference (for roasting).

The recommended cultivars are grown in rows 45cm wide, with an interrow spacing of 15cm. During the flowering stage, the hand weeding is coupled with earthing up of the pegging zone. The runner varieties are sown at a lesser seed rate. Rust and leaf spot (*Cercospora arachidicola* and *Cercosporidium personatum*) are the most common diseases. Red hairy caterpillar (*Amsacta moorei*), Arachis leaf miner (*Stomophteryx subsecivella*), white grubs and blister beetles (*Mylabris spp.*) are the common pests.

National Coordinated Research Project

With the major objective of consolidating and intensifying research in oil seeds, the Sri Lanka Department of Agriculture launched a research project with the assistance of the International Development Research Centre, Canada. The project, headquartered at the Agricultural Research Centre, Angunakolapelessa, established a close liaison with the Scientists working in oilseeds at other regional research stations of the Department of Agriculture. They are located at Maha Illuppallama, Kilinochchi, Karadian Aru, Makandura and Girandura Kotte.

The specific objectives of the project are:

- To study the possibility of raising world's selected oil crop species under different agroecological regions within the dry and intermediate zones of Sri Lanka.

- To breed new varieties with higher yield and seed oil content and select those most suitable to the diverse physical environment.

- To select the most suitable oil crop species and cultivars for different dry land cropping systems.

- To evolve the best and economical techniques for the cultivation of the major oilseed crops under dry farming and irrigated conditions.

- To identify the pests and diseases of economic importance and to develop and evaluate varieties resistant to them.

The major emphasis in the national coordinated project was given to the two crops traditional to Sri Lanka agriculture, namely, sesame and groundnut.

Variability of quantitative characters, heritability and the correlations were studied in groundnut bunch *(ssp. fastigiata)* cultivars for several seasons. The heritability (in the broad sense) was found to be high for the seed size and low for shelling percentage. The other characters had their heritability values ranging from 0.41 (for the number of seeds per pod) to 0.47 (for the number of seeds per plant). These results along with the coefficients of variability at genotypical and modificational (paratypical) levels are presented in Table 2.

Table 2 : Genotypical (CV_g) & modification (CV_m) variability and heritability (H^2) of some quantitative characters in bunch groundnuts.

Characters	CV_m,%	CV_g,%	H^2
Number of pods	49.1	45.3	0.460
Number of seeds	47.8	44.9	0.469
Pod weight	46.9	43.9	0.467
Shelling percentage	8.9	6.0	0.312
Seed weight	47.7	44.1	0.461
Seed size (100 seed weight)	12.1	18.8	0.707
Number of seeds per pod	12.4	10.4	0.413

Although the heritability values of most of the characters studied were rather high, identification of better genotypes for characters such as the number of pods, number of seeds, weight of pods would be extremely difficult under field conditions due to their high modificational variability. Genetic differences for the seed size and the number of seeds per pod will be much easier to identify (Pathirana, 1982 a). Our results are in agreement with the variability studies undertaken by Joshi et al (1981).

The seed yield per plant was found to have high genotypic correlations with pod weight and the number of seeds per plant (Table 3). The data presented in Table 4 indicate that the shelling percentage does not have negative relationships with other important yield components.

Table 3: Genotypic correlations (rg ± sr) of seed yield per plant and shelling percentage with other characters.

	Seed Weight	Shelling Percentage
Pod weight	0.994 ± 0.001	0.404 ± 0.080
Shelling percentage	0.416 ± 0.081	-
No. of pods	0.912 ± 0.012	0.225 ± 0.108
No. of seeds per pod	0.215 ± 0.094	0.471 ± 0.076
100 seed weight	0.392 ± 0.083	0.425 ± 0.069
No. of seeds	0.854 ± 0.026	0.372 ± 0.081

Note: Correlations are significant at 5% and 1% levels if they exceed 0.180 and 0.228 respectively.

The genotypic correlations among the seed yield components were found to be low and nonsignificant. The seed yield recorded the highest correlation with the number of pods per plant (Table 4).

Table 4: Genotypic correlations (rg ± sr) among yield components.

	No. of Seeds Per Pod	100 Seed Weight	Seed Weight Per Plant
No. of pods	0.012 ± 0.098	0.044 ± 0.010	0.912 ± 0.017
No. of seeds per pod	-	0.092 ± 0.099	0.215 ± 0.094
100 seed weight	0.092 ± 0.099	-	0.392 ± 0.083

The breeding program initiated in 1980 envisaged yield improvement. However, breeding for quality has been emphasised ever since Sri Lanka entered the export trade in groundnuts. Two types of varieties are sought for the export market. They are the bold seeded and high seed oil varieties. Other objectives of the groundnut improvement program are breeding for earliness and drought resistance for growing groundnut as a rainfed crop in the southwest monsoon season, to develop 4-4$\frac{1}{2}$ month varieties for the Maha season in the eastern groundnut belt, as well as rust and leaf spot resistance.

<u>Mutation breeding</u> - Gamma rays from a ^{60}Co source were used to induce mutations in yield components in two adapted cultivars - GN 13 and Vietnam. Selections were carried out in M_2 generation for increased pod yield, seed size and other characteristics (Pathirana, 1982 b). Several promising selections were tested in major yield trials and in the multilocational variety testing program. The mean yield and agronomic characteristics of the mutants and promising varieties in the coordinated trials (Maha season, 1982/83) conducted in seven locations (with three to four replications per location) are presented in Table 5.

Table 5: Characteristics of some groundnut cultivars in coordinated trials (mean of seven sites - Maha 1982/83).

Cultivar	Pods per Plant	100 Seed Weight (g)	Shelling Percent	Pod Yield (kg/ha)
South China	23.0	37.3	72.9	1778
X - 14	21.2	42.9	69.8	1821
V 53 Tatu	20.5	44.4	72.6	1802
Red Spanish	15.7	42.2	69.5	1581
180/21	19.8	44.3	74.6	2112
180/22	26.1	46.4	70.2	1796
No. 45 (check)	19.9	39.9	71.3	1683

The mutant variety 180/21 selected in M_2 population of GN 13 cultivar treated with 5 krad gamma radiation recorded a 20% yield increase over the recommended variety No. 45. It was characterised by high yield in both favourable and unfavourable conditions for crop growth. It has a larger seed and higher shelling percentage as well.

After many seasons of multilocational yield testing, the varieties South China, X-14, V53 Tatu and No. 45 were shown to have wide adaptability to the diverse physical environment. Another interesting fact revealed in this study was that A-92 (a variety withdrawn recently from the recommended list) is capable of producing above average yields in poor environments.

Another mutation breeding project to improve the yield of the popular cultivar Red Spanish was initiated recently. The yield of this variety is lower than that of other recommended varieties (Table 5). Progeny testings of the selections are underway.

Breeding for earliness - The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) supplied us with segregating populations from crosses involving early maturity and high yielding varieties; 16 such populations and 7 early maturity cultivars were grown in the Yala, 1983 season, and single plant selections were carried out for progeny testing in the subsequent seasons.

Breeding for disease resistance - 31 rust resistant and 20 cercospora resistant breeding lines and varieties were supplied by ICRISAT. These lines are being tested for their resistance and yield. A hybridization program will be initiated to improve the yield and quality of the resistant lines under Sri Lanka conditions.

Breeding for large kernel - Two selections carried out at the Regional Research Station, Maha Illuppallama from the cross NCAC 11074 X Robut 33-1 and another selection from the cross JH 89 X Chico have larger kernels than the recommended varieties. These selections are characterised by semi spreading growth habit, two seeded pod and high yield. These varieties will be tested in the coordinated regional trials from Maha 1984/85 seasons.

A long term fertilizer experiment has been laid out in Monaragala, where groundnut is a popular crop and has much potential for increasing production. Initial results indicate that 10-20kg/ha of K_2O and 40-60kg/ha of P_2O_5 are optimal for groundnut in these soils.

Intercropping trials carried out with cotton has shown that groundnut is the best intercrop for cotton. The data presented in Table 6 indicate that the net income from intercropping cotton with groundnut is higher than growing cotton alone or with soybean or green gram. The early returns obtained from the groundnut crop may give an incentive to the farmers to grow cotton which is a valuable crop with decreasing production due to its late maturity, unstable yields and other constraints.

Table 6: Yield, cost and returns from cotton crown as a mono crop or intercrop (Yala, 1982)

	Yield (kg/ha)	Gross Income (Rs/ha)	Total Income (Rs/ha)	Cost (Rs/ha)	Net Income (Rs/ha)
Cotton alone	1368	11769	11769	10087	1682
Cotton	923	7940			
+			11874	9328	2546
Groundnut	492	3934			
Cotton	871	7494			
+			10446	9176	1270
Soybean	295	2952			
Cotton	869	7473			
+			10473	9300	1173
Green gram	187	3000			

Experiments carried out with groundnut and other field crops under coconut in the low country intermediate zone have shown that groundnut can produce a yield of 900-1200kg/ha. Groundnut has shown promise as an intercrop in castor too. Selection of varieties best suited for intercropping and methods of cultivation for these conditions are being developed.

Sesame improvement program at Angunakolapelessa was hampered by a fungal disease - *Phytophthora nicotianae* - which destroyed much of the breeding material for several seasons. The objectives of the breeding program include high yielding white seeded cultivars for export, *Phytophthora* resistance, high seed oil content, resistance to shoot webber *(Antigastra catalaunalis)*, powdery mildew *(Oidium sp.)* and phyllody, non sensitivity to day length and temperature for wide adaptability.

Local cultivars are widely used for hybridization in the sesame breeding program. Direct selection in heterogenous populations collected from farmers' fields has resulted in substantial yield increase. One such variety (Anuradhapura) significantly out yielded the recommended white seeded cultivar MI 3 at two locations in the national coordinated variety evaluation trials conducted in 1982. This variety has higher seed oil also (Table 7).

Table 7: Characteristics of the leading sesame cultivars in coordinated variety trials (Yala, 1982).

Variety	Days to* Maturity	Seed Yield* (kg/ha)	Oil Content (%)
Australian Introduction	71	371	53.1
Strain I	80	392	53.0
3329	79	428	50.2
Tainan white	81	402	50.4
Anuradhapura Sel-1	80	496	58.7
MI 1	82	350	52.4
MI 2	83	473	-
MI 3 (check)	79	358	53.8

*Mean of six locations.

As the available germplasm does not have sources of resistance to *Phytophthora* rot, a mutation breeding program was initiated to induce resistance. Three varieties were irradiated with six doses of gamma rays. 345 surviving plants were harvested in the M_2 bulk populations grown in the disease nursery. Progeny testing was carried out in the subsequent generation. Fifty four selections had one or more surviving plants. A high percentage of surviving plants were found in the selections from 60 krad Kekirawa local X MI 1 Sel. 1 treatments. Further testing of these selections under highly conducive conditions for the development of the disease is necessary to confirm their resistance. As the majority of the apparently resistant lines have black or brown seeds, a hybridization program with white seeded cultivars of high yield potential has been initiated to select resistant lines with white seeds and high yield.

Variety testing of castor at Angunakolapelessa and Girandura Kotte has confirmed the superiority of the recommended variety, Hazeera No. 1 . Trials carried out for two seasons have recorded an average yield of 1947kg/ha from this variety. The oil content of the varieties studied fluctuated from 46.5% (in Thailand B) to 54.1% (in Sa-2). Hazeera No.1 had 50.8% oil on dry seed basis.

Fatty acid composition of most of the varieties were similar with a very high level of ricinoleic acid (from 90.1% to 93.0%). Only the variety Gauc was different with a relatively low level of ricinoleic acid (60%) and relatively high level of linoleic acid (30.3%). In other varieties the linoleic acid content fluctuated within a narrow range from 3.6% to 4.7%.

Preliminary studies conducted have shown that sunflower is capable of producing satisfactory yields as a Yala or a late Maha (planted in late November) season crop. It is necessary to pollinate the flowers artificially to induce good seed set.

References

1. Joshi, M.S. Jayaramaiah, P.J. Habib A.P.; Angadi, S.P. (1981). Phenotypic and genotypic variability in quantitave characters in groundnut. Genetica Agraria, 35 (1), 1-5.

2. Pathirana, R. (1982 a). Variability of quantitative characters in bunch groundnut. Sri Lanka Assoc. Adv. Sci. 38 (1), 4.

3. Pathirana, R. (1982 b). Effect of gamma radiation on the variability of seed yield components of groundnuts (*Arachis hypogaea L.*) in M_2. Induced mutations for the improvement of grain legume production II, IAEA-TECDOC 260, pp. 129-132.

Acknowledgement

The authors wish to thank the Deputy Director (Research) Dr. Irwin Gunawardene, Director of Agriculture Dr. Walter Fernando and Dr. Hugh Doggett of IDRC for their interest and valuable suggestions for improvement of the oilseeds research undertaken by the Department of Agriculture. Financial assistance by the International Development Research Centre (Canada) and the International Atomic Energy Agency (IAEA) is also gratefully acknowledged.

Discussion: Country Presentation - Sri Lanka

It was confirmed by Dr. Pathirana that the high yielding groundnut strain 180/21 had arisen from his mutation breeding experiments and that the strain was stable and in about M_7 generation.

Considerable discussion took place on the usefulness of broad sense heritability measurements as an effective breeding tool. However, Dr. Pathirana believes the heritability studies identified those plant characteristics contributing to yield that were most highly heritable. He indicated that the data were drawn from the measurement of 60 plants for each variety grown at one location and that such data provided a measurement of the variability which existed in his germplasm. Time did not permit further discussion of this matter.

The question of degree of self fertility in sesame was raised. It was noted that outcrossing can be very high in Sri Lanka (68%). Others agreed that depending on pollinating insect activity, outcrossing in sesame could be as low as 5% or over 60%.

Session 6

Problems and Potentials: Sesame, Groundnuts, Rapeseed, and Sunflower

Chairman: Hassan Ishag

Rapporteur: Hugh Doggett

Development of Male Sterile Inbred Lines and Hybrid Cultivars of Indehiscent Sesame

D.M. Yermanos[1]

Abstract

Intensive genetic research with sesame at UCR during the last 6 years has led to the following accomplishments: (1) High-yielding dehiscent and indehiscent strains have been developed; (2) large amounts of hybrid vigor have been found in F_1 sesame populations, although sesame is a self-pollinated crop; (3) a male sterile line has been developed which can be used to develop male sterile inbred lines of indehiscent sesame.

These inbred lines could be used for the production of hybrid sesame seed, as is done with corn, to breed high-yielding hybrid indehiscent strains that can be harvested mechanically by direct combining. High yields and mechanical harvesting would lead to the acceptance of sesame as a major high-protein food crop in the southwestern states, as well as in several developing countries.

The objective of our research project is to utilize recently discovered genetic traits and concepts for the development of a new, renewable food resource which is of significance to semiarid regions around the world where malnutrition often prevails.

Background

Sesame is a valuable food crop grown on a small scale, mostly in agriculturally and economically depressed and overpopulated semiarid regions of the world. Its adaptation, in terms of latitude, is similar to that of cotton, but sesame needs far less water and fertilizers.

The major reason for sesame remaining as a minor crop is that it is a labor-intensive crop. Sesame varieties grown around the world are dehiscent types that allow the seed to shatter at maturity, through the ages and now, the harvest of sesame is done by hand. Thus, although there is a strong demand for sesame in the U.S, it is not grown commercially due to lack of mechanization, and about 30 thousand tons of seed are imported annually. Another reason for the low acreage of sesame is the low yields per area realized. This is largely because of the

[1]Professor of Genetics, University of California, Riverside, CA 92521

fact that as a minor crop it has received minor attention in terms of plant breeding research effort. Average yield of sesame in most countries is a mere 200-300 lbs per acre, while in our research plots, it approaches 2,000 lbs per acre.

Intensive genetic and agronomic research with sesame at UCR over the past 6 years has led to the following developments:

1. High-yielding indehiscent varieties have been bred which can be combine harvested directly and which have exceptional drought and heat tolerance.

2. Large amounts of hybrid vigor have been observed in certain crosses because of which, significant increases in yielding ability are possible (4).

3. Genetic male sterility has been found in certain breeding materials. This opens the way for the development of hybrid sesame cultivars for commercial plantings.

4. Modifications have been designed for commercially available grain combines which adapt them to the harvest of sesame.

5. Methods have been developed for growing and harvesting sesame as a main, single crop or as a companion crop.

   These (methods, equipment, and germplasm) form the basis for a major leap forward in the commercial production of sesame and indicate the directions for new research, the objectives of which are:

1. To develop indehiscent, male sterile lines of sesame. Male sterility in sesame is controlled by a single recessive gene (1,2,3). Through backcrossing of male sterile lines followed by selection, sterility will be transferred to indehiscent lines of sesame available at UCR.

2. To develop and yield test numerous F_1 populations derived from crosses between male sterile and male fertile parents to identify superior parental combinations.

3. To investigate the practical, agronomic and economic aspects of producing hybrids of seed indehiscent cultivars of sesame for planting commercial acreages.

4. To incorporate the "rough seed coat" character into the new indehiscent cultivars to facilitate the decortication of the seed. This trait is controlled by a dominant single gene. Decortication of "rough seed coat" seed can be done easily by inexpensive seed scarifiers without the use of lye, salt or other chemicals presently used by decortication plants.

Discussion of Research Objectives

Objective 1 - Studies of male sterility in sesame at UCR have shown that it is not of cytoplasmic nature, but a genetic trait under the control of a single recessive gene (2). F_2 populations derived from crosses between male sterile and male fertile lines had 25% male sterile individuals as expected for a single recessive gene model. By continuous backcrossing of the male sterile segregants to a recurrent indehiscent parent and selection of indehiscent male sterile individuals as the nonrecurring female parent in each backcrossing cycle, isogenic lines of indehiscent sesame will be developed differing only at the male sterility locus. This can be accomplished in about nine backcross generations. Using techniques developed at UCR, which make it possible to grow three generations of sesame in the greenhouse each year, this objective can be reached in 3 years.

Objective 2 - Various degrees of heterosis have been observed in sesame, reaching levels as high as 40% over the better parent of a biparental cross. Attempts to use hybrid vigor in the sesame have just begun; heterosis is still an untapped resource and a powerful tool for sesame improvement in terms of yield and yield components. If the increments in yield obtained in other agronomic crops through the use of hybrid vigor can also be realized with sesame, this would revolutionize its culture around the world.

Objective 3 - The use of genetic male sterility for production of hybrid seed is not as efficient as the use of cytoplasmic male sterility coupled with the use of fertility restorer genes. The latter are not available yet in sesame. Thus, genetic male sterility could provide the initial, practical approach for the production of hybrid sesame seed at this time until better methods are developed. To this end, a breeder would develop F_1 lines, heterozygous at the male sterility locus (i.e., MSms, where MS and ms are the alleles for male fertility and male sterility, respectively). These F_1 lines would be male fertile and would produce F_2 seed which, when planted, would give rise to F_2 plant populations segregating in a 1 MSMS:1 msms ratio. These F_2 populations, having 25% male sterile plants, would be used as female parents in crossing blocks for the commercial production of hybrid planting seed. Rows of such female parents would be interplanted with rows of suitable, normal, male fertile lines which would constitute the male parents. Soon after the initiation of flowering and during the 8-week period of flowering of sesame, all male fertile segregants would be rogued out of the female parent rows, leaving only the male sterile plants. With reduced interplant competition due to roguing, the latter would produce more flowers and therefore more seed per plant. Also, the male sterile plants of the maternal rows, following insect cross pollination with the male fertile pollen parent, would produce seed with an MS ms genotype at the sterility locus. This seed would produce only male fertile offspring and would be suitable for commercial plantings.

Since seed production will be based on 25% of the plants, on one of each pair of rows, the expected seed yield would be around 300-500 lbs, given that yield per acre in our plots in California is close to 1,800-2,000 lbs. A pound of sesame seed is more than enough to plant 1 acre of land. Thus, each acre of hybrid seed production would provide seed for 150-300 acres of land. It is conceivable that two or three rows of parent 1 could be planted with each row of parent 2, if sufficient activity of pollinating insects can be generated in the crossing field by introducing bee hives or even by enclosing the crossing field with mosquito netting and releasing bees inside the enclosure. If this plan worked, each acre of seed production could provide enough seed for more than 1,000 acres of field plantings.

Objective 4 - Sesame is traditionally decorticated before being used in food preparations. This is done because the seed coat has no food value and may even be harmful because of its high content of oxalic acid crystals that can cause irritations on the lining of the digestive system if large amounts of natural sesame seed are ingested. The decortication methods used now involve soaking of the seed in lye or salt solutions at high temperatures to loosen the seed coat of the cotyledons. The seed is subsequently subjected to rubbing, to separate the seed coat from the seed, and to extensive washing to wash off the chemicals used. This process is carried out in large and expensive decortication plants which require both a major investment and technical know-how to build. These requirements are hard to satisfy, especially in the less-developed countries, where most of the sesame is grown. Chemical decortication also adds to the cost of sesame and lowers the quality of seed in terms of taste and possibly in relation to the digestibility of the seed proteins.

The "rough seed coat" trait causes a mechanical weakness in the attachment of the seed coat to the cotyledons. One can remove the seed coat of this type of sesame by merely rubbing the seed between his/her hands. Commercially, this seed can be decorticated by using simple and inexpensive alfalfa seed scarifiers in which the carborundum rings were replaced by rubber ones. As already mentioned, the incorporation of the "rough seed coat" trait to "smooth seed coat" cultivars that are available in the market is very easy because the trait is controlled by a single dominant gene.

The introduction of male sterility, the production of new indehiscent isogenic lines, the use of various parental gene combinations, may cause major shifts in gene frequencies in the germplasm that will be the end result of this project. To ensure that this reshuffling of genes will not cause a deterioration in the nutritional value of sesame, analytical work will be conducted parallel to the breeding work to monitor any changes in fatty acid composition of the oil or in amino acid composition of proteins.

Bibliography

1. Osman, G.H. 1980. Genetic male sterility in sesame. Ph.D. Thesis, Department of Botany and Plant Science, University of California, Riverside.

2. Yermanos, D.M. 1981. Genetic male sterility in sesame: Inheritance. J. American Oil. Chem. Society Monograph, "New Sources of Fats and Oils", p. 69.

3. Osman, G.H. and D.M. Yermanos. 1982. Genetic male sterility in sesame (*Sesamum indicum L.*). Reproductive characteristics and possible use in hybrid seed production. Crop Science (In press).

4. Yermanos, D.M. 1980. Sesame in hybridization of crop plants. In: W.R. Fehr and H.H. Hadley (eds.), Hybridization of Crop Plants. p. 549-563, Amer. Soc. of Agron., Madison, Wisconsin, 765 p.

Groundnut in Southern Africa - Its Status and Research Requirements

S.N. Nigam[1]

The region covered by the Southern African Development Coordination Conference (SADCC) member countries, Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe, is very large and diverse. It lies between the Atlantic (11°E) and Indian Oceans (41°E) and stretches from near the equator to about 30"S, and has total area of 4.9 million km^2. In elevation, it ranges from sea level to mountains of over 3,500 metres with the major part of the region being on a plateau with an elevation of between 900 and 3,000 meters. Although 95% of the region is in the tropics, the whole of Lesotho and Swaziland, one third of Botswana and a small portion of Mozambique lie outside the tropics. These differences in location and physiography are reflected in the wide range of climates, soils and photoperiods found within the region. Well over 75% of the region is semi-arid as defined under ICRISAT's mandate.

Groundnut is an important cash and food crop in Southern Africa. Table 1 shows the FAO extimates of area and production of groundnuts in the SADCC countries.

Malawi and Zimbabwe are the biggest producers among the SADCC countries while the crop is not grown in Lesotho. Mozambique also has a substantial area under groundnuts but its total production is low.

---

[1]Groundnut Breeder, ICRISAT Regional Groundnut Program for Southern Africa, Chitedze Agricultural Research Station, Private Bag 63, Lilongwe, Malawi.

Table 1: Area and production figures for groundnuts in SADCC countries. (FAO Monthly Bulletin of Statistics, 1983:6(1))

Country[a]	Area (1000 ha)		Production (1000 Mt)	
	1981	1982	1981	1982
Malawi	250F	250F	180F	180F
Mozambique	170F	170F	80F	80F
Tanzania	94F	96F	56F	58F
Zambia	50F	50F	30F	30F
Zimbabwe	240F	240F	239	115[b]

[a] Figures not available for Angola, Botswana, and Swaziland.
[b] Unofficial figure

The next table gives the average yield of groundnuts in SADCC countries.

Table 2: Average yield of groundnut (kg/ha) in SADCC countries. (FAO Monthly Bulletin of Statistics, 1983:6(1))

Countries	1981	1982
Angola	N/A	N/A
Botswana	N/A	N/A
Malawi	720	720
Mozambique	471	471
Swaziland	N/A	N/A
Tanzania	596	604
Zambia	600	600
Zimbabwe	995	479
Africa	797	738
North Central America	2573	2630

Average groundnut yields in the region are very low compared to North Central America where average yields are over 2.5 tons/ha. Groundnuts are grown mainly by small-scale farmers, who obtain very low yields. Yields of over 4 tons/ha have been obtained on research stations and large scale farms in the region. As a matter of fact, the record yield of groundnut (10 tons/ha) was reported from Zimbabwe from the cultivar Makulu Red grown on a large farm.

The potential for increasing yields and hence total production in the region is great provided the existing constraints are removed.

Constraints

Constraints to groundnut production in the region have been identified at all stages from sowing through to marketing:

1. Poor cultural practices.
2. Damage from diseases and insect pests.
3. Low soil fertility.
4. Lack of suitable varieties for different agroecological areas.
5. Drought stress.
6. Shortage of labour and draught power.
7. Poor market prices.
8. Non-availability of good quality seed.

In certain areas post-harvest drying problems and aflatoxin contamination can reduce groundnut production and quality.

Staple grain crops and more remunerative cash crops get priority in planting, groundnut commonly being sown 2-3 weeks after the onset of the planting rains. Insufficient seed, failure to use good quality seed, and seed and seedling diseases result in low plant stands. In some areas groundnuts are still grown at much wider spacings than is recommended by extension services. Late planting and low populations result in increased incidence of groundnut rosette virus (GRV) and in weed control problems. Sometimes GRV completely wipes out the crop. However, under good cultural practices, a different set of constraints applies, and drought and leaf disease usually become of much greater significance.

Disease spectrum varies not only from country to country, but also within countries. Of the fungal diseases, leaf spot (*Cercospora arachidicola*, *Cercosporidium personatum*), rust (*Puccinia arachidis*) web blotch (*Phoma arachidicola*), pepper spot and leaf scorch (*Leptosphaerulina trifolii*), pod rots and *Aspergillus flavus* are important on a regional basis. Recent studies in Tanzania have shown 36% yield loss caused jointly by rust and leaf spot (Simons, Unpublished data). Rust has become so serious in Southern Mozambique that it has almost destroyed the groundnut crop there.

Among the virus diseases, GRV is most important and is capable of causing almost 100 percent loss in crops planted late and at wide spacing. Peanut Mottle Virus (PMV) is another common disease; however, the extent of losses caused by it is not known.

Among the insect pests, Hilda (*Hilda petruelis*), aphids (*Aphis craccivora*) and termites are frequently encountered and sometimes they cause serious damage to the crop. Aphids also act as vectors of GRV and PMV. Other insect pests such as thrips and jassids can also occur in serious proportions in the field. No effort has been made to quantify yield losses caused by insect pests.

Generally, groundnut in the region is grown without any nutrient input. During the surveys in Malawi, Mozambique, Tanzania and Zimbabwe, with few exceptions nodulation was invariably found to be inadequate. Low soil pH further accentuates the problem and can induce "pops" and poor seed growth.

With the exception of Malawi and Zimbabwe, the varietal picture in the region is not very encouraging. Even in these two programs, development of short season varieties has received little attention. In Zambia and Tanzania, previously released varieties have largely become mixed. In Mozambique no recognized improved varieties exist. In Botswana and Swaziland, varieties are of South African origin and perform well only under good management.

The importance of drought as a factor limiting groundnut production varies within the region. In Malawi and Zambia, it is less important than in other countries where rainfall distribution is uneven. Mid-season droughts of 2-3 weeks are common in the region.

Labour and draught power also affect groundnut production in the region. Where hand tillage is practiced, land preparation and planting are done after the first rains. Even with draught power, earlier operations are precluded due to poor state of health of animals after a long dry season.

Weeding and harvesting are other labour intensive operations in groundnuts which, if not done on time, lead to decreased quality and yields. Labour priority goes to staple grain crops

Groundnut prices in official markets are much lower than those prevailing in the local unofficial village markets. Low prices offered by the government make groundnut an unattractive crop in terms of priority and labour and other inputs.

Due to lack of a seed production infrastructure, farmers are not able to get good quality seed of improved varieties. In some places, virtually no groundnut seed is available.

Status of Groundnut Research

With the exception of Swaziland, research programs in the SADCC countries are active to varying degree.

Currently, the largest program is in Malawi, where the crop is of greater significance to the economy than in any of the other countries. This program and that of Zimbabwe have been maintained for a long time and have successfully contributed to the improvement of the crop. Although Zambia and Tanzania have a history of groundnut research, the programs were allowed to lapse and have only recently been restarted with external assistance (Zambia, FAO and World Bank; Tanzania, ODA + IDRC). The program in Mozambique has been started with IDRC assistance. There is no groundnut research worker in Swaziland.

Limited availability of skilled and trained manpower, discontinuity in research and personnel changes have contributed to slowing down of progress.

Most of the programs have breeding, pathology and agronomy components. In addition Malawi covers physiological, microbiological and seed quality aspects. The Zimbabwe program has the best research infrastructure and facilities in the region and at one time was the strongest. However, due to movement of personnel, its impact has been reduced.

Most of the major programs in the region had a sizeable germplasm collection in the past, but much has been lost. Presently, the largest collection in the region is available with the program in Zambia.

Breeding programs in Zimbabwe and Malawi have been most active and have released 7 and 6 varieties respectively for cultivation. Breeding activities in the region have relied heavily on "introduction" and "selection". This has paid rich dividends in Zimbabwe and Malawi where five and four varieties have resulted from the introduced material. However, in the longer run further improvements can only be achieved through hybridization. There is no hybridization activity in Botswana + Mozambique. Zambia has recently undertaken a moderate program. As Malawi has temporarily suspended hybridization, Zimbabwe is the only program continuously making new crosses. Resistance breeding has only recently received the attention it merits.

Since groundnut sales are most remunerative in the confectionery grades, the breeding programs in general place considerable emphasis on seed size and other quality characters. This has resulted in less attention being paid to the requirements of the small farmers who grow the bulk of the crop under rainfed conditions and with limited resources.

Increasing cooperation with ICRISAT has resulted in the supply of useful germplasm and breeding material to the national programs in the region and the availability of more research information is slowly bringing greater awareness and a shift in research priorities and activities.

ICRISAT Regional Groundnut Program

Realising the inadequacy of research on groundnuts in the region and the urgent need to coordinate existing research efforts and to build up effective groundnut research organizations where these are at present lacking, the ICRISAT Regional Groundnut Program was established at Chitedze Agricultural Research Station, Malawi, in July 1982 with IDRC financed assistance. This action was taken by ICRISAT in response to a 1980 request by heads of state of nine SADCC countries for such regional assistance.

The major objectives of the program are:

1. To develop high yielding breeding lines/populations adapted to the region's different agroecological zones and with resistance to the main factors presently limiting production at the small farmers level.

2. To cooperate with national groundnut research and development programs in the SADCC countries in both regional and local research projects.

3. To train groundnut research workers from SADCC countries in various aspects of groundnut research at the regional centre in Lilongwe and at ICRISAT Centre in India.

4. To organize workshops/symposia to evolve regional research strategies and disseminate up-to-date research information in the region.

As it is in the initial phase, the program has only breeding and pathology components. The following research priorities have been identified:

1. Breeding for disease resistance - Breeding for disease resistance will receive the utmost attention of the team. Among the fungal diseases, early leaf spot, late leaf spot and rust will get the maximum attention. At a later date, work could be initiated on *Phoma arachidicola*, *Aspergillus flavus* and pod rots. Among the virus diseases, GRV will get the top priority. Limited work will be done on PMV.

2. Breeding for increased yield and quality - This project will primarily generate the base materials for the disease resistance breeding project besides producing useful material for situations where the usual constraints may not occur or can be controlled.

3. Breeding for earliness - Development of short season varieties will be of prime importance particularly for the small scale farmers.

The strategy is:

1. Breeding for disease resistance - Excellent sources of resistance to leaf spot, rust and GRV are available. Advanced breeding populations have been developed at ICRISAT Centre using leaf-spot- and rust-resistant sources. This material has been successfully screened in India and elsewhere for late leaf-spot and rust resistance. Lilongwe provides an ideal site for early leaf spot resistance screening. After ICRISAT's late leaf spot and rust-resistant lines have been screened for early leaf-spot resistance, promising lines will be evaluated for yield under different agroecological conditions in the region in cooperation with the national programs. Breeding for GRV will be initiated in the regional program as this virus apparently does not occur outside Africa. Major emphasis will be placed on incorporation of GRV resistance into short season varieties. Efforts will be made to incorporate multiple disease resistance in high yielding lines.

2. Breeding for increased yield and quality - High yielding breeding material obtained from the ICRISAT Centre in India will be yield tested in regional trials after preliminary evaluation at Lilongwe.

Since cultivars with bold seed size command premium prices in the confectionery trade, seed size and quality will be important selection criteria in this project.

3. Breeding for earliness - Development of high yielding short season varieties have not received adequate attention in the past. Considerable resources will be devoted to identifying short season varieties in both *fastigiata* and *hypogaea* groups.

Results

1. Germplasm - Six hundred germplasm lines, primarily of South American origin, were field evaluated for disease resistance, yield and adaptability. Some 40 lines were identified as having high yield and earliness. These lines are being multiplied in the off-season nursery in the Lower Shire Valley in Malawi. A preliminary yield trial will be conducted in the coming season. None of these germplasm lines showed any useful resistance to the major diseases in the region.

   Malawi germplasm was field evaluated for rosette resistance and 12 highly promising lines were identified. Some of these lines include earlier reported resistant sources in their ancestry.

   Reported sources of resistance for early leaf spot in the USA did not show any marked resistance to this disease at Lilongwe. Efforts will continue to find better sources of resistance to early leaf spot. More germplasm from the Bolivian and other regions will be introduced and the material will be screened against major diseases.

2. Breeding for disease resistance - GRV - About 100 crosses have successfully been completed involving promising sources of rosette resistance. The F_1s will be planted in the field in the coming season. Some of the crosses attempted involved late leaf-spot and rust-resistant parents.

   Rust/Leaf spot - About 1,000 early and advanced generation rust-and late leaf-spot resistant populations were screened for early leaf-spot resistance. Some promising selections have been made for early leaf-spot resistance, and it is hoped that these selections will carry good levels of resistance against the three pathogens. This material will be yield tested in the coming season. Some more promising material will be obtained from the ICRISAT Centre.

3. Breeding for increased yield, quality and earliness - One thousand early and advanced breeding lines were planted in the field for yield evaluation and further selection under Lilongwe conditions. Some 80 promising lines were identified based on high yield, seed size and earliness. These lines are being multiplied in the off-season nursery in Malawi. These lines will be included in the regional yield trial in the coming season. New breeding material is also being obtained from the ICRISAT Centre. A hundred crosses have successfully been completed involving high yielding varieties of the region.

   During the past year, several surveys have been conducted in the region and a clearer perspective of the groundnut situation in the region is now available. As the team expands further, other research projects will be undertaken and the program will evolve on multidisciplinary lines. To strengthen the program and develop more active cooperation in the region, a workshop on groundnut research problems and research priorities in southern Africa will be organized early next year.

Problems and Potentials of the Oilseed Brassicas

R.K. Downey[1]

The oilseed rapes (*Brassica campestris* and *B. napus*) and mustard (*B. juncea*) are the fourth most important world edible oil sources, being surpassed in oil production only by soybeans, sunflowers and palm (Table 1). Although a very high percentage of the crop is used domestically by producing countries, the trade in *Brassica* seed, oil and meal is increasing year by year.

These crops are well adapted to the more vigorous climates of the temperate zone and in high elevations, and as winter crops in the subtropics. The main producing regions are Canada, China, the Indian subcontinent and northern Europe, both west and east (Fig. 1).

The three *Brassica* species are closely related to one another as well as to black mustard, the cole vegetables and *B. carinata* of Ethiopian origin, which appears to have some potential as an oilseed crop (Fig. 2). Both annual and biennial forms of the rapes are commercially grown, but the mustards appear to have little or no winterhardiness. The early and hardy *B. campestris* species is best adapted to the extremities of the temperate zone, and as an early winter crop in India and parts of Pakistan (Table 2). Winter *B. napus* dominates the acreage in Central Europe and China, while the annual form is important in Canada. *B. juncea* is the main winter crop in India and Pakistan.

In future years this distribution pattern may change. Reports from Spain, California, Australia and Canada, given at the recent International Rapeseed Congress in Paris, highlighted the potential of *B. juncea* as an edible oil crop for semi-arid regions. In general, they reported this species to yield more seed, hold its seed better, have better drought and disease resistance than the two rape species, and to be earlier maturing than *B. napus* (Downey 1983).

Given this background, let us now look at the problems and potentials of these *Brassica* oil crops. The main reason for growing these seed crops is for the oil they contain. All species have the capability to produce at least 40 to 44% oil on a dry weight basis. Until recently, all varieties contained an unusual but natural 22 carbon monoenoic fatty acid in their oil, called erucic. It was concluded after much nutritional investigation that where rapeseed or mustard oil made up a significant portion of a high fat diet, such as it did in Canada and northern Europe, it would be

---

[1]In charge, Oilcrops, Agriculture Canada Research Station, 107 Science Crescent, Saskatoon, S7N 0X2, Canada.

nutritionally desirable to lower the erucic acid intake. As a result, low erucic acid strains and varieties have now been developed in all three *Brassica* oilseed species, and the genetics and chemical breeding procedures to develop such varieties have been documented. For those who wish to know more of the nutrition of high and low erucic acid rapeseed oil, they are referred to a new book edited by Kramer, Sauer and Pigden, 1983. Good progress is also being made by plant breeders in increasing the proportion of the nutritionally desirable linoleic acid from the present 25% to over 30%, and at the same time reducing the unwanted linolenic acid from 9 to less than 7%, and hopefully below 3%.

Basically these *Brassica* crops will provide a high yield of a nutritionally desirable oil with excellent keeping qualities for both the liquid oil market and the manufacture of margarines and shortenings. However, the oil makes up only 40 to 44% of the seed weight, and for the crop to be competitive the highest possible value needs to be obtained from meal which remains after oil extraction. This meal contains about 40 to 42% high quality protein and is nutritionally equivalent to soya protein. The major drawback to the use of rape and mustard meal as a high quality feed rather than as a fertilizer is the presence in the seed of sulphur-based compounds called glucosinolates. These compounds give the desired odor and flavor to the cole vegetables and to the condiment mustards, but they can be an antinutritional factor and cause palatability problems if the seed is improperly processed during the extraction process. This is particularly true for monogastric animals and poultry (Bell 1983).

Although the intact glucosinolates are relatively innocuous, the seed-borne myrosinase enzyme will chemically split the glucosinolates giving sucrose and the nutritionally undesirable isothiocyanates, oxazolidinethiones or nitriles if moisture is present when the seed is crushed (Fig. 3). In most small extraction mills and ghanis this reaction is allowed to occur with the result that the feed value of the meal is reduced and the price equated more closely to an organic fertilizer than a high quality feedstuff. The additional problem which these sulphur-bearing breakdown compounds create is that they are soluble in the oil, and in countries which prefer hardened oils, such as margarine, vegetable ghee or vanispati, the sulphur will inactivate the hydrogenation catalyst during the hardening process. The result is the loss of an expensive catalyst and unexpected downtime at factory.

The stop-gap answer to the glucosinolate problem was to heat inactivate the myrosinase enzyme as the first step in oil extraction by cooking the flaked seed without the addition of water. However, the ultimate solution has been to breed rapeseed varieties which contain very low levels of glucosinolates in the seed. The availability of the low glucosinolate

Table 1: World edible vegetable oil production and percentage contributed by the main oilseed and tree crops.

Oilseed or Tree Crop	Annual Production (%)					5-yr. Av.
	1978	1979	1980	1981	1982	
Soybean	31.5	35.0	31.3	32.9	30.8	32.3
Sunflower	12.5	13.6	12.0	12.1	12.2	12.5
Rapeseed	9.8	8.2	9.7	9.5	9.9	9.4
Cottonseed	8.0	7.8	8.1	8.3	8.5	8.1
Peanut	8.9	7.5	7.6	7.6	7.6	7.8
Other seeds*	4.3	3.9	3.8	3.8	3.9	3.9
Palm	13.2	13.3	14.5	14.5	16.6	14.4
Coconut	7.6	7.3	8.4	8.1	7.5	7.8
Olive	4.2	3.4	4.6	3.2	3.0	3.7
Total Edible	37.1	41.2	39.4	42.0	42.0	40.3
Total Indust**	1.4	1.4	1.4	1.3	1.2	1.3

*Primarily sesame (1.6); corn (1.2) and safflower (0.8).

**Approx. 55% linseed oil.

Table 2: Approximate percent acreage occupied by each *Brassica* oilseed species and form in the main production areas.

Production Area	Napus		Campestris		Juncea
	Ann.	Bien.	Ann.	Bien.	Ann.
Canada	50	0	50	0	0
Indian continent	1	0	40	0	60
China & Korea	3	90	2	2	3
Europe E & W	2	93	3	1	1

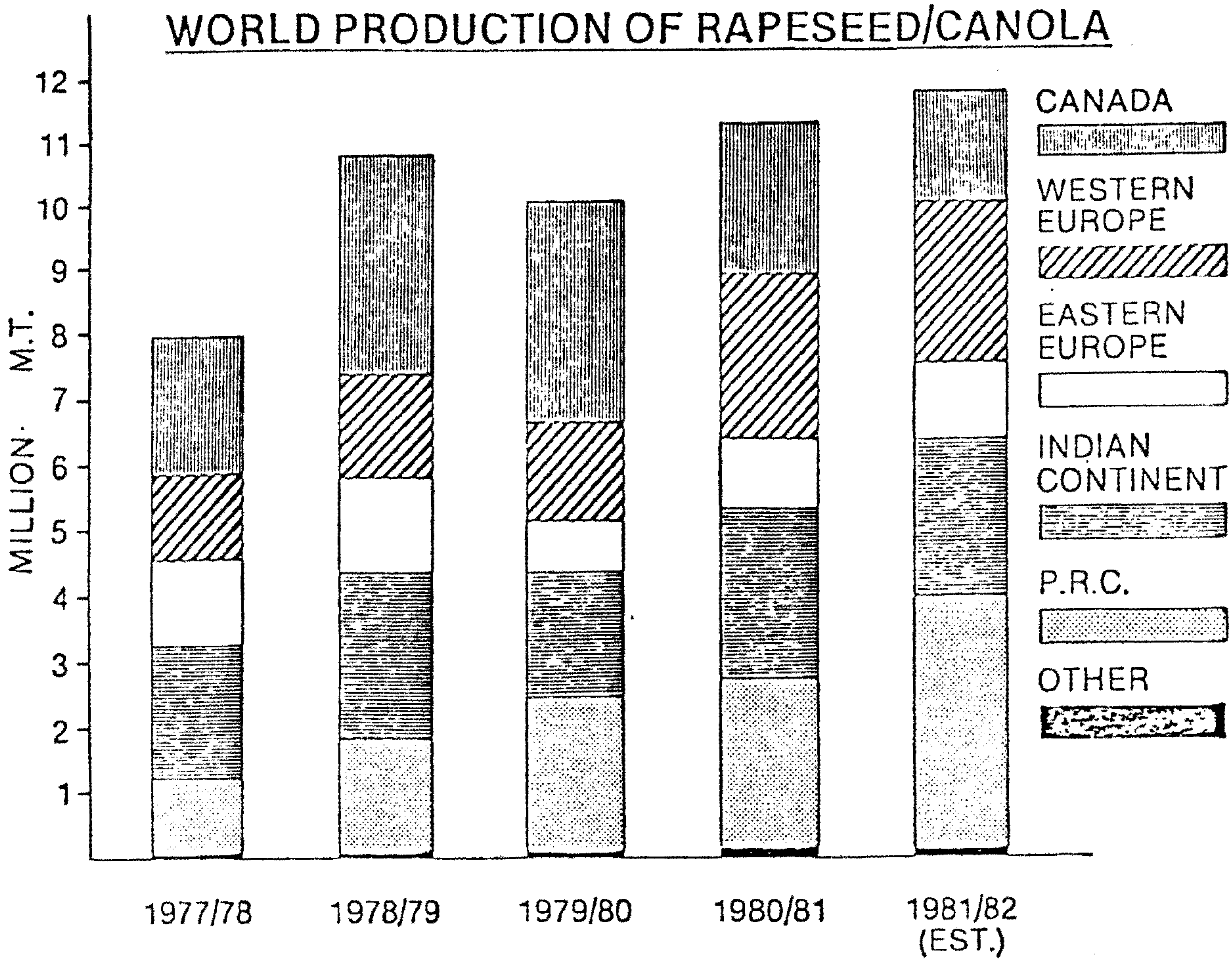

Fig. 1. World production of rapeseed/canola, 1977 through 1981.

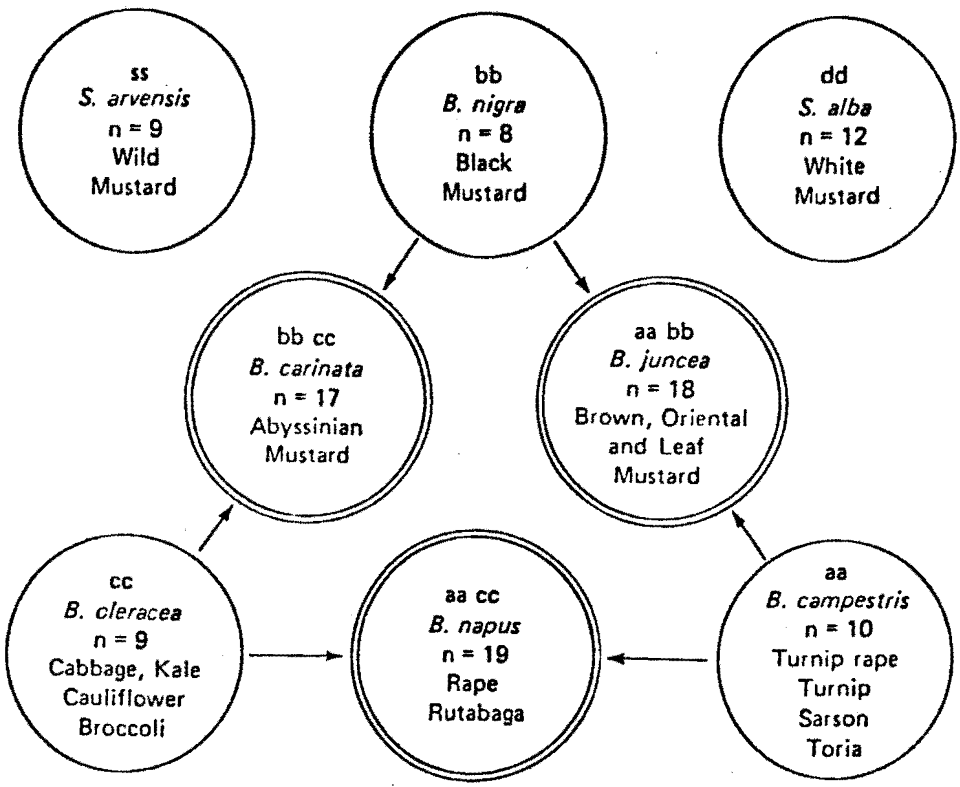

Fig. 2. Genome relationships of some economically important Brassica species.

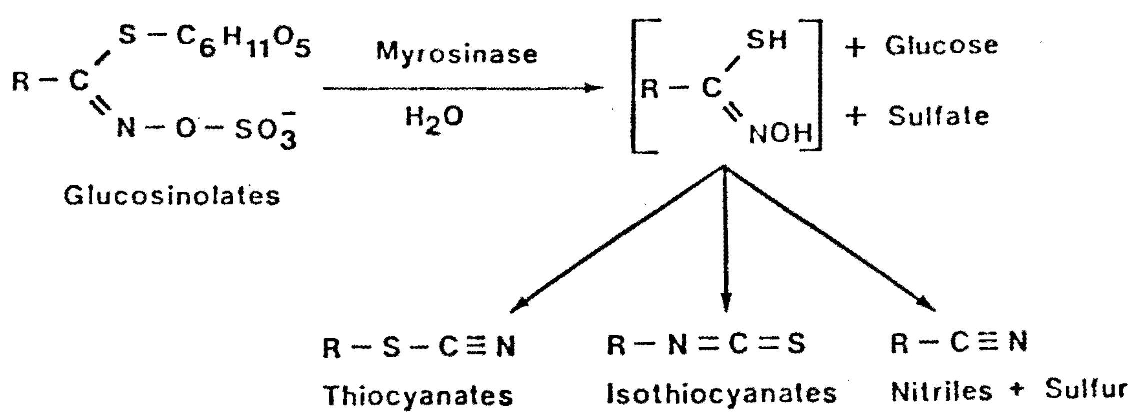

Fig. 3. General structure of glucosinolates and enzymatic hydrolysis products.

meals has markedly increased the value and marketability of the meal, both domestically and in world markets, and resulted in more easily refined and hardened oil. Canola meal, as low glucosinolate meal is now called, must, by definition, contain less than 30 umoles of the commonly measured glucosinolates as compared to 100 to over 160 umoles normally found in *Brassica* oilseed meals. Present Canadian rapeseed/canola varieties normally contain less than 15-20 umoles when released to producers, and it is expected that in the future canola meal will normally contain no more than 10 umoles of glucosinolates. However, to fully exploit the potential for *B. juncea* as an oil crop, low glucosinolate strains must be developed. A recent report from Davis, California, indicates that such plants have been identified in Chinese introductions (Cohen et al. 1983). However, this has still to be confirmed in analyses of the progeny.

The technique and equipment for accurately measuring the quality factors of erucic acid and the glucosinolates has been technically demanding and expensive since gas chromatographic and spectrophotometric equipment has been required. Indeed, with high pressure liquid chromatography we are finding traces of glucosinolates in rapeseed and other *Brassicas* which were previously undetectable (see McGregor et al. 1983 for review and discussion of glucosinolate analysis). However, techniques have now been sufficiently simplified in procedures, and equipment for use by breeders in almost any country. Paper chromatography (Thies 1971) or differential solubility (McGregor 1977) for erucic acid determination and the Palladium test (using only a grinder and colorimeter) for the glucosinolates (Thies 1982) will give low cost but sufficiently reliable values for breeders to develop "canola" quality varieties.

In some countries, however, the need for higher seed yields is much greater than the need for improved nutritional quality. One of the more exciting possibilities which now exists is the development of hybrid varieties in all three of the *Brassica* oilseeds. Studies using hand or natural crosses showed that hybrids can be expected to yield 30 to 45% more seed than standard varieties, and that the yield advantage of hybrids is likely to be greatest under unfavorable or stressful growing conditions (Hutcheson et al. 1981; Sernyk 1983). Several CMS systems have been identified at least one in each of the *Brassica* oilseeds, but none has yet been commercially exploited. The Chinese are commercially using a genic system and obtaining a 30 to 35% yield increase, but labour requirements would make it uneconomic in most other countries (Lee and Zhang 1983).

The main CMS systems being investigated are:

1. Radish cytoplasm in *B. napus*; however, no suitable restorer has yet been found, and leaf chlorosis has been a problem.

2. *B. napus* cytoplasm (Thompson-Shiga system). Restorers and maintainers known but pollen sterility imperfect at higher temperatures.

3. The Hinata *Diplotaxis muralis* system with *Diplotaxis* cytoplasm in *B. campestris* (also works in *B. napus* and *B. juncea*). This system with known restorers and maintainers appears to have the most commercial promise at the moment.

4. The New Delhi *B. juncea* system is thought to involve *B. nigra* cytoplasm. Sterility is good and can be transferred to other genera. Maintainers are no problem, but the availability and effectiveness of the restorer has yet to be determined (Anand and Rawat 1983).

   (For a discussion of systems 1 through 3 see Shiga 1980). It is probable that hybrid varieties of rapeseed/canola or mustard will be in commercial production by 1990.

The other area of excitement and great potential is the fast breaking developments in the application of biotechnology to the *Brassica* oilseeds. This plant group appears to be one of the most pliable and responsive to the techniques of haploid production through anther culture, protoplast fusion, injection and other very basic and useful techniques (see papers on this subject in Proceedings of the 6th International Rapeseed Congress, Paris, 1983).

Although the breeders and their chemist and biotechnology colleagues have and are making significant advances towards improved quality and yield characteristics, we cannot lose sight of the fact that the *Brassica* are lush growing crops and ideal hosts for many diseases and insects. Time does not permit a discussion of these problems but in this part of the world aphids have to be considered a potentially limiting factor, although some changes in plant structure may provide a degree of protection (Malik 1981).

Great strides have been made in *Brassica* oilseed crop improvement over the past 20 years, and the opportunities for even greater and more rapid advance appear to be as real today as they have ever been. But to keep up the momentum, international cooperation, particularly in the exchange of germplasm and technical knowledge, is an essential ingredient. I hope that this workshop has fostered and brought about such exchanges and that together we can significantly increase the availability of nutritious oils and meals so essential to the health and welfare of the world's population.

References

Anand, I. J., and D.S. Rawat. 1983. Interspecific hybridization and fertility restoration in Indian mustard. Proc. 6th Intern. Rapeseed Congr., Paris. In press.

Bell, J.M. 1983. Nutrition and toxicants in rapeseed meal: A review. J. Anim. Sci. In press.

Cohen, D.B., P.F. Knowles, W. Thies, and G. Robbelen. 1983. Selection of glucosinolate-free lines of *Brassica juncea* Z. Pflanzenzuchtg. In press.

Downey, R.K. 1983. Developments in rapeseed genetics and breeding -- An overview. Proc. 6th Intern. Rapeseed Congr., Paris. In press.

Hutcheson, D.S., R.K. Downey, and S.J. Campbell. 1981. Performance of a naturally occuring subspecies hybrid in *B. campestris L* var.*oleifera* Metzg. Can. J. Plant Sci. 61: 895-900.

Kramer, J.K.G., F.D. Sauer, W.J. Pigden (eds.). 1983. High and Low Erucic Acid Rapeseed Oils. Production, usage chemistry and toxicological evaluation. Academic Press, Toronto, 582 pp.

Lee, S.L., and Y. Zhang. 1983. Utilization of genic male sterility *(Brassica napus)* in Shanghai, China. Proc. 6th Intern. Rapeseed Congr., Paris, In press.

Malik, R.S. 1981. Morphological, anatomical and biochemical basis of aphid, *Lipophis erysimi* Kalt., resistance in Cruciferous species. Sveriges Utsadesforenings Tidskrift. 91: 25-35.

McGregor, D.I. 1977. A rapid and simple method of screening rapeseed and mustard seed for erucic acid content. Can. J. Plant Sci. 57: 133-142.

McGregor, D.I., W.J. Mullin and G.R. Fenwick. 1983. Review of analysis of glucosinolates. Analytical methodology for determining glucosinolate composition and content. J. Assoc. Off. Anal. Chem. 66: 825-849.

Shiga, T. 1980. Male sterility and cytoplasmic differentiation. pp. 205-221 in Tsunoda, S.; Hinata, S.; Gomez-Campo, C., eds. *Brassica* Crops and Wild Allies. Biology and breeding. Japan Sci. Soc. Tokyo.

Sernyk, J.L. 1983. Heterosis in summer oilseed rape *(Brassica napus L)*. Proc. 6th Intern. Rapeseed Congr., Paris. In press.

Thies, W. 1971. Rapid and simple analyses of the composition of the fatty acids in individual rape cotyledons. 1. Methods of gas and paper chromatography. Z. Pflanzenzuchtg. 65: 181-202.

Thies, W. 1982. Complex-formation between glucosinolates and tetrachloropalladate (II) and its utilization in plant breeding Fette Seifen Anstrichmittel 84: 338-342.

Sunflower Breeding, Problems and Potentials

Walter Dedio[1]

Considerable progress has been made in sunflower breeding during the last 3 decades resulting in a tremendous boost in sunflower production, particularly in the Western countries. The major advances in sunflower breeding have occurred in two different parts of the world at different times with different breeding approaches.

The first big stride was made by the Soviet Union, who used a modified type of recurrent selection to improve the open-pollinated varieties, which were released in the 1960's. Their biggest progress was made in improving oil content in varieties such as Peredovik which is still grown around the world. Yield and disease resistance such as rust and Verticillium wilt were also improved in their varieties.

After discovery of the cytoplasmic male sterility by Leclercq in the late 1960's, it became possible to produce genuine hybrids. American breeders took advantage of the heterosis in hybrids which resulted in 15-20% yield increase, and within a few years hybrid seed was marketed by several companies. The hybrids also were more self-compatible, more uniform with stronger stems and had better disease resistance, particularly to downy mildew. Hybrid breeding is now being carried out in Europe, Australia and South Africa. The main disadvantage of hybrids is the high cost of F_1 seed which would have to be bought every year. This could be a problem in some of the developing countries.

The overall approach in these two areas of breeding is therefore, quite different. The first method deals with improving a population, and self-sterility is important to ensure as much cross-pollination as possible. In hybrid development, one is looking for more self-compatibility as the hybrid is genetically homogeneous. I will deal first with basic mechanical techniques briefly that may be used in the countries represented here. I also intend to mention some areas where we might co-operate in developing cultivars adapted in the different regions.

I do not intend to go into much detail in the artificial hybridization technique as this has been published by Dedio and Putt (1980) in <u>Hybridization of Crop Plants</u>. Briefly, we use a forceps for removing unwanted florets and a brush with camel's hair for transferring pollen to the mother plant. Other workers use cotton balls or leaves to transfer pollen.

---

[1]Sunflower Breeder, Agriculture Canada Research Station, Morden, Manitoba, Canada.

It is important that emasculation be done early in the morning to prevent self-pollination, particularly when one is working with self-compatible lines. Ideally, this would be about 7:00 in the morning when the anther tube is extended sufficiently to be grasped by the tweezers.

Several different types of bags are used to prevent out-crossing and to collect pollen in North America. These include the Delnet plastic bags, paper and cotton bags. We prefer the plastic bags, obtained from an American supplier, because of their transparency and therefore enabling us to see the stage of floral development and also because these bags are perforated, allowing for ventilation and drying of the head. These bags, however, are expensive and fragile and can be used once or twice only. Also because these bags are perforated, some out-crossing can occur as the pollen grains can get through.

Now I would like to turn my attention to the germplasm that we have and could be available for your breeding programs. Most of our material is in inbred form since we are involved exclusively in hybrid development. These lines, however, can be incorporated and used in development of synthetic varieties.

There is about a 6 week range in maturity requirement in the germplasm that we have. In Canada, because of the short growing season, most of the material is of short growing season type. Some of our better early lines are CM 447, CM 591 as well as HA 232 and HA 301 which were released by the United States Department of Agriculture. Some good late maturing lines are HA 303 and HA 831 from USDA.

Most of the early lines are of short stature with the shortest being about 50-60cm tall. The tallest lines are well above 200cm which we receive from Kenya. The short hybrids generally do not yield as well as the taller ones but they do appeal to some growers because they are less likely to lodge and are easier to harvest. Another source of lodging resistance may come from wild sunflower which seem to have a stronger root system. We have observed that plants outcrossed with wild *H. annuus* were more difficult to rogue.

Several lines are available with oil content as high as 55%. These include the USDA lines HA 302 and HA 300 and some of the lines in our breeding program. Unfortunately emphasis on oil content has not been as much as it should be. Analyses for oil content are done by the Nuclear Magnetic Resonance method which makes it possible to analyze few hundred samples a day. Since it might not be possible for every research institute to purchase an NMR instrument, perhaps they can band together and buy one.

Four diseases are of concern to us in North America and three of these are being considered in our breeding program, as it is possible to incorporate resistance to these. From what I gather, two of these can be a problem in the countries represented here. Rust is a worldwide problem, but, fortunately, good resistance is available and has been incorporated in most of the hybrids. Lines such as HA 290, CM 588, CM 392 and CM 400 are good sources of rust resistance and at the same time have good combining ability. We have also identified additional lines with rust resistance. Screening for resistance to rust is carried out by planting a very susceptible line such as S37388 every fifth or sixth row. The susceptible rows are inoculated with rust spores in talc or in light mineral oil suspension and usually in the evenings when there is some dew present. Secondary infection results in the spread of the rust to adjacent rows.

Downy mildew stunts the plant shortly after germination. The disease develops when humid conditions are present at time of emergence. In North America, almost all the hybrids have resistance to this disease. The resistance comes from the male parent which is usually branching, a character conditioned by recessive genes. The character does not show up in the F_1 plant and is not desirable in sunflower cultivars as it reduces yield. We have, however, released restorer lines CM 587, CM 590 and CM 592 which are non-branching, and can be used in your breeding programs. In addition, some years ago, USDA released several lines from the Sputnik cultivar with downy mildew resistance incorporated. I have just made several crosses using these lines with rust resistant ones with the intention of incorporating resistance to both diseases. This germplasm can be made available to anyone requesting it.

Screening for downy mildew resistance is normally done in the greenhouse by dehulling three-to four-day old seedlings and inoculating at 16-18°C by immersion for five to six hours in a spore suspension. They are then transplanted into unsterilized greenhouse soil and readings made 15-18 days after transplanting. It might be possible to have the screening done in the field if natural infections are frequent enough.

We have not put any effort into improving the drought resistance of our cultivars as moisture is usually adequate in the North American growing areas. Some cultivars from the USSR such as Don 695 have been reported to yield better under drought conditions than other cultivars. Unfortunately, we do not have this cultivar in our collection.

One approach to improving drought resistance could be through use of wild *Helianthus* species which often grow in arid areas. In Canada, we have observed *H. petiolaris* growing on top of sand dunes where hardly any other vegetation was present. This species can be hybridized with the cultivated

H. annuus and we hope to do this shortly. We can provide the seed of *H. petiolaris* which needs stratification before it would germinate or supply you with germplasm with one or two backcrosses. It might be easier for you to do the screening and testing as you have more appropriate natural conditions.

Losses from predators such as birds, particularly blackbirds, can be fairly heavy. United States have put much effort in developing bird resistant varieties and last spring have released 3 bird-resistant synthetics, BRS-1, BRS-2 and BRS-3 which can be used in breeding programs. The bird resistance comes from white color hulls, long wrap-around bracts, flat or concave heads, long necks, and tightly packed seeds.

The long drooping neck is generally being avoided in North America breeding programs in favour of upright heads with short necks because of their attractiveness and their lower chances to accumulate water at the back, resulting in head rot. The long neck type is more likely to lodge but it still might be preferable to have this type in hot climate countries. Besides affording some protection from birds, the head is not exposed to direct sunlight which could result in seed failing to develop.

Whether one uses self-fertile or self-sterile lines depends on the objective of the breeding programs. In hybrid development, self-compatibility (or fertility) is essential for good pollination and seed set to occur. In development of synthetic cultivars, it would be preferable to have a high degree of incompatibility to ensure as much cross pollination as possible. The lines from North America probably can be used best by crossing with open-pollinated cultivar plants. If the self-sterile plants are used as the female it may not be required to emasculate the plants. Lines with cytoplasmic male sterility background such as most restorer lines should be avoided as female plants in crossing programs. So far no problems have been found having cytoplasmic male sterility background aside from the sterile plants that would appear and being less attractive to bees. The restorer lines with cytoplasmic male sterile background can be used as pollinators since the cms is maternally inherited and is not transferred with the pollen.

Discussion: Problems and Potentials. Sesame, Groundnuts, Rapeseed, Sunflower

Dr. Yermanos augmented his prepared paper by describing his vision of ideal sesame production. The seed used would be ivory white, and large with 55%+ oil content, the meal after extraction containing some 75% of methionine-rich protein. Color may not be important as the decorticated seed is always white. The seed-coat would be rough and, therefore, easier to decorticate with simple equipment. Decortication would not be done until just before oil extraction, so that any damage during decortication would not have time to affect the oil quality.

Seed would be pelleted for planting, thus eliminating problems from uneven seed size. The pellets could be coded to avoid mixing of seed. Seed rates would then be about 0.5kg/ha. Yields improve with close spacing, achieved with tractor planting by using double rows on beds 1m apart. The beds ensure drainage and freedom from waterlogging.

Weeds would be controlled with preemergence herbicides such as Lasso, Prepar or Preplan, and the sesame would itself suppress any subsequent weed growth. Pest control may be necessary in some situations.

Sesame does not respond profitably to fertilizers, so the crop would be grown on fertile land. A crop desiccant (dequat) would be applied when the lower leaves were beginning to senesce, but the crop would not be combined until completely dry, as any green material clogs the combine (which was described and illustrated). Also the plant type should have only one capsule per leaf axil as additional capsules pass through the combine unthreshed, owing to their orientation. A maturity length of 75-90 days seems ideal.

Subsequent discussion underlined the need for studies of the filling and ripening of sesame seed in relation to the time of cutting the plant. Dr. Yermanos suggested a space of 15 days from the beginning to the end of flowering is the maximum to avoid excessive shattering.

Much more information on crop management is needed, including the development of fertile soil for the crop.

Dr. Nigam noted that the parasitic weed *Alectra* is often found on the crop. He underlined the need for improvement management.

Participants from Sudan, Tanzania and Mozambique noted that the highest yielding and most adapted material had generally been developed, or collected in Africa. They questioned whether sufficient attention is being given to the local African germplasm.

A plant pathologist will soon join the Malawi-based team, and an agronomist or physiologist may be added also.

Erucic acid levels were discussed. There is no evidence that erucic acid is deleterious to health, and the need for low erucic acid levels arises largely from bureaucratic pressures.

Glucosinolates are deleterious to livestock, especially to monogastrics, but the glucosinolate levels can be very much reduced by simple methods during processing.

Crambe oil is unlikely to be commercially useful, as the seeds are difficult to hull and the meal is high in glucosinolates. Dr. Downey suggested that *B. juncea* might provide a better source of oil with high erucic acid.

Sunflower discussion centred on the suitability of population improvement by recurrent selection for the developing world, rather than hybrids. This has been successful in Russia.

Session 7

Discussion Groups
Recommendations
Closing

Chairman: K. Riley

Rapporteur: H.E.G. Osman

Discussion and Recommendations on:

Oil-crops Network Activities

During the first part of this session, participants were divided into three groups. Each group was assigned discussion topics as follows:

- Group I - Information exchange, training and visits
- Group II - Germplasm exchange
- Group III - Future workshop, meetings and cooperative projects

Each group then presented a summary of its discussions and recommendations for consideration by all workshop participants. A summary of the final discussion follows.

General

Although the primary objective of the network is to link oil-crop projects supported by IDRC in the region (East and Northeast Africa, and South Asia), it was suggested that other oil-crop scientists or projects in the region not supported by IDRC could participate in the network.

Oil crops projects could still remain in the network even after direct IDRC support for the project had finished.

Information Exchange

Many participants stated that it was very difficult to obtain up-to-date technical information in their fields. Improving access to information was seen as a useful network activity. The following forms of information exchange were suggested.

Newsletter

An oil-crops newsletter should concentrate on distributing technical information, and on keeping participants informed on the work that each is doing. The IDRC network advisor should compile the newsletter, to be sent out once a year. The newsletter would require the active participation of all the participants in the network in submitting articles or information for inclusion in the newsletter.

The newsletter could contain:

(a) Extracts or summaries from the most recent annual report from each project. The results from the annual report should be summarized in 2-3 pages.

(b) Short articles or reports on a particular topic. This could be a technical advance, an interesting preliminary finding, or the findings of a completed project or activity.

(c) Names and addresses of oil-crop scientists to be listed by crop. This list could include scientists both within and outside the region.

(d) A short list of germplasm lines or advanced lines which each project has available for exchange as well as the requirements that must be met for the lines to be sent out of the country.

(e) Personal items, such as movements of scientists who are participating in the network.

(f) A list of new books on oil crops.

Books and Journals

These are often expensive and require foreign exchange. It was mentioned that projects supported by IDRC usually have a budget for the purchase of books and journals. Projects should submit requests for books and journals to the Program Officer in the IDRC Regional Office.

Participants were informed that there are a number of newsletters and abstracts now being published which cover several of the oil crops:

- Tropical Oilseeds Abstract, is published monthly by Commonwealth Agricultural Bureaux, and covers sesame, safflower and castor.

- The Sunflower Newsletter is published quarterly and based in the Netherlands.

- Cruciferae Newsletter is edited in Scotland and contains articles on rapeseed and mustard. This newsletter is published annually.

It was also mentioned that IDRC-supported projects can receive computer printouts of references, listing title, author and journal, on a specific subject. These references are sent at regular intervals from the IDRC library in Ottawa.

3. Training and Visits

Visits by IDRC staff and consultants to projects, as well as visits by scientists to each other's projects were found to be useful and should be continued.

The need for more training was stressed, especially for technical staff. ICRISAT training is available on groundnuts, but appropriate technical training in other crops needs to be identified or developed.

The Sudan Oilcrops Project is preparing a training manual which could be considered for publication by IDRC.

Germplasm

There is need for improved storage for two types of materials.

A working collection

The collection of lines that the breeder feels have immediate use in his crop improvement program. The working collection should be stored in a cool room at the project site.

It was felt that part of IDRC project support could be used to upgrade storage for working collections.

The Germplasm Collection

This collection contains a great diversity of germplasm lines and landraces, which have been evaluated by the breeder. This collection may possess traits that have potential use in the future. This collection should be characterized and documented and placed in long term storage.

There is an urgent need to find long term storage for germplasm collections from many of the national programs.

It was suggested that the regional germplasm centres in Ethiopia and in India should be requested to provide long term storage for these collections. The International Board of Plant Genetic Resources (IBPGR) in Rome may also be able to help with long term storage.

The exchange of germplasm lines between participants and other scientists was seen as an essential component of the oil-crops network.

It is not possible for IDRC to directly provide germplasm or breeding lines to national programs, as is done by the International Agricultural Research Centres. Instead national programs were encouraged to directly exchange germplasm with each other. The network should facilitate germplasm exchange whenever possible.

Germplasm exchange is often complicated by uncertainties. about quarantine requirements for certain diseases which may be brought in with the seed. The workshop urged that the "Annotated list of seed-borne diseases" which was last issued in 1968 by the Commonwealth Mycological Institute, be updated. This would help countries to formulate appropriate quarantine regulations.

Each project should make a short list of lines that possess specific useful properties and that can be exchanged. These lists could be included in the newsletter.

Each project should also outline the requirements to be met before germplasm lines can be sent out of the country. This information is to be included in the newsletter.

Scientists making requests should be specific about the lines or germplasm that they require.

More collections of oil crops are needed, especially in countries which are centres of diversity.

Scientists in other countries who might be willing to exchange oil-crop germ plasm or advanced lines should be contacted.

Future Cooperation and Workshops

Regional Nurseries

It was felt that exchanging replicated trial or regional nurseries on a regular basis may be desirable in the future, but, at present, network activities should concentrate on germplasm exchange.

International Conferences

These were felt to be very useful for obtaining up-to-date information, and for meeting other oil-crop scientists. When a scientist has the chance to attend an international conference, he should submit a report on the conference to the newsletter, or to the next workshop, so that other scientists can benefit as well.

Future Workshops

It was felt that workshops are useful as a forum for exchange of technical information and to obtain comments and suggestions on the work done by the different projects in the network.

Annual workshops should be held, hosted in turn by different projects in the network.

It was agreed that each workshop should feature 2-3 crops, and the presentations be made on a crop-by-crop basis. A sufficient amount of time should be allowed for comments on each project's presentation.

Field visits were important to pass on to the participants the experience gained by the host project.

The importance of the discussion session was stressed. Discussion could concentrate on future plans of the projects, or on evluating ways of transferring improved technology to the farmers.

It was suggested that castor and safflower be included in future workshops.

The crop experts who were invited to this workshop had provided valuable input. Crop experts should be invited to future workshops.

In order to keep the "working group" atmosphere in a workshop, a maximum of 25 participants should attend. A limited number of national staff from the project hosting the workshop could be invited as observers.

Closing Remarks

Hugh Doggett[1]

It has given me great pleasure to attend this workshop. We would like to thank the Government of Egypt for making us so welcome, and for making available to us the hall and conference room of the Foreign Relations Building. We thank Dr. Ahmed Momtaz, Director of the Field Crops Institute, for strongly supporting this workshop, and for making freely available to us the services of his staff. We are also most grateful to the Director of the Oilcrops Research Section of the Agricultural Research Centre, Dr. Badr El Ahmar, and to his staff, for their hospitality, and help, and for arranging the Field Trips that we attended. These helped us to form a good picture of farming here in Egypt, of the on-going research, and of the progress being made. We were honoured that Dr. Moustafa Serry was able to join us at the workshop.

Some years ago, the Crops Group of IDRC was reviewing the needs for work on neglected crops. Among those identified were plantains with bananas, and several of the annual oil-seed crops. We felt that the best approach to meeting this need would be through networks of projects. A network is a group of projects on related commodities or disciplines, which work cooperatively, sharing ideas, information, and materials. They are helped in this by the activities of a network adviser. Gradually, we established such a network, with Dr. Ken Riley located in Ethiopia as the adviser, and this is the first workshop. We are glad that so many of the scientists of the network have been able to gather together here.

I have much enjoyed being with you all again and have appreciated the excellent standard of presentations and discussions at this workshop.

The differences between our varied situations are very striking. In Mozambique, for example, there has been little development of agricultural research, or of agricultural help to the farmers who grow annual food and oilseed crops. We were shown a photograph of a typical small farmer, and that photograph was an important reminder of the real life situation in many of our countries. The farmer and his family constitute the labour force and are consumers of most of the produce. Agriculture is woven into the very fabric of everyday life for such farmers. Here in Egypt, we saw small farms with a highly developed standard of farming, which makes good use of tools and machinery. The farmers and their families are themselves

---

[1] Senior Scientific Adviser, IDRC, England.

descendants of the settled agriculture which began in the Fayoum depression some six thousand years ago. These farmers have been doing their own research and development down the generations, assisted during this century by the activities of the government research and extension services.

So many of our countries are farmed by families working rather small farms, their standard of husbandry varying somewhere between the two extremes that we have just considered. This has been determined both by the historical duration of the period of settled agriculture, and by the availability of research and extension support during modern times. Across the sea, there are extensive, superbly run farms, also operated by very few people, perhaps two people with the aid of machinery may manage 200 hectares. There, agriculture is now agrobusiness. Returning to Africa, few countries other than the Sudan have sufficiently large unpopulated arable areas in which extensive farming of the American type is likely to be possible. For most of us, the family on the small farm, living their agriculture as the very stuff of life will represent the prevailing situation for many years to come. I hope you had a good look at Dr. Malithano's photograph and will continue to picture it in your minds.

There are also considerable differences in the level of advancement of research on our oilseed crops. The groundnut crop has a very strong research program in Hyderabad, itself able to draw on much past and present research done in the USA. The groundnut project in Malawi will be a source of strength to workers on the eastern side of Africa. You will have noted at this workshop that Dr. Nigam is an authority on groundnuts. He has offered to make crosses for those who care to ask, and will do all he can to help us in our programs. ICRISAT gives the groundnut crop research great strength.

The sunflower crop has research strength in the USA, Canada and Europe: rapeseed in Canada and Europe, safflower in USA and flax (linseed) as an oil has been worked on in the USA and Canada. I believe that niger (noug) has never received any attention in the affluent world as an oilseed crop

Another disparity which impressed me was that between the various soils: Egyptians farming on the deep rich silt from the river Nile, the Tribal people of India growing the ancient crop niger on thin, barren and stony hill soils. Dr. Nigam questioned whether work on niger improvement and agronomy is appropriate for the latter situation. I think so, for the present, because people are still dependent upon niger, and we may be able to increase yield. One day, we hope to see the better soils so greatly improved that they can carry the population from these very poor soils. The latter will then revert to permanent cover of trees or grasses, properly managed for wood production and livestock.

The Network

I have underlined the disparities presented above, because we in IDRC see networks of projects as a medium to help to lessen at least some of these great differences. We believe that a network is not worthy of the name, unless we have a network adviser, the network co-ordinator who serves its needs. The basic concept of the network is that we help each other to keep right up to date with ideas, methodologies, and germplasm, sharing knowledge and materials, and discussing each other's activities. Our network adviser visits the projects, to discuss problems and to be available to help in all possible ways. He will arrange frequent workshops, held at a different site each time, so that we may get to know each other's programs on the ground and be able to receive and offer experiences and advice. In this way, we shall know where particular germplasm and kinds of experience are to be found.

Some of our crops will never have the assistance of an international centre. We hope that there may be ways to compensate for this to some extent through the network operations. Certain research activities may be allocated among the projects by mutual agreement. Close co-operation over research planning, interchange of germplasm, and sharing of results with all help to strengthen and speed the activities within the various projects.

A valuable feature of this workshop has been the presentations made by our four visiting consultant scientists, Dr. Dedio, Dr. Downey, Dr. Nigam and Professor Yermanos. I hope that one day we shall see Professor Yermanos's vision of ideal large-scale sesame production realised here and in the Sudan, as well as in some other countries.

There was one feature of our presentations which deserves comment. At one end of the scale, we had the statement that all the recommendations for growing the crop had been worked out, but the farmers were not adopting them. At the other end of the scale, one of our participants was doing the greater part of the research through farmers, and in their fields. This sounded as though it is working.

For 26 years, I worked in the framework of experiment stations. Our teams were using systems research and at Serere we worked out an agricultural system involving the cattle and all the local crops, all aspects of rotation, land preparation, crop plant types, tools, labour costs and other inputs were carefully examined and put together as a system. On paper, it looked a real winner for the local farmer. Our economic studies showed that the Serere agricultural system was much more productive than the local systems and was very profitable in cash terms.

Unfortunately, no farmers adopted it. We blamed the extension services. Had we not demonstrated an excellent and profitable agriculture for the area? This was all rather depressing: we had spent all those years working hard to help the farmer improve his lot - but if the farmer was not using our results, all our hard work and planning was wasted.

It was for that reason that I was always especially glad that Dr. Hulse and myself supported as one of our earliest projects cropping systems work at the International Rice Research Institute (IRRI), in those days known as multiple cropping. You all know how successful that work has been with Dr. Zandstra leading the Asia Cropping Systems Network (ACSN) work at IRRI for the last few years.

The main lesson from the ACSN is the need to get the farmer fully involved in the actual research and to look at it as a whole - the holistic approach - taking into account the way in which the whole social and economic life of the farmer is integrated with his farming system. I felt that the participant from Mozambique is feeling his way towards this kind of approach - research by the farmer and the scientist as a close partnership.

If the farmer is not adopting our research findings, all the money poured into experiment stations and International Agricultural Research Centres is wasted, even though the research itself is excellent and the written papers in the scientific journals are excellent. All our efforts are wasted; we could as well have been sitting in comfortable city offices, instead of sweating in the sun in rather isolated places.

I do hope that we shall be able to consider this issue much more fully at our future workshop.

This workshop is the first to be held in our oilseeds network. We in IDRC aim to learn how to do things better, and we shall find the conclusions from your discussions very helpful for our future planning and operations.

Finally, we thank all the delegates for their excellent presentations of their work, and for the high level of interest shown in each other's activities. Our grateful thanks to Dr. Fawzy Kishk, Mr. Gordon Potts, and the ladies in the IDRC-MERO Regional Office for all their help and hard work; also to Dr. Ken Riley, our Network Adviser, for all the thought and effort that he has put into this workshop. We are extremely grateful to the scientists from India, Canada and the USA who have come to share their knowledge with us. Two of them will visit some of our projects after this workshop.

I wish you all God's help in your work, and many successes to report at our next workshop. Let none of us forget that small family whose very life is farming, as we plan and work our way towards our next meeting.

Table : Population, gross national products (g.n.p.), changes in g.n.p. over the past 20 years, and land areas for the countries represented at this workshop. (World Development Report, 1982).

Country	1980 Population (m)	\$U.S. g.n.p.	1960-1980 Mean Annual Percent Change in g.n.p.	($km^2 \times 10^3$ Land area
Ethiopia	31.1	140	1.4	1,222
Mozambique	21.1	230	-0.1	802
India	673.2	240	1.4	3,288
Sri Lanka	14.7	270	2.4	66
Tanzania	18.7	280	1.9	945
Sudan	18.7	410	-0.2	2,506
Egypt	39.8	580	3.4	1.001
United Kingdom	55.9	7,920	2.2	245
Canada	23.9	10,130	3.3	9,976
U.S.A.	227.7	11,360	2.3	9,363