Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa

International Crops Research Institute for the Semi-Arid Tropics

Abstract

Citation: Waliyar, F., Ntare, B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992, Ouagadougou, Burkina Faso. (In En, Fr.) Patancheru, A.P, 502 324, India: International Crops Research Institute for the Semi-arid Tropics. 224 pp. ISBN 92-9066-271-9. Order code CPE/F 084.

Representatives from 20 countries and regional and international organizations concerned with groundnut production and research in West Africa attended a meeting in Ouagadougou, Burkina Faso to review progress made in groundnut research since the second meeting held in 1990 and to review progress made in groundnut.

Presented in the volume in English and French are the welcome, opening and closing addresses, summaries of 41 papers and recommendations of the working groups. The papers reviewed groundnut research on agronomy, breeding, pathology, and utilization.

Resumen

Compendia de Actas de la Tersero Reunion Regional de ICRISAT para el Africa del Oeste, 13-17 de Septtembre 1992, Ouagadougou, Burkina Faso. Representantes procedientes de 20 paises asi como desde diversas organizaciones internacionales relacionadas a la produccion y la investigacion de mani en el Africa de Oeste asistieron a una reunion en Ouagadougou, Burkina Faso con el objetivo de analizar el progreso alcanzado durante la segunda reunion celebrada en 1990 asi como proseguir la recommendaciones hechas la reunion.

Este tomo consta de los discursos de bienvendia, apertura y clotura, resumenes de 41 ponencias y la recomendaciones. Las ponencias examinaron las investigaciones sobre mani en la areas de agronomia y produccion, seleccion, patologia y utilizacion.

Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa

14-17 Sep 1992
Ouagadougou, Burkina Faso

Edited by

F. Waliyar,
B. R. Ntare,
J. H. Williams

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Andhra Pradesh 502 324, India

1993

About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut: these six crops are vital to life' for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 18 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors: it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO). the World Bank, and the United Nations Development Programme (UNDP).

Sponsors

International Institute for Research in the Semi-Arid Tropics (ICRISAT)

Peanut Collaborative Research Support Program (Peanut CRSP)

Organizing Committee

F. Waliyar, J.H. Williams, B.R. Ntare, Z. Bertin

Contents

Preface

The purpose of the meeting was to review the progress made in groundnut research since the second meeting held in 1990 and to follow up on recommendations made at that time. The meeting was jointly sponsored by ICRISAT and Peanut Collaborative Research Support Program (CRSP). Special appreciation is extended to the Institut national d'etudes et de recherches agricoles (INERA) for their organizational contribution to this meeting. The West African countries represented were Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Cote d'lvoire, Ghana, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. Also represented were the Peanut CRSP, Institut de recherches pour les huiles et oleagineux (IRHO), Food and Agriculture Organization of the United Nations (FAO), ICRISAT Center, SADC/ICRISAT Regional Improvement Program and ICRISAT Sahelian Center.

Fifty-five participants attended the meeting and 41 papers were presented. Participants visited the INERA research station at Gampela. Recommendations from the working groups (Agronomy, Breeding, Pathology, and Utilization) were discussed and approved at the plenary session.

The proceedings comprise summaries of papers presented at the meeting. Full papers are available on request from the Program Leader, Groundnut Improvement Program, ICRISAT Sahelian Center, B.P. 12404, Niamey, Niger (via Paris).

Welcome from INERA

Honored guests, distinguished participants, ladies and gentlemen,

I wish to express my appreciation for your presence at the opening ceremony of the Third Regional Groundnut Meeting for West Africa. I also wish to thank our colleagues who have come from far away locations to participate in this Workshop and to exchange their experiences in groundnut research with their colleagues in Burkina Faso.

This Workshop is organized by ICRISAT, in collaboration with INERA and the USAID Peanut CRSP. It is held in Ouagadougou following the recommendation of the First Regional Groundnut Meeting in Niamey in 1988. to have workshops in locations other than the ICRISAT Sahelian Center. The idea was further developed during the Second Regional Groundnut Meeting in 1990 and Ouagadougou was selected. The choice is an honor for Burkina Faso and attests to your confidence in our country.

Groundnut research is conducted in Burkina Faso by the Programme oleagineux annuels et legumineuses a graines, one of the eight programs of INERA, whose activities extend to sesame, soybean, groundnut, and cowpea.

The groundnut program has approximately ten specialists at INERA and at the University of Ouagadougou, whose work focuses on two themes related to the agroclimatic characteristics ofour country. The first concerns drought resistance conducted in the central and northern part of the country, and the second is resistance to diseases in the southwest region. The ultimate objective is to obtain a high quality groundnut for oil and food products, which can be used for local consumption and export.

During these four days, you will have the opportunity to discuss your activities, results, and perspectives in the fields of agronomy, breeding, pathology, and entomology. You will also visit the INERA and University of Ouagadougou experimental fields at the ISN/IDR research station, some 20 km from Ouagadougou.

I wish you a pleasant stay in Burkina Faso and success with your work. Thank you.

C. Belem
Director
Institut national d'etudes
et recherches agricoles (INERA)

Welcome from ICRISAT

Honorable guests, ladies and gentlemen,

I welcome you to the Third ICRISAT Regional Groundnut Meeting for West Africa. In a few words, I would like to present the objectives of this Workshop, which is held every two years: (1) to promote the exchange of scientific information between scientists and researchers who work on this important food crop; (2) to enable researchers from the national and regional programs of the subregion to follow progress and establish new objectives; (3) to continue the efforts of the Peanut Collaborative Research Support Program (CRSP), CIRAD, and ICRISAT in collaboration with the national programs, so that specific regional problems can be addressed; and (4) to minimize duplication of efforts by groundnut researchers.

ICRISAT's progress depends on collaboration with the National Agricultural Research Systems (NARS) and other research institutes. This integration is essential for a coordinated development and rapid integration of technologies intended for the farmers of the subregion.

ICRISAT seeks and finds a high level of collaboration in all aspects of its groundnut work with its partners in the national programs and universities. This workshop is an example of the good collaboration between ICRISAT, CIRAD, Peanut CRSP, different institutes of the scientific community of the region, and INERA. At this point, I would like to thank the Ministry of Higher and Secondary Education and Scientific Research, for allowing us to organize this Workshop in Burkina Faso. We especially appreciate the organizational efforts put forth by INERA.

ICRISAT recently invited members of the national research program to participate in the review of its research programs, an aspect which shows the importance which it places on relations with the national research programs. The directors of three national programs collaborated with us in reviewing the research of the Groundnut Improvement Program.

ICRISAT is not the only institution to undertake a review of its research programs. The Consultative Group for International Agricultural Research (CGIAR) is currently establishing its priorities. These positions are already included in our medium-term plan. The CGIAR has requested us:

- to increase efforts to develop the groundnut and resource management programs;
- to intensify efforts in the Guinean and Sudanian zones, two areas where research is capable of having applied and profitable results:
- to give more attention to multidisciplinary research.

Finally, we give great importance to resolving the problems linked to groundnut research. I hope this meeting will serve to increase collaboration between researchers from the different countries. Thank you.

C. Renard
Executive Director
ICRISAT Sahelien Center

Opening Address from CNRST

Honored guests, ladies and gentlemen, scientists and groundnut specialists,

I wish to welcome all the groundnut scientists who are participating in the Third Regional Groundnut Meeting, and who will be sharing their knowledge and experience in agronomy, breeding, and crop protection for this legume which is so important to our economic and social policies.

Groundnut has always and will continue to have an important position in Africa. For many years, it was developed as an industrial crop with a strong influence on the economies of most of our countries. Today, it occupies a favored position in our food and economic strategies, given its use as an oil and the development of confectionary varieties. However, in spite of this, groundnut production remains low in our countries. Among the many reasons for this condition, I would like to state some of the following:

- climatic factors, with the diverse forms of drought, have generally harmed agricultural production:
- cropping techniques are not very effective, thereby limiting production: and
- biotic constraints, such as diseases, pests, and viral diseases.

These factors seriously limit the development of an export market for confectionery groundnuts, in particular toward the European countries who require a high quality groundnut.

This overall situation specifically describes our country, where groundnuts are important economically as an export product, independent from their consumption in the country. Our statistics show that for a few years, production has been increasing, thanks to the joint efforts of research and extension. Within our agricultural policy, we are convinced that groundnut can be a leading crop, as significant to the economy as cotton.

The establishment of the Groundnut Finance and Extension Corporation (SOFIVAR) assists in implementing government policy to develop groundnut production. As a result, a special program was created within INERA which gives priority to groundnut. Work is undertaken by different teams of the University of Ouagadougou research and teaching staff at Farako-Ba, Kamboise, Niangoloko, Gampela, Kouare, and in our laboratories. All of these activities aim to make available to producers, varieties that are resistant to the main diseases and that match the level of quality required for the international market.

During four days, you will review the accomplishments ofgroundnut research in agronomy, breeding, and entomology, and especially your thoughts on future perspectives to promote a true policy of scientific and technical cooperation between countries. Without any doubt, you will evaluate the recommendations of the previous Workshop.

We are aware of the limits of our countries to finance the research sector. Also, we are convinced that it is through inter-country cooperation and exchange of our scientific teams, that we can optimize human and material resources to find solutions to our common problems. Without influencing the results ofyour work, I am certain that your discussions will set forth directions for the short, medium, and long term, based on the principles I have described.

I wish you success in your work and declare the Third Regional Groundnut Meeting for West Africa officially open.

V. Ouedraogo
Representative of the Director General
Centre National de la recherche
scientifique et technologique (CNRST)

Agronomy

Aspects of Groundnut Phosphorus Fertilization in Burkina Paso

P. Cattan[1]

Soils in Burkina Faso are in an advanced state of mineral deficiency, mainly phosphorus. Presently, there are three sources of P in Burkina Faso: low solubility (BK-P) rock phosphate from Kodjari deposits; improved phosphate (IP) derived from (BK-P) treatment through a method of partial attack; and soluble phosphate.

Apart from the types of phosphates, difficult crop development conditions contribute to uncertain fertilization effects. It becomes necessary to define conditions of manure efficiency and profitability. BK-P and IP products were therefore evaluated in comparison with a soluble phosphate (Triple superphosphate: TSP) from 1988 to 1991 in farmers' fields in various cropping conditions in the North Central area of Burkina Faso. The results of 80 trials and 40 confirmation tests can be summarized as follows:

1. The effect of TSP-based fertilizer ranges between 200 to 650 pods per kg ha^{1} (control yield between 750 and 950 kg ha^{-1}).
2. During the trials, groups with the highest responses (more than 370 pods per kg ha^{-1}) were observed on recently cleared fields and on fields where organic and mineral restitutions frequency is the highest.
3. Tests have linked the increase of fertilizer efficiency to high densities and cropping patterns, including groundnut cultivation or fallow periods (more than 530 pods per kg ha^{-1} vs. 310 for rotations based only on food grains).
4. BK-P efficiency is estimated at 40% compared with SP for the entire experiment. IP efficiency is 65% for trials and 80% for tests. There was little variation in the ranking of the different phosphates.

1. Chercheur, CIRAD/CA INERA, Kamboinse, Burkina Faso.

Waliyar, F. Ntare. B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICR1SAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992, Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

With the tests results, margin calculations were made for the surveyed fields:

For BK-P (6000 CFA ha^{-1} for the type used), 35% of fields reached a margin of zero and 15% showed a profit of more than 20,000 CFA. For TSP (15 000 CFA ha^{-1} for the type used), 20% of fields had a margin of zero and 50% obtained a yield of more than 20 000 CFA.

The trials showed that, with a poor production in the beginning, the effect of fertilizer is subordinate to the care given to fertility maintenance in plots (organic and minerals restitutions, fallow). Tests showed the role of densities and crop rotations in making manure profitable. Margin calculations underline that these factors affect the success of a fertilizer policy and focus on the need to adapt manure to cropping conditions. Soluble phosphate, despite its high cost, increases chances of profit making.

Increasing Groundnut Yield by Seed-Treatment Chemicals and *Bradyrhizobium* Inoculation

J.K. Adu and S.M. Misari[1]

Field trials were conducted in 1986 under rainfed and irrigated conditions to evaluate the effect of seed-treatment chemicals and *Bradyrhizobium* inoculation on the performance of groundnut at Samaru, Nigeria. The chemicals used were Aldrex-T®, Aldrin®, Fernasan D, Furadan 3G®, Lindane®, Marshall 25ST, Promet 405D, Thiram® and a combination of Thiram® with either Marshall 25ST or Promet 405D. The highest germination percentage (76.8%) was obtained by applying 1% Promet 405D plus 0.11% Thiram®. Nodule initiation was comparatively improved over the control treatment by application of either 2% Marshall 25ST or 1.1% Promet 405D. However, the application of 1.5 kg ha^{-1} Furadan 3G® resulted in the highest mean pod yield of 1535 kg ha^{-1}. This chemical also appeared to be the most effective against rosette disease. *Bradyrhizobium* inoculation improved germination, the number of initial nodules, and pod yield relative to the control without inoculation, but had no effect on dry weight of nodules.

1. Researcher; Deputy Director, Institute for Agricultural Research (IAR), Ahmadu Bello University, PMB 1044, Zaria, Nigeria.

Waliyar. F.. Ntare. B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992, Ouagadougou, Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Support Research for Groundnut in Guinea Buissau

Joao Fernandes[1]

For all crops, particularly cotton and groundnut which were introduced recently, Guinea Bissau did not have adequate technical references to guide an agricultural development organization. From 1978, several trials were conducted in farmers* fields. Research was oriented towards two basic objectives:

- Reduction of work time and soil preparation for early crop establishment.
- Introduction of early-maturing varieties for greater flexibility in sowing dates.

Trials on sowing dates conducted during three years on variety 69-101 (120-day maturity cycle), indicated that for the same amount of work, farmers could increase their yield by sowing early. On the other hand, for the same sowing dates, soil preparation practices did not affect yield, but a 12 day delay in the sowing date brought about a significant decrease in yield, from 300 to 400 kg ha^{-1}.

We did not observe any effect of manure on groundnuts and yield increase was insignificant compared with the nonfertilized control. This lack ofresponse led us to advise the adoption of a cropping system without fertilizer during extension. More trials were conducted in order to find an explanation for this lack of response.

Two trials to test various protection methods (nematicides, fungicides and insecticides) and fertilization, have shown that insecticide treatment did not have much effect on yield. However, we observed that leafspots control allowed an increase of more than 40% in production. With

1. Ministere du Developpement rural et de l'agriculture, Projet du developpement rural du service semencier et de la recherche d'accompagnement, B.P. 39, Bafata, Guinee-Bissau.

Waliyar. F., Ntare, B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

a heavy rainfall in 1987-88, a slight rust attack was observed, particularly on early-maturing varieties.

Through harvest analysis, no fertilizer or fungicide effects were observed on production quality, except a slight fertilizer effect on dehulling yield. A test on edible groundnut technological traits, showed that variety 73-27 was the most interesting. Varietal trials on early-maturing groundnut showed that variety QH 243 C had good agronomic potential and quality seeds.

The aim of support research is to provide direction for technical services in the choice of extension themes. It has allowed a number of observations:

- In view of tillage results, animal traction policy should stress small jobs as compared to plowing.
- Even though plowing did not significantly improve yields, a beneficial effect was noted for weed control
- In direct sowing, when a first rain occurs in early June, first weeding should be done ten days after sowing. Direct sowing allows optimal exploitation of early erratic rains in June and weeding can be performed quickly during dry spells.

Effect on the Yield of Groundnut Intercropped with Maize and Cassava in Farmers' Fields in Liberia

S. V. Kamara[1]

Groundnut or peanut (*Arachis hypogaea)* is grown as a separate crop by 11-25% of the agricultural households in Liberia. Approximately 3% of the households grow groundnuts intercropped with rice. It is produced over a range of environments by smallholders with less than 1 ha, primarily to meet their subsistence needs, and the surplus is sold to local markets. The crop is eaten raw, fresh, dried, boiled, roasted, dry-fried, or made into paste. It is also used as spreads or to make soups or stews.

The results of yield trials conducted on the effect of groundnut intercropped with maize and cassava indicated that in general, groundnut sown as a sole crop produced higher yields than groundnut intercropped with maize and cassava. In 1988, groundnut intercropped with maize gave a yield advantage of 50.75 kg ha^{-1} over groundnut intercropped with cassava.

The 1989 cropping season produced more groundnuts than the 1988 season when they were sown as a sole crop. When groundnuts were intercropped with maize and cassava, the 1988 cropping season gave a yield advantage over the 1989 cropping season. Groundnuts produced a higher yield as a sole crop than intercropped with maize and cassava. This might have been due to less competition between groundnuts and maize for available nutrients and sunlight. The canopy of the cassava plant is more dense than the maize plant, thereby providing a large surface for absorption of light energy and carbon dioxide, which are essential for photosynthesis.

1. Agronomist, Ministry of Agriculture, Monrovia, Liberia.

Waliyar, F., Ntare, B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992, Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Groundnut Agronomy in Central African Republic

R.P. Yakende[1]

The Central African Republic covers 623 000 km^2 and has two types of tropical climates: Sudano-Sahelian (800-1000 mm) and Guinean-forest (1600-1800 mm). Groundnut is grown throughout the country as a sole crop or intercropped with cereals (maize, millet, and sorghum). It occupies 24% of the cultivated surfaces allocated to food crops and is second in production after cassava. It has an average yield of 0.45 to 0.96 t ha^{-1}.

There are many production constraints however, the most apparent are:

1. Agronomic: Unimproved seeds, lack of control for fungal and viral disease, non-respect of cultural practices and no use of fertilizers.
2. Economic: No organized market for commercialization of farmers production and no processing plants.
3. Human resources: Insufficient scientists, no groundnut specialists (breeder, plant pathologist, entomologist) and lack of contact with the outside world.

As there is no research institution in the Central African Republic, research activities are conducted by agricultural companies and projects in farmers' fields. Generally, trials are carried out in controlled environments, then on-farms for confirmation and demonstration tests. Two on-station variety trials showed that Flower 113 A has significantly performed well compared with control QH 243C with respect to yield as a short cycle groundnut, and also as a second-cycle crop. Variety RMP15 seems to be adapted to cropping conditions.

1. Chef de station de Poumbaidi, Departement des recherches, B.P. 122, Bangui Lokouanga, Republique Centrafricaine.

Waliyar. F., Ntare, B.R., and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992, Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

There were also two intercropping trials between maize and four groundnut varieties at the extension level. Results showed that maize yielded better than groundnut, which had a very poor yield. This low yield may be due to high sowing densities of the two species, since the equivalent density coefficient was 1.78, which is above the norm of 1.4. It is hoped that this yield can be improved by reducing the two crop densities and revising their spatial arrangement. .

Finally, we have initiated, still on-station, an intercrop with sorghum and three different duration groundnut varieties. If sorghum is to be the main crop, it is in the farmers' interest to chose an A2 density (27 778 plants ha^{-1}) as the maximum sowing density. On the other side, with groundnut as main crop, sorghum sowing density should be Al (13 889 plants ha^{-1}).

Generally, if two crops have same level, the recommended density is 20.833 plants ha^{-1}, equivalent to 1.20 m x 0.40 m with one plant per mound. At this density, sorghum and groundnut yields should be between 1.4 and 1.5 t ha^{-1}. Varieties RMP15 and Flower 113A have been noted for their pod yields compared with local varieties.

In order to improve groundnut production, local and exotic varieties have been collected for observation in different cycles. As compared with late-maturity control, 47-16 and 69-101 showed good yield performance. Among early varieties, JL 24 performed better than the control.

Breeding

Adaptability of ICRISAT Groundnut Lines in the Sudanian Zone of Northeastern Benin

M. Adomou[1]

Groundnuts are considered as a food crop in Benin and play an important part in providing food for the country. They are consumed in many ways and are grown throughout most of the country. Variety and foliar diseases, primarily late leafspot, are the most important factors limiting groundnut production. In order to propose productive and disease-resistant varieties to farmers, the INA Food Crops Research Station in northeastern Benin conducted collaborative trials with the ICRISAT Sahelian Center's Groundnut Improvement Program.

During the 1989 and 1990 rainy seasons, selected ICRISAT groundnut breeding lines were evaluated in seven on-station trials. Eight early-maturing and 14 late-maturing lines were selected from these trials. The cultivars have been undergoing multilocational evaluation since the 1991 cropping season at two sites in the northern Guinean zone, two locations in the Sudanian-Savannah and one site in the Sudano-Sahelian savannah. The results of these trials indicate that:

- Late leafspot is one of the major factors that limits yield. Evaluations at INA show that yield losses due to this disease can reach 20 to 50% of the crop.
- Yields increase from the South (Northern Guinean Zone) to the Center (Sudanian-Savannah Zone). Variety 55-437, which showed high susceptibility to rust on-station, produced interesting yields. This situation may be due to higher pressure of late leafspot in the Southern Zone, where the humidity is higher.

1. Responsable du Programme de recherches sur l'arachide, Station de recherches sur les cultures vivrieres d'INA, B.P. 3 N'dali, Benin.

Waliyar. F., Ntare. B.R., and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992. Ouagadougou, Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324, India: International Crops Research Institute for the Semiarid Tropics.

ICGV-SM 83001 and ICGV 86072 performed well in all locations with yields above the control TS 32-1 21 and 13% respectively). These trials will be continued for two more seasons.

- Cultivar MH 2 could be grown at high densities in order to increase its yield. At a density of 200 000 plants ha^{-1}, its cover rate ranges from 50 to 60% with a productivity of 1.7 t ha^{-1} in the trials. It can successfully be intercropped with other crops.

Breeding Early-Maturing Groundnut Varieties Resistant to Rosette Disease in Nigeria: Problems and Prospects

S.R. Boye-Goni, S.M. Misari, P.E. Olorunju and O. Alabi[1]

Groundnut rosette virus disease is transmitted by aphids *(Aphis craccivora* Koch) and has been present in Nigeria for over 50 years. Two forms of rosette, the green rosette and the chlorotic rosette, are commonly found in Nigeria.

In the southern Guinean Savannah zone, farmers consider the rosette virus as a risk in growing groundnut. Early planting and close spacing are not always reliable control measures. Therefore, it was necessary to develop rosette-resistant varieties of appropriate maturity cycles.

Initially, the main objective of the breeding program was the production of rosette-resistant varieties for this zone, where the predominant varieties were late-maturing Virginia types. Many high yielding rosette-resistant varieties were developed using resistant varieties obtained from Senegal and Burkina Faso. Most of these varieties were released for commercial production.

After the rosette epidemic in 1975 that affected all the groundnut producing areas, attention focused on shorter cycle (80-100 days) rosette-resistant varieties for the Sudanian and Sahelian zones.

The first attempt to develop early-maturing rosette-resistant varieties was in 1964. Late- and medium-maturing rosette-resistant selections were made from the crosses, but it was not possible to recover any early-maturing rosette-resistant selections (80-100 days). Three lines (M170.72, M495.72, and M95.71), though poor yielders, were retained because of their stable resistance. Many crosses were attempted again using M95.71,

1. Entomologist; Deputy Director; Breeder; and Pathologist, IAR, Ahmadu Bello University, PMB 1044, Samaru, Zaria, Nigeria.

Waliyar, F.. Ntare, B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICR1SAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou, Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

M495.72, and KH149A as sources of resistance. Between 1983 and 1985, a total of 186 selections were made from the progenies. The 186 selections were screened for four years under glasshouse and field conditions to learn their reaction to rosette. Forty-nine out of the 186 selections were highly resistant.

While it has been possible to transfer the resistance gene into late-maturing Virginia types, it has not been easy to transfer it to early-maturing Spanish types. Results of this study were very encouraging, particularly for the development of early-maturing rosette-resistant varieties, although they did not yield an agronomically acceptable early-maturing variety. The result could however, provide the basis for further research.

Groundnut Variety Experiments in Central Burkina Faso: Summary of Results: 1989-1991

J. Gautreau et Z. Bertin[1]

After three years (1989-1991) of comparative varietal experiments, the INERA Groundnut Improvement Program at Kamboinse is able to provide results of the performance of early- (90 days) and very-early (75-80 days) maturity varieties in the central and central-northern regions of Burkina Faso. The experiments were mainly based on Fisher block design trials with six replications in four locations: Gampela and Saria (near Ouagadougou) and Kouare and Pobe (in the north).

Among the very-early varieties studied, good performance was observed for AHK 85-3 (compared with controls TS 32-1 and Chico), as well as for 85-19 (derived from the local breeding program), ICGS (4) 11, ICGS 26, and ICGS 31. The mean pod yield for three years was 2.3 t ha^{-1}, averaging the yield of the 90-day control, but with an early-maturity advantage for Chico. These varieties could be proposed for the northern areas of the country after on-farm evaluation.

Recorded yields for AHK 87, the local confectionery variety, were satisfactory, since the mean yields over three years were not less than 2.1 t ha^{-1}. Twelve varieties out of 13 yielded statistically more than the control QH 243C (rosette-resistant variety from the southwest region), and were equivalent to the yield of the control CN 94C. However, only one-third had satisfactory 100-seed weight (25% more than QH 243C). Furthermore, six varieties from Niangoloko (series SH 470) produced excellent pod yields at Gampela (2.0 to 2.7 t ha^{-1} compared with 2.2 t ha^{-1} for the control QH 243C), with mean 100-seed weight of 47 to 49 g against 38 g for the control.

1. Ingenieur agronome; Attache de recherche, lnstitut d'etudes et de recherches agricoles (INERA), 03 B.P. 7192, Ouagadougou 03, Burkina Faso.

Waliyar, F.. Ntare, B.R, and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

In 1992, agricultural research in Burkina Faso had a wide-range of varieties fulfilling various agronomic and commercial requirements. These varieties have the potential to bring to producers in the central and northern areas of the country, improved production and income compared to traditionally cultivated types. Varieties directly derived from research should however, go through a final on-farm evaluation before being proposed for extension.

Groundnut Productivity for Haulm, Kernel and Oils Yields in the Northern Savannah Zone of Ghana

K.O. Marfo[1]

Groundnut is basically an oil crop, however in Ghana the kernel is used as food, either boiled or roasted. The crop is also an essential component in the cropping system in northern Ghana because of its ability to fix atmospheric nitrogen for associated or subsequent cereal crops. Additionally, the crop residue is an important livestock fodder. Therefore, the identification and development of groundnut genotypes that have most of these traits is desirable.

In this study, groundnut genotypes belonging to early- (90-95 days), medium- (100-105 days) and late- (over 110 days) maturity groups were evaluated for three important traits: kernel, haulm (crop residue) and oil yields. The study also determined the feasibility of selecting for these three traits into a single genotype and studies were conducted in the Guinean and Sudanian Savannah zones. The results indicated that for early- and late-maturity lines, selection can be made for genotypes that combine all these characteristics.

In the Sudanian Savannah zone, early-maturing groundnut varieties are highly desirable because of their ability to resist terminal drought, which occurs frequently in this area. The identification of early-maturity groundnut lines with high kernel and haulm yields, as well as high oil contents, would be an asset.

1. Food Legumes Breeder, Agricultural Experiment Station, Nyankpala, P.O. Box 52, Tamale, Ghana.

Waliyar. F.. Ntare. B.R. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India; International Crops Research Institute for the Semi-arid Tropics.

Improvement of Local Groundnut Varieties in Southern Congo

N. Ndilou[1]

Groundnut production in the Congo has traditionally remained at the farmer level. The southern region of the country, consisting of four agricultural zones (Niani, Pouenza, Lekoumou, and Pool) is the most important groundnut producing area (average yield of 1000 kg ha^{-1}). The decrease in yields in the last twenty years (1965-1984) is the result of progressive deterioration of groundnut varieties released by the Institut de recherches des huiles et oleagineux (IRHO) and also the lack of agricultural research activities for more than ten years. Farmers use a mix of more or less genetically stable lines, called local lines. These groundnut populations have less than 38% oil content.

An agricultural research support program was established in 1985 with the objectives to reconstruct the genetic inheritance, select existing local lines and release them in farmers fields. Investigations covered more than three quarters of the country, 38 different populations were identified and 55 lines were isolated. Presently, eight local varieties have been selected and two exotic genotypes (JL24 and TS 32-1) were used as parents for their improvement. Selection criteria were early-maturity, yield, and oil content above 45%. Several hybrids derived from crosses were identified. This important varietal improvement program faces serious problems since 1990 as it does not receive stable financial support.

---

1. Selectionneur, Centre de recherche agronomique, B.P. 28, Loudima, Congo.

Waliyar. F., Ntare. B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou/Burkina Faso, (In En.. Fr.) Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

Aspects of Groundnut Variety Improvement in Chad

B. Noudjalbaye[1]

Groundnut is grown in the two main climatic zones in Chad: the Sahelian zone with a rainfall ranging between 500 and 900 mm a year and the Sudanian zone with 900 to 1200 mm a year. With cultivated lands estimated between 130 000 to 200 000 ha and production between 100 to 150.000 tons, groundnut is the third most important food crop after millet and sorghum.

In the Sahelian zone, varieties 55-437 and Rose of Delhi are widely used and distribution of TS-32-1 is in progress. In the Sudanian zone introduced varieties are 55-313, 73-33, 55-437, GH 119-20 and Rose of Delhi.

In general, cultivation is performed manually or using animal traction. Recommended sowing densities are not always used and groundnut is often intercropped with millet, sorghum or maize.

There are a number of constraints limiting groundnut production in Chad:

- Varieties are either landraces or a mixture of low yielding varieties.
- Drought or drought spells at the time of flowering or fructification.
- Non-compliance of farmers to cultural recommendations (sowing dates, densities, use of fertilizer).

  No organized commercial network.
- Lack of protection against parasites causing damage in the field and during storage.

1. Bureau de la recherche agronomique, Ministere de l'Agriculture, B.P. 441, N'Djamena, Tchad,

Waliyar, F.. Ntare. B.R. and Williams, J.H. (eds.) 1993, Summary Proceedings of the Third ICR1SAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992. Ouagadougou, Burkina Faso. (In En.. Fr.) Patancheru, A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Groundnut varietal improvement in Chad has a short-term and long-term component. The short-term aspect consists of introducing new varieties from specialized institutions, such as the Institut de recherches pour les huiles et oleagineux (IRHO) and ICRISAT. In 1989, 11 new groundnut varieties, including nine from ICRISAT, have been introduced on the Gassi station in the Sahelian zone. Of these nine varieties, ICGV 87157 and ICGS(E)22, seemed to be promising for the area. Over the long-term, local landrace collection carried on in 1987 with assistance from the International Institute of Tropical Agriculture (IITA), produced 78 entries. These landraces have been identified, homogenized and screened in order to retain varieties that were best adapted to the region.

To promote groundnut production in Chad, it is imperative that research be directed towards the following objectives:

- Development of new varieties that are more productive and better adapted to the different regions and their use in farmers' fields.
- Effective recommendations need to be made to farmers.
- Studies should be initiated on groundnut fertilization in rotation because of soil deterioration.
- Crop protection methods against pests should be studied.

Adaptation of Groundnut (*Arachis hypogaea* (L)] to the Post-Rainy Season in a Sahelian Environment

B.R. Ntare[1], B.J. Ndunguru[2], and J.H. Williams[1]

In the Sudano-Sahelian zone of West Africa, only one rainfed crop of groundnut is possible. There is potential for groundnuts to be grown as a dry-season crop where irrigation is available. We conducted an experiment at the ICRISAT Sahelian Center (ISC) to study the effect of sowing date on phenology and yield of four groundnut cultivars under irrigation in the dry seasons of 1990/91 and 1991/92. Eight sowing dates at two weekly intervals beginning with 15 November in each season were used. Sowing date significantly affected time to emergence, flowering and maturity with groundnut sown in November/December taking the longest time to reach these phenological stages. Pod yield declined by more than 50% from early sowing (November/December) to late sowing in March. Haulm yield and relative crop growth rate were slightly affected by sowing date. Early sowing resulted in a larger proportion of dry matter partitioned into pods than the later sowing. The observed responses appear to have been due to temperature differences during the different growing periods. It is concluded that groundnut for the dry-season should be sown in November to allow the crop to develop under relatively cool temperatures which improved productivity.

1. Principal Breeder; Principal Physiologist and Groundnut Team Leader, ICRISAT Sahelian Center, B.P. 12404, Niamey, Niger.
2. Team Leader and Principal Agronomist, SADC/ICRISAT Groundnut Project, P.O. Box 1096, Lilongwe, Malawi.

Waliyar. F.. Ntare, B.R, and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992, Ouagadougou, Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

Performance of Groundnut Cultivars as Affected by End-of-Season Drought in a Sahelian Environment

B.J. Ndunguru[1], B.R. Ntare, J.H. Williams[2], and D.C. Greenberg[3]

Development of drought tolerant groundnut *(Arachis hypogaea)* is an objective of the ICRISAT Sahelian Center (ISC) breeding program, but success has been limited by inadequate screening techniques and lack of clearly defined drought stresses. Thirty-six cultivars known to vary in yield potential were grown under rainfed and irrigated conditions at ISC to assess the response to end-of-season drought common in the Sahel. The susceptibility of cultivars was determined using a stress susceptibility index for pod yield (S_y), crop growth rate (S_c), partitioning (S_p) and yield per se. Cultivars 796 and 55-437 were identified as the most relatively drought tolerant while 28-206 was the most susceptible. Based on yield per se, only two cultivars, ICGV 87087 and ICGV 88168 yielded above-average in both stressed and nonstressed conditions. Cultivars with vigorous early growth, a relatively large biomass accumulation and capable of remobilising stored assimilates to reproductive sinks may be better adapted to drought stress.

1. Team Leader and Principal Agronomist, SADC/ICRISAT Groundnut Project, P.O. Box 1096, Lilongwe, Malawi.
2. Principal Breeder; Physiologist and Groundnut Team Leader, ICRISAT Sahelian Center, B.P. 12404, Niamey, Niger.
3. Former Principal Plant Breeder, ICRISAT Sahelian Center. Present address: 23 Pierce Lane, Fulbourn, Cambridge CB1 5DJ, United Kingdom.

Waliyar. F.. Ntare. B.R.. and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

Groundnut Breeding Project in Nigeria

P.E. Olorunju[1]

The breeding program in Nigeria started in 1928 and its objectives are to develop genotypes with the following attributes:

- high yield with good agronomic characteristics;
  durations appropriate for various ecological zones;
- drought tolerance/resistance for the Sahelian and Sudanian-Savannah zones;
- high nutritional quality;
- pest and disease resistance.

Breeding Activities from 1986 to Date

Breeding activities before 1986 resulted in the release of rosette-resistant varieties suitable for the northern and southern Guinean Savannah zones. The Sahelian and Sudanian Savannah zones need short-season rosette-resistant varieties that are not yet available to the farmers.

Since 1986, the focus has been on the major problems of drought and groundnut rosette disease. A study of the rosette disease involved breeders, pathologists, virologists and a vector entomologist. It included the inheritance of resistance, mechanisms of rosette resistance, and epidemiology because apparently all available rosette-resistant varieties were late-maturing and not much information was available on the disease.

A disease resistance study was conducted by the Institute for Agricultural Research (IAR), Zaria, in collaboration with the University of Georgia, USAID Peanut Collaboration Research Support Program (CRSP), and the Institute fur Viniskrankheiten de Pflanzen, Braunschweight, West Germany. Crosses between resistant x susceptible lines differing in season

1. Breeder/Virologist, IAR, Ahmadu Bello University, PMB 1044, Samaru, Zaria, Nigeria.

Waliyar. F.. Ntare, B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou, Burkina Faso. (In En., Fr.) Patancheru, A.P. 502 324. India: International Crops Research Institute for the Semi arid Tropics.

length were followed by selection in the early segregating generations as proposed by Bock and Nigam (1988). Field screening was reinforced with mechanical inoculations in the greenhouse and laboratory using ELISA and Electrophoresis (Olorunju et al., 1991 and 1992).

Progress

Crosses involving rosette-resistant varieties, introductions, and locally bred varieties are being screened in the field. Germplasm maintenance and study of their reactions to disease in both early generations and advanced lines are major undertakings. Introductions and released varieties are maintained for breeding purposes. Twenty-six lines derived from 1984-85 selections have been screened for rosette resistance using the new screening technique. Thirty-one showed no rosette symptoms in 1991 while 23 had about 10% rosette infection. These are being screened again this year to confirm their resistance.

In 1991, fourteen F_4 lines derived from 12 resistant (R) x susceptible (S) crosses were screened for rosette resistance. Eight R x S crosses did not have any symptoms and five were derived from crosses involving early-maturing lines. A total of 84 breeding lines were tested in replicated preliminary trials. Breeding lines were selected for the main variety trial (MVT), based on yields and reaction to rosette, leafspots, and rust. Pod yields ranged from 1400 to 3133 kg ha^{-1}.

In the MVT, advanced lines were tested in the various ecological zones in Nigeria. In 1991, pod yield ranged from 2400 to 4066 kg ha^{-1} with an average yield of 2996 kg ha^{-1}. Some lines were simultaneously evaluated in State trials and will be recommended for release to farmers.

Seed multiplication is usually part ofthe breeding program. In 1991, six recently released IAR varieties were multiplied in a total of 10.98 ha. In 1992, only breeders' seed is being produced while foundation seed is multiplied by the IAR seed production project.

Evaluation of some American Groundnut Lines in Burkina Faso

P. Sankara, M. Ouedraogo[1], O.D. Smith[2]

In view of groundnut production problems encountered both in Texas and Burkina Faso, we have assigned the following objectives to our collaborative research: (1) to evaluate adaptation, stability and acceptability of groundnut lines or varieties in Burkina Faso in order to determine their utilization potential; (2) to identify local differences which may be used in the creation of varieties adapted to the country; (3) to assess foliar disease resistance (rust and leafspots) of promising varieties and their resistance to aflatoxins; and (4) to study the impact of organic amendments on groundnut growth and yield in the Bobo Diolasso region (Farako-Ba). In this communication, we are focusing on the objectives 1 and 2 and the part on foliar diseases and organic amendments will be dealt with in future papers.

Test material was made of 13 lines or varieties selected from 150 genotypes. The study was conducted for three consecutive years: from 1985 to 1988. Different varieties were from Texas A&M breeding program, ICRISAT and Burkina Faso. Mean rainfall of sites ranged between 750 to 1100 mm, and soils consisted of clay, sandy clay and sandy loams.

Measured parameters are the following: (1) population density (number of plants per hectare) and (2) pod and kernel yields. Data were analyzed using SAS and MSTAT software. All possible groupings of data according to years and sites were made. Through statistical analysis of results, we made a separation of mean yields of varieties on each site. At Bobo Dioulasso, it was noted that varieties ICGS 56 and ICGS 32 were better than the control as far as pod and kernel yields were concerned.

1. Assistant Professor and Professor, Universite de Ouagadougou, IDR, Ouagadougou, Burkina Faso.
2. Professor, Department of Soil and Crop Science, Texas A&M University, College Station, Texas, 77843-2132, USA.

Waliyar, F., Ntare. B.R., and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

However, these variations were not significant at the 5% level. The highest density per hectare was observed with ICGS 56 (67.5%) and this probably caused the advantage shown by that line.

Mean pod yields by site and year showed that: (1) the best yields seemed to be exclusively at Gampela, Saria and Tenkodogo sites and (2) yields at Bobo Diolasso and Niangoloko were low. From the results, we can draw the following conclusions and recommendations:

1. There are stresses other than rainfall and foliar diseases in groundnut production at Bobo Diolasso and Niangoloko. We think that soil acidity at Bobo Diolasso is an important factor in the decrease of yields.

2. Groupings in two of the sites does not exclude the need to test varieties in the future in each of these sites due to the fact that results confirm good performance of different varieties in sites within a same group, but without interactions being significant.

3. Texan lines, which are crosses between Tammut-74 and PI365553 were generally less productive than TS 32-1. Crosses between TS 32-1 and very productive Texas varieties, followed by breeding in Burkina Faso, may be the source of more adapted varieties to Burkina Faso conditions.

4. Florunner, ICGS 56 and TX 855155 retained our attention at Bobo Diolasso and Niangoloko and should be considered for future tests on these sites. These varieties had both pod and kernel yields higher than the control.

Breeding Disease Resistant Varieties for Semi-Arid Environments[1]

O.D. Smith[2], C.E. Simpson[2], L.J. Wilding[2], M. Ouedraogo[3], G.E. Aiken[2] and P. Sankara[3]

Goals of this Peanut CRSP project are: (1) strengthening peanut breeding and selection programs; (2) developing useful peanut lines for West Africa and Southwest USA; and (3) identifying cultural practices that maximize yields of current and potential cultivars. Project thrusts include variety and advanced line peanut evaluation (WAPEP), disease evaluation, and examination of environmental influences and genotype/environment interactions.

WAPEP involves an annual introduction of elite lines/populations for evaluation and selection by host country collaborators. Approximately 220 entries, 30 per year, have been introduced. They have been derived from parents with characteristics of growth duration, drought tolerance, foliar and soil-borne disease resistance, productivity, and have potential usefulness in West Africa. Entry yields have varied greatly among and within tests. A few lines show potential as demonstrated by the entry Tx874263 which, at Gampela, Saria, and Tenkodogo, averaged 35% more pod yield than TS 32-1 in 1991. Entries from other sources are also in the testing program. In Senegal, Fleur 11 averaged 32% higher in pod yield than 55-437 in 21 ISRA tests since 1985. It exceeded TS 32-1 in pod yield at 4 of 5 locations in Burkina Faso by a minimum of 6.5% in 1991.

Yield variations among locations and years have been large. Data analyses for 13 entries at five locations in Burkina Faso revealed significant genotype x environment interactions. On a paired location basis, genotype x location interactions were insignificant (P>.05) only for tests at Bobo

1. Research supported by USAID Peanut CRSP Grant No. DAN-4048-G-SS-2065-00.

2. Texas A&M University, College Station, TX, 77843, USA.
3. University of Ouagadougou, IDR, Ouagadougou, Burkina Faso.

Waliyar. F., Ntare. B.R. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third 1CR1SAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

Diolasso, Niangoloko, Gampela and Saria. Genotype x year interactions occurred at all locations.

Peanut CRSP, with TROPSOILS, are conducting physical, mineralogical and chemical analyses of soils at six peanut variety test sites in Burkina Faso. Additionally, a collaborative Peanut CRSP/TROPSOILS study has been initiated to ascertain the effects of lime, gypsum, phosphorus, and ash on peanut variety performance at Bobo Dioulasso. The second year of that test is in progress.

Evaluations have been made on both foliar and soil-borne diseases, with particular emphasis on foliar diseases. Entries from 2300 germplasm lines have been screened for leafspot reaction in Texas. Those with notable resistance have and are being tested in Southwest Burkina Faso. In general, the reactions in Burkina Faso have been relative with those in Texas. About 30 of the germplasms are considered as worthy of further investigation.

In Texas, project research continues on the introgression of genes for leafspot and nematode *(Meloidogyne arenaria)* resistance, and earliness from wild species. Two germplasms with resistance to leafspot and *M arenaria* have been proposed for release in Texas. Other efforts involve resistance to Sclerotinia blight, spotted wilt virus, stem and pod rot, and *A. flavus.* Populations from parents with unique oil characteristics, and resistance to rosette virus and termites are being advanced.

Breeding Resistant Varieties: A Component for Aflatoxin Management in Groundnut

H.D. Upadhyaya, S.N. Nigam, V.K. Mehan, D. McDonald, and D.H. Smith[1]

The contamination of groundnut (*Arachis hypogaea* L.) by aflatoxins is a serious problem in most groundnut producing countries. The aflatoxin producing fungi, *Aspergillus flavus* and *A. parasiticus,* can invade groundnut seed in the field before harvest, during drying and curing after harvest, and in storage. The semi-arid tropics are conducive to preharvest aflatoxin contamination when crops experience drought before harvest. In wet and humid areas, postharvest contamination is more important. Breeding resistant varieties should provide an important component for the integrated management of aflatoxin.

Types of Resistance. The resistance to aflatoxin producing fungi operate at three sites: the pod, the testa, and the cotyledons. Sources of resistance to pod infection, seed colonization, seed infection, and aflatoxin production have been identified.

Breeding for Resistance. Breeding high-yielding groundnut varieties resistant to seed infection and colonization by *A. flavus* and *A. parasiticus* and/or to aflatoxin production is a major objective at ICRISAT. We have used sources of resistance to seed infection/colonization, and two sources of resistance to aflatoxin production in an effort to combine multi-site resistances with high yield.

---

1. Groundnut Breeder; Principal Groundnut Breeder; Groundnut Pathologist; Program Direetor (Legumes); and Principal Legumes Pathologist, ICRISAT Center, Patancheru P.O., Andhra Pradesh 502 324, India.

Waliyar, F., Ntare. B.R., and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso, (In En., Fr.) Patancheru. A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

Selection. We have modified our breeding scheme to the single seed descent method for generation advance and delay selection until the F_4 generation. In the F_5 generation, selected single plants are evaluated in progeny rows for reactions to diseases and insect pests, and yield potential. Phenotypically uniform progenies are evaluated for resistance to preharvest seed infection in imposed drought conditions. Lines are then evaluated for yield in replicated trials, and for resistance to seed colonization in the laboratory. Selected advanced breeding lines are evaluated for aflatoxin contamination. Next, breeding lines with resistance to aflatoxin contamination and high yield potential are evaluated in international trials. Resistant material reaches farmers through our cooperators in the national programs.

Progress in Breeding for Resistance. Several hundred breeding lines have been evaluated for resistance to seed colonization in laboratory tests. We evaluated 119 lines for resistance to natural seed infection and yield. Some lines have consistently shown resistance to seed infection and colonization and have given high yields: ICGVs 88135,88145, 89063, 89106, 89112, and 89115. The short-duration variety, ICGV 86168, yielded 18% more than the resistant control variety J 11 (1.74 t ha^{-1}) in 12 evaluations and showed equal or more resistance to seed colonization and infection. Three ICRISAT breeding lines (ICGVs 87094, 87107, and 87110) have shown resistance at three locations in Niger. The limitations of resistant sources makes the breeding of varieties completely free from aflatoxin contamination very difficult.

Future Plans. As we need to know the allelic relationship between the genes for resistance in different sources, we initiated genetic studies on the inheritance ofresistance to seed colonization and aflatoxin production. We started the second cycle ofbreeding and selection, with the newly developed seed infection/colonization resistant varieties as parents. We shall evaluate selected varieties for resistance to seed infection and colonization by aflatoxin producing fungi in multilocational trials.

Crop Protection

Management of Groundnut Foliar Diseases in Samaru Northern Nigeria

O. Alabi, P.E. Olorunju, S.M. Misari, and S.R. Boye-Goni[1]

Groundnut (*Arachis hypogaea* L.) is an important crop in northern Nigeria where most of the country's groundnut is produced. Early leaf spot *(Cercospora arachidicola* Hori), late leaf spot (*Phaeosariopsis personata* [Berk and Curt] V. Arx.), and rust (*Puccinia arachidis* Speg.) are the most serious diseases after the rosette virus. Losses recorded annually due to these diseases are as high as 50% of the seed yield and even more for haulms.

Disease Management

A primary research thrust at Samaru is management of foliar diseases to improve groundnut production as leaf spot diseases are mainly soil-borne. Crop rotation, early sowing, and effective weed management have been identified as valuable practices in controlling these diseases.

Fungicidal Control

Since 1976, rust always occurred with leaf spots and fungicides were screened for the control of the three diseases. In 1990, a trial started in which three fungicides, Benlate® (benomyl), Dithane M-45® and Anvil® (hexaconazole), were tested for their efficiency against foliar diseases. A susceptible variety, Ex-Dakar (55-437 or SAMNUT-18) was used for the trial. The results showed that Anvil® (a newly introduced chemical) gave a good control of the diseases and compared favorably with the earlier recommended mixture of Dithane M-45® and Benlate®. All the sprayed

1. Pathologist; Breeder; Deputy Director; and Entomologist, IAR, Ahmadu Bello University, PMB 1044, Samaru, Zaria, Nigeria.

Waliyar, F., Ntare, B.R. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

plots gave higher pod and haulm yields than the control. The plots sprayed with Benlate® had a high severity of rust, although leaf spots were controlled.

Screening for Resistance

In 1988, 1989 and 1990, screening was performed on 24 varieties. Most varieties had low disease scores for early leaf spot and rust, but high scores for late leafspot. Varieties RMP-91. RMP-12, M590-81, M343.81, M354.81. 69.101, and MDR8-15 were moderately resistant to foliar diseases. They had higher pod and haulm yields than the other highly susceptible varieties. The results of this study confirmed that RMP-12, RMP-91, (released as SAMNUT-10 and SAMNUT-11 respectively) and MDR8-15 (a multiple disease resistant material that is recommended for release), maintained their resistance to the foliar diseases. Varieties M343.81 and M354.81 showed some resistance but need to be reexamined for other agronomic qualities before considering them for release to farmers.

Conclusion

It needs to be stressed that the integrated pest management approach, using a combination of two or more control strategies, namely host plant resistance, cultural and chemical controls, is the thrust of our research and extension efforts in Nigeria.

Study of Potential Susceptibility to Rust Under Leafspot Fungal Control of New Groundnut Varieties in Burkina Faso

S. Bonkoungou[1]

The groundnut breeding program in Burkina Faso has produced varieties that are resistant to rust but are susceptible to foliar leafspots. In view of the interaction between leafspots and rust, these varieties were evaluated under fungicide treatments to control leafspots so as to better determine their potential susceptibility to rust. Carbendazim®, an effective fungicide against leafspots but does not control rust, was used at the rate of 200 g a.i.ha^{-1}.

The results suggested the existence oftwo types ofvarieties: (1) IC79 series which confirmed their resistance to rust in the presence ofor without leafspots, and (2) RH82, SH462, SH67 and TH series which showed varying degree of susceptibility.

The introduction of resistance to rust characteristics did not however, improve the productivity ofthe new varieties. None were superior to the control. Only varieties IC79-1A, IC79-21 were rust-resistant and had yields (1.5-1.6 t ha^{-1}) similar to those of their respective controls 59-426 (1.8 t ha^{-1}) and QH 243C (1.6 t ha^{-1}). Varieties SH 67A and SH462C, were the only varieties susceptible to rust that had yields (1.3-1.5 t ha^{-1}) comparable to their controls.

1. Phytopathologiste, INERA, 03 B.P. 7192, Ouagadougou 03, Burkina Faso.

Waliyar. F., Ntare. B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Survey of Groundnut Viral Diseases in Burkina Faso and Mali: Preliminary Results

M. Dollet[1], F. Waliyar[2], D. Soumano[3]

The meeting of the Consultative Group for Groundnut Viral Diseases in Africa, held at Montpellier in September 1992, recommended surveys to identify and evaluate the importance of groundnut viruses in Africa, Following this recommendation, ICRISAT initiated a survey in collaboration with IRHO-CIRAD and the national agricultural research programs of Burkina Faso (1NERA) and Mali (IER).

The surveys in Burkina Faso and Mali were performed in September 1991. Four to five fields were surveyed about every 50 km in groundnut producing areas. Fifty-one samples, which appeared to be infected by a virus, were taken to the Laboratoire phytovirologie regions chaudes-CIRAD (LPRC) at Montpellier. They were grafted to groundnut variety 69101 (sometimes RMP 12 or TMV2) and kept in climatic cells or insect-free glasshouses. Transmission of symptoms by graft were observed for 10 months. Mechanical transmission on the control was tried for every sample. Finally, *"Leaf Dip"* negative coloration electron microscope examinations were performed whenever possible on grafted groundnut or controls which showed symptoms.

The two most widespread viruses are the Peanut Clump Virus (PCV) and the Groundnut Rosette Virus (GRV). It is noted that PCV is the most important problem in research stations (Saria in Burkina Faso, Cinzana in Mali). A high disease variability was observed and also normal plant height with yellow arabesques, yellow spots and yellowing.

---

1. Division Virologie, IRHO Laboratoire Phytovirologie Regions Chaudes-CIRAD B.P. 34032 Montpellier Cedex 01, France.
2. ICRISAT Sahelian Center, B.P. 12404, Niamey, Niger.
3. Institut d' economie rural, S.R.C.V.O. Sotuba, B.P. 438, Bamako, Mali.

Waliyar. F., Ntare, B.R, and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou, Burkina Faso. (In En., Fr.) Patancheru, A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

There were isolated cases of GRV (5 to 10 per field) a bit everywhere. It was in southern Burkina Faso and central Mali that the heaviest incidence was found (always less than 10%).

Two filamentous viruses, one Potyvirus and one Closterovirus that have not yet been identified, were found in Burkina Faso. A possibly new groundnut virus has been identified at the Sotuba Station in Mali. For many clump cases, we could not identify either PCV or any other virus. All clump cases should not automatically be attributed to PCV, and furthermore, PCV could be found on groundnuts of normal plant height and stand but having various symptoms that were more or less identifiable.

Dissemination of Peanut Clump Virus by Groundnut Seed and its Detection in the Seed

G. Konate and N. Barro[1]

Dissemination of peanut clump virus (PCV) in groundnut *(Arachis hypogea* L.] was studied using progenies of some infected groundnut seeds from the field and the Enzyme Linked-Immunosorbent Assay method (ELISA). The virus could be detected in 16.5% of the seeds and 7,5% of the next generation were infected.

When groundnut seeds were grown in a field contaminated by the virus, it was shown that by eliminating the infected plants, only 0.15% of the seeds from the remaining plants produced infected progenies. It was also established that the level of virus contamination was inversely proportional to the seed size.

1. Institut d'etudes et de recherches agricoles (INERA), 03 BP 7192, Ouagadougou 03, Burkina Faso.

Waliyar. F., Ntare. B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICR1SAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso, (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Termite Damage to Groundnut: Interaction with Soil Moisture and *Aspergillus flavus,* and Evaluation of Cultivars for Resistance to Pod Damage

R.E. Lynch[1], I.O. Dicko, and A.P. Ouedraogo[2]

Collaborative research between scientists at the University of Ouagadougou and USDA-ARS, University of Georgia, USA has been conducted to determine factors associated with insects that limit production of groundnut. In Burkina Faso, termite damage to groundnut during the latter part of the growing season is one of the most serious problems. Several cultural and environmental factors interact to enhance termite damage to groundnut pods and contamination of seed with aflatoxin. The factors include groundnut genotype, planting date, rainfall, distribution of rain, drought during the latter portion of the growing season, pod damage by insects and millipedes, harvest date, drying conditions after harvest and storage conditions. Research in Burkina Faso has shown that termite damage to groundnut is one of the primary variables associated with aflatoxin contamination of seed. Termite damage may be expressed as damage to plants by tunnelling in the tap root that results in plant death, external scarification of pods, or pod penetration. Termite damage to groundnut pods increases rapidly with drought during the latter portion of the growing season and a delay in harvest beyond that is optimal for a given location. This increase in damage is directly associated with a decrease in soil moisture during the end of the growing season and coincides with an increase in the contamination of groundnut seed with aflatoxin. Our research has shown that a delay in harvest of only 14 days at the end of the rainy season is sufficient to drastically increase the level of termite damage to groundnut pods.

1. Supervisory Research Entomologist, Peanut CRSP, USDA-ARS, PO Box 748, Tifton, GA, 31793-0748. USA.

2. Professors, Institut du developpement rural, Universite de Ouagadougou, Burkina Faso.

Waliyar, F, Ntare. B.R, and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

In the USA, damage to groundnut pods by the lesser cornstalk borer, *Elasmopalpus lignosellus,* is very similar to that noted for termite in Burkina Faso, i.e., drought during the end of the growing season increases pod scarification and penetration. Research with this insect in the USA has shown a significant increase in *Aspergillus flavus* contamination and aflatoxin in seed from pods with external damage compared with seed from undamaged pods. Likewise, seed from penetrated pods had significantly more *A. flavus* and aflatoxin than seed from externally damaged pods. The increase in *A. flavus* and aflatoxin was related to a more rapid water loss in pods with external damage compared to undamaged pods. This more rapid water loss allows seed from externally scarified pods to reach a moisture content conducive to *A. flavus* growth more rapidly than seed from undamaged pods.

Evaluation of groundnut lines, identified by ICRISAT-India as resistant to termites, has been conducted in Burkina Faso during the past few years. Research has been conducted at the Banfora and Gampala research stations by evaluating 16 groundnut for termite damage in a split-pot arrangement of treatments where groundnut cultivar was the whole plot and harvest date (normal harvest versus delayed harvest) was the subplot. This research has shown that several lines, notably NCAc 343, have resistance to plant and pod damage due to termite. NCAc 343 is also one of the highest yielding cultivars, even with a delayed harvest. This cultivar has been identified previously as having resistance to thrips, jassids, *Helicoverpa,* and southern corn rootworm and should be very useful in a breeding program to develop multiple pest resistance, including resistance to termite. Research in Burkina Faso is presently underway to determine if resistance to termite damage in groundnut pods will decrease aflatoxin contamination in seed.

A Study of Peanut Clump Virus Variability

S.K. Manohar[1], H. Guilley[2], G. Jonard[2], K.E. Richards[2], C. Schmitt[2], D. Gargani[1] et M. Dollet[1].

Peanut Clump Virus (PCV) is a furovirus two component rod virus. In the early 1970s, it was observed at Bambey in Senegal and Saria in Burkina Faso. Today, this virus has spread throughout Senegal and has reached the Cote d'lvoire, Benin, Niger and has been noted in Mali. In addition, this virus has been identified as the cause of pathological symptoms on sugar cane in Senegal and Burkina Faso. It was also found on sorghum and maize.

At the beginning of PCV etiological study, the virus was associated, as its name indicates, with the groundnut clump disease. Since 1986, the virus could have been associated with completely different symptoms with no plant clump (yellow spots, mottling, ringspots, arabesques). *Chenopodium amaranticolor* is the test plant for this virus. Forty-one PCV isolates from Senegal, Burkina Faso, Niger and India, gave a classification of five different groups of symptoms. These were confirmed by a serological study.

On the molecular aspect, the RNA preparations extracted from different PCV isolates, then analyzed in a denaturing gel still showed the presence of the two main RNAs called RNA 1 and RNA 2. This result has been confirmed by the cloning and the sequential split of RNA 2 from the isolate 87 ThyTGTA2 which had 4502 nucleotides. There were six open reading phases (ORF) on this RNA. As in the case of BNYW, another furovirus, the gene containing the protein capsule is found on the 5' edge of the PCV's RNA 2. Furthermore, association of ORF 3,4 and 5 recall the

1. LPRC/CIRAD, B.P. 5035, 34032 Montpellier Cedex 01, France.
2. IBMP, 12 Rue Gal Zimmer, Strasbourg 67000, France.

Waliyar, F, Ntare, B.R. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

"Triple Block" organization found in BNYW, BSMV and many Potexviruses, a structure associated with the virus dissemination from cell to cell.

There are no resistant or tolerant groundnut varieties known to date. This study provides possible ways to obtain groundnut resistance to PVC.

Status of Research on Groundnut Leaf spots in Senegal

O. Ndoye[1]

Groundnut (*Arachis hypogaea L.*) plays an important role in Senegal's economy. It has been cultivated for many centuries since it was introduced around 1659. The first groundnut research program started in the 1920's and focused on improving knowledge of the crop and developing varieties from different populations.

Today, groundnut has dropped from first place as an export product and has been replaced by phosphates, fishing, and tourism. At the time of Senegal's independence in 1961, groundnut was generating 83% of export resources. Its share as an export product fell from 98% in 1970 to 41% in 1975.

This decrease is due to various factors, especially the drought which lasted for almost two decades in the Sahel. In addition, the new agricultural policy has led the state to withdraw from the agricultural sector in favor of private companies.

Leafspots are a major disease since they can reduce yields up to 50% in areas where groundnut has not been treated by fungicides. In Senegal, leafspot control started in the 1950's with the use of fungicides. The first products were in the form of powder and were not satisfactory. The rainfall pattern did not allow spraying without the risk of the chemicals being washed off by the rain. Later on, some chemical molecules were tested but no recommendations were made at the farmers level.

Scoring methods for leafspots according to ICRISAT's scale is performed at different stages of the plant's growth cycle, beginning at 60 days after sowing, and was used to compare ICRISAT varieties with landraces. This comparison allowed a hierarchical ranking of varieties according to their susceptibility to leafspots.

---

1. Selectionneur, Institut senegalais de recherche agricoles (ISRA), Station Nioro, B.P. 17 Nioro-du-Rip, Senegal.

Waliyar. F., Ntare. B.R, and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992. Ouagadougou, Burkina Faso, (In En., Fr.) Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

Recently, control methods for leafspots placed emphasis on breeding for resistant varieties. This approach was pointed out by Jaubert in 1952. Varietal resistance is the least expensive and the most Judicious way for developing countries to avoid the high cost of fungicides. Evaluations of hybrids bred for resistance are underway.

Leafspot control should be organized at the regional level. We do not know yet if there are physiological races. If they do exist, establishing regional or even national programs would be fully justified.

Pod Resistance of Different Varieties of Groundnut *Arachis Hypogaea* L. (Papillionaces) to Pod Scarification and Termites

A. P. Ouedraogo, I. O. Dicko[1], and R. E. Lynch[2]

Fifteen peanut genotypes (*Arachis hypogaea* L.), including 13 ICRISAT and two local varieties, were evaluated in 1987, 1990, and 1991 at the University of Ouagadougou Experiment Station at Gampela (Burkina Faso) for resistance to pod scarification and penetration by termites and millipedes. Resistance ranking of varieties were established by taking 16 samples of 100 pods from plots at harvest and determining the total numbers of undamaged and damaged pods.

Termite resistance tests revealed some peanut varieties to be appreciably more resistant to pod scarification than others. Among these were NCAc 2240, RMP 12, NCAc 2242, NCAc 2243, NCAc 343 and RMP 40. Similarly, RMP 40, NCAc 343, and NCAc 2243 were found more resistant to pod penetration by millipedes. Ranking for resistance to soil arthropod damage and pod yield at harvest were poorly correlated. For a better understanding of the relationship between peanut yield and resistance to soil arthropods, future studies should investigate the effect of soil moisture on peanut response to pod damage.

1. Professeurs, Institut du developpement rural (IDR), Universite de Ouagadougou, Burkina Faso.

2. Supervisory Research Entomologist, Peanut CRSP, USDA-ARS, P.O. Box 748, Tifton, Georgia, 31793-0748, USA.

Waliyar, F., Ntare. B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Crop Physiology Response to Fungicides by Cultivars Differing in Foliar Disease Resistance

J. H. Williams, F. Waliyar[1] and P. Subrahmanyam[2]

Ten improved groundnut lines with differing levels of resistance to foliar pathogens were grown under a series of fungicide treatments to manipulate the main groundnut foliar diseases in three seasons. Disease pressure varied over the three years: in 1987 both rust and late leaf spots were important: in 1988, early leaf spot was prominent: and in 1989, late leaf spot dominated. The green leaf remaining at different stages of growth, mean crop growth rates, pod growth rates, and partitioning to pods were used to understand the crop physiology and to investigate the relationship between resistance and partitioning.

Crop growth rate, pod growth rate, and partitioning were all influenced by both the variety and the chemical control of the foliar diseases. The increased green leaf area duration associated with resistance was similar to that obtained by fungicide spray on a susceptible line. Variations in green leaf area duration were related to pod growth rate for susceptible lines but not for resistant lines. Variations in leaf remaining at maturity without chemical intervention could be due either to differences in resistance to the pathogens or to differences in partitioning. High partitioning and resistance to rust were not mutually exclusive, but differences in susceptibility to the leafspots seem negatively associated with the partitioning. Green leaf area duration data showed that lines previously not considered to have resistance to leaf spots differed in their susceptibility to these diseases, having higher yield because of moderate protection of the canopy.

1. Principal Physiologist and Groundnut Team Leader; Principal Groundnut Pathologist, ICRISAT Sahelian Center, B.P, 12404, Niamey, Niger.

2. Principal Pathologist, SADC/ICRISAT Groundnut Project, P.O. Box 1096, Lilongwe, Malawi.

Waliyar. F., Ntare. B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso, (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Current Research on the Management of Early Leaf Spot of Groundnut at the SADC/ICRISAT Groundnut Project

P. Subrahmanyam and G. L. Hildebrand[1]

Early leaf spot (*Cercospora arachidicola* Hori.) is the most destructive disease of groundnut in the SADC region. Although yield losses vary considerably between locations and seasons, at Chitedze, Malawi, the disease causes yield losses usually exceeding 40% every year. Fungicidal control of early leaf spot is not economically feasible for many small-holder farmers. The SADC/ICRISAT groundnut team is investigating low-input strategies for early leaf spot management. These include utilization of genetic resistance, single applications of fungicides, and practices such as crop rotation, optimal sowing date, and cropping patterns that lessen disease severity and its impact on yield.

Genetic Resistance

Utilization of genetic resistance is a major component of the early leaf spot management strategy. Presently, all groundnut cultivars used by farmers in the region are susceptible to the disease. Groundnut lines initially evaluated for reaction to early leaf spot had low levels of resistance. During the 1990/91 crop season at Chitedze, we screened 1508 South American lines, 743 advanced generation and 4771 early generation breeding lines, and 126 interspecific hybrid derivatives for resistance to early leaf spot. Some 80 germplasm lines, 46 breeding lines and four interspecific hybrid derivatives had appreciable levels of resistance (scores between 5 and 7 on a 9-point scale). Some of these lines are used in our breeding program.

1. Principal Plant Pathologist; Principal Groundnut Breeder, SADC/ICRISAT Groundnut Project, P.O. Box 1096, Lilongwe, Malawi.

Waliyar. F., Ntare. B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Fungicidal Control

In some countries of the region, 6-8 applications of fungicides are recommended for control of early leaf spot. Preliminary studies by the SADC/ICRISAT groundnut team and of some NARS in the region in late 1980s showed that strategically timed single applications of fungicide can have a major effect in reducing yield losses. In the 1990/91 and 1991/92 crop seasons at Chitedze, the limited use of fungicide was tested on six groundnut cultivars. Fungicide applied either once or twice, at different stages of disease development significantly increased the yield of all cultivars.

Agronomic Practices

The effect of crop rotation on severity of early leaf spot on two groundnut cultivars (Malimba and ICGMS 42) was investigated. The disease was very early and development of the disease was rapid when groundnut followed groundnut. In groundnut followed by maize or pasture, the disease development was slower and less severe.

Sowing dates also influenced the severity of early leaf spot. Disease severity was low at initial stages of crop development in the early sowing but in advanced stages there were no differences between sowing dates. Pod yields were higher in the first sowing than subsequent sowings.

Studies on the effect of intercropping groundnut with maize and pigeon pea on severity of early leaf spot of groundnut showed variable results depending on the site.

In collaboration with the national programs of the SADC region, we hope to develop a package that combines all three components for the effective and economical control of early leaf spot.

Inventory and Distribution of Groundnut Insect Pests in Burkina Faso

S. Traore[1]

The most important work on this subject was conducted by Lynch et al (1986). It focused on the effect of thrips, aphids, jassids, termites, and millipedes. Our work continued this inventory and emphasized geographical distribution, and presents a summary of damages.

Insect collection was performed in on-station and on-farm trials. The research stations included Saria and Gampela in central Burkina Faso, Kouare in the East and Niangoloko in the West. In addition to traditional material, we also used the Dabrowski trap in entomology. We proceeded by collecting flowers and buds, searching in seed beds, and hand-pulling. We observed the following varieties: CN94C, TS 32-1, and TE 3 in eastern and central Burkina Faso, and RMP 12, RMP91, and 47-10 in the West.

At ground level, termites *(Microtermes spp)* and millipedes *(Pterodontopyge rubesceus* and *Pterodontopyge spinosissima)* were the most important pests. At the pod level, termites and millipedes made scarifications and perforations. Larvae and adult beetles of the *Tenebrionidae* family and white worms of the *Scarabaeidaea* family, were found in the soil near severed roots. Termites and millipedes were more important in the Saria, Gampela and Kouare research stations where the rainfall is less than 800 mm, but their incidence was not significant at Niangoloko (1300 mm). On leaves, stems, and flowers the following insect pests can be found:

1. Groundnut aphid *(Aphis craccivora).* Abundant and early in the West where it transmits rosette.

1. Attache de recherche, INERA, Station de Saria, B.P. 10 Koudougou, Burkina Faso.

Waliyar. F., Ntare, B.R., and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992, Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

2. Green leafhopper *(Emposa dolichi).* Present in all groundnut ecologies and has the highest level ofjassids. At Niangoloko, where there was a high increase, yellowing of leaf edges was observed.
3. Cicadulina spp. Very low in population and four species were found on-station: *C. imbila. C. triangula. C. arachidis,* and *C. similis.* The last two are believed to transmit rosette.
4. Flower thrips *(Megalurothrips sjostedti).* Caused light discoloration and swelling of leaves and a loss of flowers at Niangoloko.

Defoliators were also noticed, such as *Spodoptera littoralis* (Lepidoptere noctuidae), *Heliothis armigera* and *Maruca testulalis* and meloides of the Mylabris species, that colonize flowers in order to consume their various parts.

Main sedentary groundnut locusts are *Oedaleus senegalensis* (Orthopthere Acrididae), *Chrotogonus senegalensis* (Orthoptere Pyrgomorphidae), *Hieroglyphus daganeusis* (Orthoptere Acrididae), and *Pyrgomorgha cognata* (Ozth Pyrgomorphidae).

During the inventory, ladybug beetles and syrphids were observed among *Aphis craccivora* colonies. In Burkina Faso, termites and millipedes populations were important in areas with less than 800 mm of rainfall and *Aphis craccivora* and *Empoasca dolichi* in areas above 900 mm.

Aflatoxin Contamination of Groundnut in Niger

F. Waliyar[1] and H. Hassan[2]

Aflatoxin contamination caused by *Aspergillus flavus* in groundnut is one of the most important constraints to groundnut production in many West African countries. *A. flavus* contamination occurs under both preharvest and postharvest conditions. Preharvest contamination by *A. flavus* and aflatoxin production are important in the semi-arid tropics, especially when end-of-season drought occurs.

During the 1989, 1990 and 1991 rainy seasons, 25 lines including germplasm, advanced *A. flavus* resistant breeding lines, and cultivars from West Africa, were tested at Sadore, Bengou and Maradi in Niger. Seed collected from these trials was tested in the laboratory to estimate contamination by *A. flavus,* and aflatoxin content was measured using the ELISA method.

Average seed contamination varied from 5 to 37% according to site and year. The highest seed contamination was recorded in 1991 at Sadore. Significant differences between genotypes were found. Cultivars 55-437 and J 11 were the least contaminated. Among the ICRISAT advanced breeding lines involving *A. flavus* resistant parents, ICGV 87107, ICGV 87094 and ICGV 87110 were the least contaminated. All the known resistant lines were among the less contaminated while susceptible lines exhibited the highest seed contamination.

The results showed that some breeding line possessed good levels of resistance to *A. flavus,* reflecting the presence of genes for resistance. Since *A. flavus* and aflatoxin resistances are vital to the success of varieties, screening for these attributes should be done at the earliest possible stage.

1. Principal Groundnut Pathologist, ICRISAT Sahelien Center. B.P. 12404, Niamey, Niger.
2. Institut national de recherches agricoles du Niger (INRAN), Station de Tarna, B.P. 240, Maradi, Niger.

Waliyar. F., Ntare. B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru, A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Breeding lines should be routinely screened for resistance before sending the material for regional or international trials to avoid super-susceptible lines.

The aflatoxin contamination was measured using ELISA only from 1990 and 1991 trials. *A. flavus* contamination was well correlated and aflatoxin content ranged from 1 to 750 ppb. Only one line (VAR 27) with high contamination by *A. flavus* showed a low level of aflatoxin. Among the ICRISAT breeding lines, ICGV 87110 produced the lowest level of aflatoxin. In 1991, VAR 27 had 49% seed invasion by *A. flavus* only had 1 ppb of aflatoxin.

Utilization

Evolution of Physical and Chemical Parameters and Aflatoxin Production in Groundnut Seeds During Storage

P. A. Nikiema, S. A. Traore[1] et B. Singh[2]

Fungi and their toxic metabolites (mycotoxins), which are found in kernels, seeds and in fields, have always been of concern to people and domestic animals. One of the aflatoxin research themes is detoxification of contaminated products and/or inactivation of toxins. While these methods are indispensable to preserve human and animal health, they either can not be utilized on food products or are too expensive for wide-scale use. Another possible way to minimize aflatoxin contamination rate is to control other parameters, such as water content, temperature, relative humidity and aeration in raw material.

The objective of this study was to obtain information on the evolution of physical and chemical parameters in natural conditions for groundnut conservation in Burkina Faso, to assess these parameters, and if need be, to advocate better storage conditions. A monitoring of the evolution of physical and chemical parameters (proteins, glucides, lipids and seed water content) was carried out on two seed samples of local varieties at Boanga and Wobgo during a 12-month storage period. In correlation, a monitoring of relative humidity evolution in storage environment and aflatoxin production in seeds was conducted.

It was observed that in the two varieties of seeds, reduction in protein (6-6.6%), lipid (5.5%) and glucide (1.9%-3.5%) contents was followed by an increase in aflatoxin production {120% for Boanga and 300%

1. Faculte des Sciences et Techniques, Departement de Biochimie/Microbiologie, Universite de Ouagadougou, 01 B.P. 7021, Ouagadougou. Burkina Faso,

2. Professor, Alabama A&M University, Department of Food Sciences, P.O. Box 274, Normal, AL 35762, USA.

Waliyar. F., Ntare. B.R., and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

for Wobgo). On the other hand, evolution of seed water content follows that of relative humidity while in storage and plays a dominating role in aflatoxin production.

It is then possible to establish a correlation between the evolution of physical and chemical parameters and aflatoxin content in seeds. Water content in seeds, their hygroscopic capacity and lipid metabolism (lipoperoxydation), seem to be the more determining factors of aflatoxin production in groundnut seeds during storage. Results show that the Boanga variety is less susceptible to aflatoxin contamination compared with Wobgo, and for this reason, should be recommended as food.

Study of Groundnut-Based Products Consumed in Burkina Faso: Improvement and Conservation of Roasted Groundnut Called Marba-Tigue

R. Simde[1] A. Traore[2], B. Singh[3]

The roasted groundnut (*Arachis hypogeae),* called marba-tigue in Burkina Faso, is one of the most common forms of consumption. It is sold and eaten almost everywhere (public places, celebrations and community festivals). Marba-tigue is the source of a flourishing trade from which many women derive most of their financial income. Despite its economic and social importance, technological studies are not available even though there were problems associated with the product, namely (1) organoleptic variability, (2) non-control of raw material used in its preparation, and (3) poor conservation.

A study of the different technological stages, from the provision of raw materials up to the conservation of the final product, has given the following results:

- The origin of the variety used by women to prepare marba-tigue is unknown as traders sell a combination of varieties.
  High linoleic acid content in seeds reduces conservation time through oxidation. It then becomes necessary to determine the variety in order to choose one with poor linoleic acid content.

We have noted that raw grains are conserved, at the traders level, in the dehulled form. This practice contributes to reducing the quality of raw

---

1. Universite de Ouagadougou, B.P. 9820, Ouagadougou, Burkina Faso.
2. Directeur, INSN-IDR, Departement de Biochimie, Universite de Ouagadougou, 03 B.P. 7131, Ouagadougou, Burkina Faso;
3. Professor, Alabama A&M University, Department of Food Sciences, P.O. Box 274, Normal, AL 35762, USA.

Waliyar. F., Ntare. B.R, and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

material since it exposes seeds to conditions of rapid bacterial deterioration and fatty acid oxidation.

Water content analysis of a few samples of marba-tigue prepared from the same variety has provided values between 4.83 and 0.651%. High water content that can have possible negative effects on its conservation can occur at one of the preparation stages, namely when seeds are soaked in water before they are partially dried.

Temperature, which is an important parameter for conservation, causes different reactions that reduces biochemical and organoleptic traits of the product. In Burkina Faso, we have noted many conservation temperatures because of temperature variations during the day. These fluctuations have negative effects on conservation as high temperatures cause water evaporation in the seeds. The steam remains trapped in plastic bags containing marba-tigue and at low temperatures, it condenses on seeds and causes bacteria to increase. In addition, high temperatures accelerate oxidation reactions, thus reducing the length of conservation.

The combined action of variety, water content and conservation temperature on the peroxide rate of samples of marba-tigue conserved during three months, has given values above 20 ml/kg of oil after one month of conservation. After this period, products go rancid.

Groundnut Utilization and Possible Improvements of Indigenous Foods in the Semi-Arid Tropics

B. Singh[1]

Groundnut is widely used in the Sudan, Burkina Faso, Mali, Niger, Senegal, Nigeria, Gambia, Ghana and other West African countries as a food source in a variety of forms. The most commonly utilized form is the roasted nut, followed by paste (full-fat or partially- defatted), oil, raw and boiled.

Research has been conducted to improve the traditional method of roasting, grinding and packaging of groudnut paste. The defatted flour has been used to improve the nutritional qualities of sorghum based indigenous foods like kisra and "to" and the cassava-based product, "gari". Groundnut milk has been used to produce "mish", a concentrated yogurt-like product.

1. Professor, Department of Food Science and Animal Industries, Alabama A&M University, P.O. Box 264, Normal, AL 35762. USA.

Waliyar. F. Ntare. B.R. and Williams. J.H. (eds.) 1993, Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa, 14-17 Sep 1992, Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru, A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

General

Status of Groundnut Improvement in Sierra Leone

A. Sesay, A. C. Lahai and J. Roberts[1]

This paper presents an overview of the research activities of the Groundnut Improvement Program of the Institute of Agricultural Research (IAR) in Sierra Leone since its establishment in 1990. It highlights the major achievements, difficulties, and future activities.

The major thrust has been in varietal improvement for two reasons: the lack of improved varieties is a major constraint to groundnut production in Sierra Leone, and groundnut varieties have not been released in Sierra Leone through research. This objective is met through screening and evaluation of germplasm provided by the ICRISAT Sahelian Center on a collaborative basis. A total of 129 genotypes were evaluated in 1990 and 1991. The local check, Mares, was out-yielded by several entries by margins of 4 to 55%, indicating considerable potential for selection for local adaptation. ICGV 87157 and JL 24 emerged as the most promising genotypes. In a multi-locational trial conducted in 1991 with eight genotypes from the 1990 trial, and five of the six zonal centers of IAR, the highest yield performance was also by ICGV 87157, followed by JL 24. The highest yield for each genotype was recorded in Kabala, followed by Rokupr and Magbosi. Makeni and Njala had the lowest yields. The two genotypes, ICGV 87157 and JL 24, are currently undergoing on-farm testing to assess their performance under farmers' conditions.

To complement the varietal improvement efforts, agronomic investigations have been initiated to generate information to develop a package of reliable recommendations. Preliminary studies to determine the response of groundnut genotypes to timing and frequency of hand-weeding indicate that one weeding at 20 to 30 days after planting could give yields that are comparable to clean-weeded plots. While virus incidence was not affected, groundnut defoliation by caterpillars was enhanced by weed infestation. Yield loss associated with the leaf spots was as high as 46%.

1. Associate Scientists, Institute of Agricultural Research, Njala University College, PMB Freetown, Sierra Leone.

Waliyar. F.. Ntare, B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324, India: International Crops Research Institute for the Semi-arid Tropics.

Related studies showed planting date and genotype effect on the incidence of bacterial wilt, a disease that is of increasing importance in groundnut farms in Sierra Leone.

In the future, the search will continue for improved genotypes with exceptionally high adaptability. Detailed studies on agronomic practices, poor stand establishment, and poor pod filling in large-podded genotypes will be emphasized.

Groundnut Agronomy in Cote-d'Ivoire

A. Amalaman[1] et N.K. Placide[2]

Groundnut is the most widely grown legume in the Cote d'lvoire, with a production of 80 000 to 100 000 tons per year. Groundnut can be sown flat or in ridges, and as a sole crop or intercropped with cereals. Early-maturing or late-maturing groundnut is grown at low densities. Climatic conditions (overcast weather, high moisture and dew) make groundnut prone to many foliar diseases. The majority of the production is consumed locally and distributed through traditional trade channels. However, it can benefit as an important industrial outlet for oil and for paste already on the market.

Preliminary results indicate that higher fertilizer rates of 10-18-18 and single superphosphate did not improve groundnut pod yields. Before better fertilizer methods are available, fertilization should not continue on groundnut grown in rotation with already fertilized cotton or maize, since it can have residual effects from fertilizers that are used on these crops.

All varieties received from the Burkina Faso rust control program had good levels of resistance for rust in comparison with the controls. Most did not show any signs of rust, which was encouraging, however they were susceptible to leafspots at different levels. At Bouake, where rosette is endemic, all rust-resistant varieties were susceptible to rosette, with the exception of RH 152E. In contrast, at Ferkessedougou, these varieties performed well in terms of rust resistance.

All local genotypes collected after 1989 and 1990 developed different levels of leafspots, rust and rosette symptoms with the exception of 10 which showed low disease symptoms. These 10 genotypes will be studied further to assess their agronomic characteristics in relation to infestation levels.

1. Assistant de recherche, Institut des Savanes, IDESSA 01, B.P. 635, Bouake 01, Cote d'lvoire.
2. Phytopathologiste, IDESSA 01, B.P. 635, Bouake 01, Cote d'lvolre.

Waliyar, F., Ntare, B.R. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

The Peanut Collaborative Research Support Program: West African Component[1]

D.G. Cummins[2] and O. D. Smith[3]

The Peanut Collaborative Support Program (CRSP) is authorized by the Foreign Aid Bill of the United States Congress and is funded by the United States Agency for International Development (USAID) through a grant to the University of Georgia. Subgrants support peanut research projects at Alabama A&M University, The University of Georgia, Texas A&M University, and North Carolina State University, in collaboration with institutions in the West African countries of Burkina Faso, Mali, Niger, Nigeria, and Senegal. Collaborative linkages also exist with countries in Southeast Asia, the Caribbean, and the Near East.

Peanut was chosen as a subject crop of the CRSPs, because it is grown worldwide, is an important food crop, and there are many globally important constraints to production and utilization that can be best solved through collaborative research. Also, peanut contributes to sustainability, because it is a legume and is adapted to crop rotations and intercrop systems. It provides food and cash income on many small farms in West Africa as well as worldwide.

The Peanut CRSP has three major goals or thrusts, all of which apply to West Africa: (1) to develop sustainable agriculture production and food delivery systems that are environmentally sound, (2) to develop resource management systems to relieve situations that restrict efficient management of production and utilization, and (3) to communicate research outputs to clientele. An integral part of the research is an enhancement of research capability for both the United States and the host

1. Research supported by USAID Peanut CRSP Grant No. DAN-4048-G-00-0041-00.

2. Professor, and Peanut CRSP Director, University of Georgia, Georgia Station, Griffin, GA, 30223-1797, USA.

3. Professor and Peanut CRSP Principal Investigator for the West Africa Cultivar Improvement Project, Texas A&M University, College Station, Texas

Waliyar, F., Ntare, B.R. and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Ground nut Meeting for West Africa, 14-17 Sep 1992. Ouagadougou, Burkina Faso. (In En., Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

countries through collaborative research, the provision of equipment and supplies, and the training of research and support personnel*

Host country beneficiaries of the technology developed are small-scale farmers, which include rural women, food processors, and both rural and urban consumers. Benefits come in the form of adequate quantities of more nutritious and safe food, and increased incomes. Similar benefits accrue in the U.S.

Progress is being made in several major areas of the West African Program, and a brief summary follows:

Genetic Resources. A high yielding cultivar was released last year by ISRA-Senegal, Fleur 11, and an 85-day maturity cultivar is near release. Some superior lines have been identified in Mali and seed is being increased for on-farm testing and possible release as new cultivars. Work in Burkina Faso is evaluating germplasm for disease and insect resistance. A rosette virus resistant cultivar is being increased for farmer use in Nigeria, and breeding efforts are focusing on transfer of rosette virus resistance into short-maturity germplasm.

Pest Management. Research in Burkina Faso at the University of Ouagadougou has identified insect tolerant germplasm, and has shown that early harvest reduces termite damage and subsequent aflatoxin contamination in the peanut seed. Neem is being evaluated for insect control in peanut.

Natural Resource Management. Soils on peanut research sites have been characterized in Burkina Faso to enhance technology transfer to similar production areas and research is underway to increase production on acidic, high aluminum and manganese soils in Southern Burkina Faso. An extensive report has been developed and published in French and English -- "Peanut Production, Marketing, and Export: Senegal, Gambia, Niger, Mali, and Burkina Faso" -- and is available from the Peanut CRSP Management Office, University to Georgia, Georgia Station, Griffin, Georgia, 30223-1797, USA.

Food Products and Consumer Use. Research in Burkina Faso has focused on enriching cereal grain flours with peanut flour and using the enriched flour to improve existing foods and expand the use in items such as weaning rations.

Future Plans. The Peanut CRSP is presently authorized for funding through 30 June 1995. During 1992-94, an extensive review and planning process will be undertaken with the view of a five-year extension beginning 1 July 1995. Annual reviews and planning efforts continually modify the program to keep it abreast with current problems. Major reviews may change program directions and could cause changes in institutions and countries participating in the CRSP, which is increasingly possible as funding becomes more limited. Expansions to new countries may result from support from local USAID Missions or other sources, such as the recent addition of Egypt to the CRSP by support from USAID/Egypt.

Sustainable production and food delivery systems have been a focus and will continue to be strengthened in the Peanut CRSP, Sustainable systems must be environmentally and economically sound.

FAO Support to Groundnut Development in Africa

L. J. Marenah[1]

Groundnut is a major source of dietary protein, calories, and edible oil, as well as an important potential contributor to improved soil fertility through its biological nitrogen fixation. Therefore, the crop has been receiving commensurate attention from FAO technical assistance programs in Africa. Currently, there are projects in Madagascar and Zambia that emphasize groundnut research and development directed at small-scale farmers.

The Project in Madagascar

The activities of this project are described as follows:

- Organization of seed multiplication, quality control, and distribution, based on existing adapted varieties.
- Adaptive research to test introduced rosette-resistant varieties and cultural practices to control rosette, together with nematodes, were identified as two of the most important factors limiting groundnut production.
- Testing of animal-drawn machinery, as well as their local manufacture.
- Organizing local in-service training courses for extension personnel, as well as overseas training in research and improved production and seed technologies.
- Technical assistance for improved oil extraction and refining to process the significantly increased production achieved by the project within two years.

1. Regional Plant Production and Protection Officer, FAO Regional Office, P.O. Box 1628, Accra, Ghana.

Waliyar. F.. Ntare. B.R, and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

The Project in Zambia

The hybridization program has produced improved high-yielding confectionery and oil groundnut varieties using a large collection of germplasm created by the project. Germplasm screening has identified several genotypes resistant or tolerant to leafspots, rosette, and leafhopper that are used in the breeding program. Effective fungicides against leaf spots, rust, and insecticides for the short-term control of soil pests have also been identified. More than 10 professionals have received advanced training in different disciplines and library facilities have been developed.

Support to Other National and Intercountry Programs

Almost 20 African countries, including eight in West Africa, have benefitted from FAO technical assistance projects. Furthermore, as part of the FAO's promotion of intercountry technical cooperation in research and development, it prepares projects on groundnuts for funding by the Common Fund for Commodities.

Conclusion

These activities demonstrate the vital role played by the FAO in strengthening the technical capacity of national institutions and the transfer of technologies and improved genetic materials from national and international research centers to extentionists and farmers. It is concluded that the activities of the FAO complement the technology generation and training functions of the international agricultural research centers and other regional organizations.

Summary of Groundnut Research Activities in Togo

B. Nambou[1]

Groundnut is widely grown in Togo, both as a sole crop or intercropped with maize, sorghum, millet, cassava or other crops. Agricultural research activities for groundnut are at a standstill and have been limited to varietal trials, intercropping and fertilization. They are conducted by the Togo Cotton Corporation (SOTOCO), the Notse Rural Development Project (PDRN), the National Corporation for the Renewal and Development ofTogo Cocoa and Coffee Plantations (SRCC), the Agricultural Research Directorate (DRA), SAFGRAD, IRAT and Care International.

The National Institute for Food Crops (INCV) is currently collecting local cultivars as the first step towards establishing a research program on groundnut improvement in Togo. This program aims to provide farmers with different varieties of groundnuts, best suited to their needs. There are three categories of new varieties which have been introduced by our national institutes: (1) early-maturing varieties (85-110 days); (2) medium-maturing varieties (110-130 days); and late-maturing varieties (130-150 days).

The only early-maturing varieties which are recommended to farmers are TS 32-1, TE-3, and 61-24 while RMP-12, and RMP-91 are the medium and late varieties currently going through extension. Varieties that will soon be proposed for pre-extension are BS-5, BS-3, JS-62, JS-117, 73-33, 57-313, 69-101, 756A, and 28-206.

Intercropping is a common practice by small-scale farmers in Togo. Taking into consideration all the factors and constraints, it has become essential to initiate a coherent and adaptive research program for

1. INCV, Cacavelli, Lome, Togo.

Waliyar. F.. Ntare. B.R. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

groundnuts. Given the importance of edible groundnuts, the Virginia type groundnut in its unshelled form should be encouraged, since marketing is easier and less competitive than for seeds.

Future research should have the following objectives:

- Continue collection of local germplasm.
- Improve agronomic qualities of existing varieties.
- Improve the quality of food products for utilization.
- Focus national agricultiral research systems on groundnuts..
- Intiate ICRISAT trials in farmers' fields at the national level.

The CORAF Groundnut Network

R. Schilling[1]

The Conference of African and French Heads of Agricultural Research (CORAF) was set up in 1987 by 12 french-speaking African countries, that had worked together for many decades, with no linguistic or political exclusion. The Groundnut Network is one of five basic crop networks (maize, rice, cotton, and cassava). The organization, priorities and activities of the Network have been presented in previous regional workshops and at the International Groundnut Meeting held at ICRISAT Center in Hyderabad, in November 1991.

CORAF's recent evolution has been characterized by new francophone and lusophone members (Zaire, Burundi, Rwanda, Cape Verde, and Guinea-Bissau), as well as its official political status as a legal entity, conferred at a meeting of research ministers from member states held in Dakar in 1991. English-speaking countries have indicated their interest by participating in different workshops. Nigeria, represented at the last plenary meeting by a federal delegate, has officially confirmed its interest, and we hope this will lead to its membership or association with the network in the near future.

The Groundnut Network publishes a news bulletin, scientific documents, maintains a directory of scientists, and hosts thematic workshops. On an operational level, a center has been established at the Bambey research station in Senegal, where regional strategic research will be conducted. A center specializing in crop protection was established by the CORAF Follow-up Committee at Farako-Ba; a specialized center for zones with bimodal rainfall pattern is presently under study.

Many collaborative projects with international funding are currently in progress: there is a project to improve irrigated cropping techniques; a breeding project to improve drought tolerance: and a foliar disease control

1. Agronome, Division oleagineux annuels, CIRAD-IRHO, II Square Petrarque, 75116. Paris, France.

Waliyar. F.. Ntare. B.R. and Williams, J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou, Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

project. These projects associate not only network members, but many European countries (France, United Kingdom, Spain, Portugal, and Greece) and non-tropical zone member countries (Botswana and Brazil). The European Economic Commission is the primary donor for these research projects through its "Techniques of Science and Development" programs.

The Groundnut Network has participated in drawing-up projects with the CNUCED-FAO Groundnut Programs, of which two have been approved in principle. It has relations with ICRISAT, Peanut CRSP and the African Groundnut Council, and is at the service of African groundnut research and all African workers in the groundnut field who are interested in applied agronomic research for development.

Summary of Results of Groundnut Research in the Humid Zone of Central Africa

R. Schilling[1]

IRHO involvement in Congo was to continue groundnut research that had come to a halt since 1964. Highlights of this research are enumerated below.

1. Foliar diagnosis enabled plant nutrient deficiencies to be detected and determine crucial levels of these elements. In continuous cultivation, there is a rapid decrease in groundnut yields after a few cycles. The first cycle always yielded more than the second. At the same time, a cyclic variation in soil pH was observed.

2. A yield decrease in continuous cultivation was associated with an important increase in manganese content of leaves. This increase might also result from prolonged stripping of soils. Even though groundnuts are resistant to manganese, they are affected in extreme cases by manganese toxicity when its contents in leaves reach 1.000 ppm.

3. Use of calcium in the form of lime or ground limestone caused manganese toxicity symptoms to disappear and improved plant calcium nutrition which led to improved yields. Calcium should be deeply applied so that it is in contact with roots and contributes efficiently to root system development and rhizobial synthesis. Calcium application was efficient for four cycles; after the first application at a high rate (2.5 t), only small quantities (0.5 t) were needed afterwards.

1. Agronome, Division Oleagineux annuels, CIRAD-IRHO, II Square Petrarque, 75116, Paris, France.

Waliyar. F.. Ntare. B.R.. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992. Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

4. Calcium alone is not enough to reconstitute a depleted soil fertility. Green manure or more accurately, cover plants, should be used. Two plants that can be used in Congo are pigeonpea and stylosanthes. They should be cultivated after calcium application.

5. Two hundred and thirty-four crosses were made at the research station of Loundina with a 58% success rate. Following selection at Niari a number of lines primarily for edible types were retained for further evaluation.

6. Sowing of very-early maturing varieties should be done at high density (at least 165,000 plants/ha). Seeds should be treated with a product combining fungicide and insecticide to improve plant establishment.

7. Weeds significantly reduce groundnut yields. *Carex and Imperata* are particularly dangerous. The best control measure is to weed by hand as soon as they appear and at regular intervals. Groundnut diseases and pest incidence remain low in South Congo. It is recommended to:

    - avoid rosette by planting as early as possible at high density;
    - avoid parasitic fungi attacks by disinfecting seeds and crop rotation;
    - avoid parasitic insects damage at harvest by using field proper drying and by thoroughly disinfecting storage places.

8. Three instruments may be introduced in traditional agriculture in Congo which will allow farmers to double their cultivated surfaces and to increase harvests. These are the small monorow sowing machine, the small hand-thresher and the IRHO groundnut washer for unshelled groundnuts.

Breeding Disease Resistant Peanut Varieties for Semi-Arid Environments: II. Drought Tolerance and Avoidance[1]

A. M. Schubert[2], O. D. Smith, G. Aiken[3], and A. J. Jaks[2]

The desirability of producing peanut cultivars for semi-arid environments that can produce stable and adequate pod yields despite deficiencies in rainfall is obvious. Drought periods occur at different times of the growth cycle in different locales. In contrast to West Africa's general pattern of late-season drought, the Southwestern USA is more likely to experience mid-season drought with increasing levels of rainfall as harvest-time approaches. Despite these differences, it is reasonable to assume that at least some mechanisms by which plants might deal with a deficient water supply are common to both circumstances. It is also reasonable, in a collaborative research program, to try to devise experimental methods whereby desirable traits for each environment can be evaluated at both locations whenever possible.

To these ends, we have tested experimental tools to identify traits for selecting peanut plants that can significantly tolerate or avoid drought stress. We have tested these tools in rainfed field plots and under conditions where water supplies were systematically varied.

We have studied peanut germplasm selected to exhibit a range in growth traits and abilities to tolerate water stress. These lines were grown under varying patterns and degrees of drought stress under rainfed conditions at Yoakum and other South-Central Texas sites in different years. Entries were compared for pod yield, pod and kernel traits, leaf relative water content, leaf porometer data, water potential via hydraulic leaf press, soil water extraction patterns, foliar temperatures, and differences in plant measurements with varied degrees of intra-row

---

1. Research supported by USAID Peanut CRSP, USAID Grant No. DAN-4048-G-SS-2065-00.

2. Texas A&M University, P.O. Box 755, Yoakum, TX, 77995, USA.

3. Texas A&M University, College Station, TX, 77843, USA.

Waliyar. F.. Ntare. B.R, and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17Sep 1992. Ouagadougou, Burkina Faso. (In En., Fr.) Patancheru, A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

competition. The effects of accumulated water stress as indicated by daily leaf temperature measurements on pod yields and quality were quantified in a standard cultivar over a three-year period. Forty-eight selected peanut lines were studied in three crop years for reaction to varied water levels supplied by a source line irrigation system. Various data analysis schemes have been attempted to devise a variety performance index constructed from pod yield and pod yield versus water level response slopes from the line source experiments.

While pod yields and other parameters have varied significantly during some measurement periods and we have been able to pretest prospective germplasm, we have not successfully integrated the relationships into consistently useful selection criteria to date. PNUTGRO and EPIC computer models are being tested to aid in interpretation of environmental and crop factors.

ICRISAT Research Progress and its Significance to Research within the Region

J.H. Williams[1], B.J. Ndunguru[2], F. Waliyar and B.R. Ntare[3]

The ICRISAT program, with the assistance of representatives from three national agricultural research services (NARS), recently completed a review of the research conducted over the recent past. Summaries of each project review were presented with an interpretive summary of the implications of the progress to improve groundnut production and research possibilities for the NARS to exploit the outcome of the research. The research was considered to have been very productive, largely due to good collaboration by scientists in the national research systems and universities, and the multi-disciplinary approach used.

Breeding material introduced from other environments proved more adaptable to the region than other species. Wider use of variety introductions should be considered by the NARS as a method of exploiting the vast range of improved materials developed in other countries. Collaboration with the SADC project generated early-maturing rosette-resistant material with drought resistance characteristics needed for the Sahel. Research has shown that the runner type has considerable advantage in the no-input Ca-deficient situation prevalent in the region. Similarly, research has suggested that high temperature tolerance is an important requirement for adaptation to the Sahel and methods of selection for this attribute are being evaluated.

1. Principal Physiologist and Groundnut Team Leader; ICRISAT Sahelien Center, B.P. 12404, Niamey, Niger.
2. Team Leader and Principal Agronomiest, SADC/ICRISAT Groundnut Project, P.O. Box 1096. Lilongwe, Malawi.
3. Principal Groundnut Pathologist; Principal Breeder, ICRISAT Sahelian Center, B.P. 12404, Niamey, Niger.

Waliyar. F.. Ntare. B.R. and Williams. J.H. (eds.) 1993. Summary Proceedings of the Third ICRISAT Regional Groundnut Meeting for West Africa. 14-17 Sep 1992, Ouagadougou. Burkina Faso. (In En.. Fr.) Patancheru. A.P. 502 324. India: International Crops Research Institute for the Semi-arid Tropics.

Cropping Systems and Agronomy

The present cropping systems were investigated in sites representing the three main agroecological zones. Intercropping was the dominant method of cultivation, fertilization was limited, and populations were suboptimal. The poor and variable growth had been researched: it was concluded that the problem was primarily caused by low pH induced problems, which maximized the consequences of nematode attack. Liming and organic matter amendments could achieve normal growth.

Crop Protection and Quality

The extent of yield losses due to foliar diseases showed that leaf spots and rust caused between 20 and 60% yield losses. The resistances exploited by the breeding program in India were effective in the region and could result in considerable improvements in pod and fodder yield. *Aspergillus flavus* remained a problem, particularly in the drought prone Sahelian soil. However, the existing varieties had good levels of resistance to seed invasion, as did introduced materials with the same attributes.

For the future, scientists involved in groundnut research should seek to build the multi-disciplinary teams needed for successful cropping systems research. This may be achieved by establishing linkages with the appropriate scientists in the region. ICRISAT is committed to supporting the evolution of regional cooperation in networks, or using mechanisms which will enhance progress toward agricultural transformation.

Based on the evidence over the past six years, future research in the region should look to exploit the potential benefits of rotation combined with foliar disease resistance and judicious use of crop protection chemicals. All lines developed by breeders should be screened for resistance to *A. flavus* invasion in environments appropriate for effective screening, but integrated problem management research to minimize pre- and postharvest invasion by this fungus is required. The breeding programs should expand their horizons to include the calcium uptake efficient runner types that seem more promising for low input environments, developing in this class of material high partitioning, disease resistances and drought tolerance.

Recommendations

The four working groups expressed similar observations and recommendations on the following topics:

Training

- The Training and Visitors Center in Niamey, Niger was completed. A 3-week course was held from 5-16 Aug 1992 for West African participants on *Insect Pests and Diseases in Pearl Millet and Groundnut*

- Information on short-term courses should be widely disseminated to the national programs.

- Training for technicians continues to be a major concern. However, training should not be limited to technicians and should expand to include scientists from the national programs. Training of national program researchers was re-emphasized, especially at the PhD level.

- Training and equipment for national programs continue to be extremely important. As an example, training in aflatoxin analysis and equipment for analysis is critical for many national programs.

Information Dissemination

- The groups noted that a manual on groundnut diseases will be published shortly by ICRISAT. Manuals on breeding, entomology and pathology are being prepared. It was recommended that researchers from national programs be included in the preparation of publications.

Regional Trials

- Regional trials continue to cause financial and organizational problems. A regional coordination was proposed, incorporating national, transnational and international organisations. A centralized coordinating group could be in charge of organizing the trials and reinforcing financial support.

- The groups recommended that ICRISAT provide minimum support to regional trials and encourage national programs to participate more successfully in these trials.

Working Group on Agronomy

1. The group was pleased to note that a workshop on groundnut network seed distribution had been held in Dakar in January 1991. However, as only CORAF member-countries were present, it recommended that the proceedings be sent to all groundnut producing countries in the region. Availability of good quality seed material remains a top priority and a coherent strategy should be established.

2. Crop management systems should be based on climatic data. Temperature and rainfall maps should be collected to provide a better knowledge of the African semi-arid tropical zone. They can be used to draw up management systems which will integrate production objectives, maintenance of soil fertility, and protection of the environment.

3. Recommendations made to farmers should take into consideration socio-economic and institutional constraints which often inhibit the application of research results. Researchers and international institutions should work together to ensure that the recommendations are compatible with the technical and financial means of the small farmer, who is greatly concerned with risk reduction.

4. Postharvest technology should be given more attention to obtain a better use of groundnut products at the level of the producer and the consumer. The group recommended that information and technical expertise that is distributed to certain countries be extended to others. The FAO is requested to contributed technically and financially to this effort.

5. The group observed that an improvement in groundnut production is linked to a good marketing organization. It recommended that agro-economic studies be undertaken to assure that the producer

would be able to obtain a satisfactory supply of inputs and a reasonable marketing policy.

6. ICRISAT, in collaboration with the FAO, Peanut CRSP, and CIRAD, should make its knowledge available to the countries who wish to organize and reinforce their research structures. The later should encourage and reinforce network activities to reach a better definition of groundnut research objectives and coordinated regional actions.

7. The group recommended that promotional and marketing efforts of groundnut products be undertaken at the African and international level. The public should be better informed of the nutritional and economic importance of groundnut, to urge decision-makers to grant the necessary financial means to groundnut research so it can fulfill its objectives.

Working Group on Breeding

1. Contact should be maintained between the national programs and the ICRISAT Sahelian Center. The group suggested that ISC centralize breeding results for short-duration and rosette-resistant varieties produced by SADC/ICRISAT (Malawi) and IAR in Samaru (Nigeria) and that these varieties be made available to national programs. In consideration of the limited space at Samaru, the group proposed that Niangoloko (Burkina Faso) be selected to assist Samaru. The Groundnut CRSP program should consider providing training for the technician who would be in charge of the program.

2. Germplasm collection of landraces should continue, such as the one currently planned in collaboration with ICRISAT for 1993 in Cameroon. This same activity should be considered for other locations.

3. To enable national programs to request appropriate material from ICRISAT, a circular should be sent to collaborators indicating the characteristics of the material.

4. Trials should be conducted to determine the scope for the runner bunch and pod size differences to resolve pod filling problems.

Working Group on Crop Protection

The recommendations of the 1990 meeting were reviewed and progress was noted in several areas:

- Regional trials were conducted through ICRISAT in Niger. Nigeria. Benin, Burkina Faso, Guinea, and Cameroon.
- Trials on resistance to rust, leaf spots, and fungicide sprays to control foliar diseases were conducted.

The Crop Protection Working Group proposed the following recommendations:

1. The group recognized the importance of international institutions (ICRISAT, CIRAD, Peanut CRSP. and ORSTOM) in strengthening the national programs. Increased coordination and cooperation with the national programs would help to improve research and prevent duplication.

2. There is a need for discipline-specific meetings on plant protection, agronomy, aflatoxin. and groundnut utilization. They recommended that ICRISAT consider these needs and seek funding from other sources (CIRAD. ORSTOM. Peanut CRSP). It was noted that a workshop on Groundnut Virology was planned for August 1993 in Dundee, Scotland.

3. The group suggested that ICRISAT should support and coordinate an international workshop on foliar diseases that would be held in Africa.

4. Precautions should be taken in the exchange of germplasm to prevent dissemination of seed-borne viral diseases, especially introductions to West Africa.

5. A small leaflet should be prepared listing germplasm lines in West Africa with resistance to plant pathogens, insects, and aflatoxin contamination and the addresses for obtaining seed.

6. Governments in West Africa should be aware of the serious problem of aflatoxin contamination and improve information dissemination.

7. Regional trials need to be conducted in plant pathology and entomology to determine the roles of resistance, crop rotation, and fungicides. The influence of groundnut morphology (bunch versus runner types) on plant protection should also be compared.

Working Group on Utilization

1. The group noted the small participation of experts in food technology and hopes that ICRISAT will give more attention to this area and that there will be more participation from scientists in this field in future workshops.

2. The group emphasized that an increased collaboration should occur between food technology researchers and researchers in other fields, such as agronomists, breeders, and pathologists. This would encourage a better integration of groundnut research and bring about improved processing technology.

3. The group hopes that local processing techniques will be maintained, while trying to promote methods which are more effective and better adapted. Semi-industrial processing techniques should be encouraged in some cases, such as processed flour for child nutrition.

4. Scientists should be better informed regarding the choice of raw material to be used for processing.

Closing Address

After four days of discussions, we have reached the end of the Third Regional Groundnut Meeting for West Africa, organized by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), in collaboration with INERA and the Peanut Collaborative Research Support Program (CRSP). I would like to sincerely express my congratulations for the conclusions which you have reached.

During this workshop, you have not only shared your scientific knowledge, but above all, you have sought to know how your future research can contribute to groundnut production in your countries, both qualitatively and quantitatively. As it was mentioned in the opening address, groundnut is an important crop in the economy of our countries. It is a substantial source of revenue for our countries who export it, and it plays a major part in feeding our people. In sum, groundnut production contributes to the improvement of our populations: consequently all efforts which can possibly increase its production should be granted.

The sessions of this workshop devoted to breeding, agronomy, pathology, and entomology were conducted with this in view. In your conclusions, the orientations were defined according to the areas mentioned above.

I can assure you without hesitation, that my department, and I would dare to hope all the research departments in our respective countries, will pay particular attention to the conclusions and recommendations of this meeting.

In wishing you a safe journey back to your countries, I hereby declare closed the Third Regional Groundnut Meeting for West Africa, organized in Ougadougou, from 14-17 September 1992.

I thank you.

M. Sedogo
Director General
Centre national de la recherche
scientifique et technologique

Participants

J. Adu
Researcher
IAR, Ahmadu Bello University
PMB 1044
Zaria. Nigeria

M. Adomou
Responsable du Programme de recherche sur l'arachide
INA. BP 03
N'Dali. Benin

O. Alabi
Pathologist
IAR, Ahmadu Bello University
PMB 1044
Zaria, Nigeria

A. Amalaman
Assistant de recherche
Institut des Savanes
O1 BP 635
Bouake 01. Cote d'lvoire

S. Attiogbevi
Research Assistant
1CRISAT Sahelian Center
B.P. 12404
Niamey. Niger

J. Baidu-Forson
Principal Economist
ICRISAT Sahelian Center
B.P. 12404
Niamey. Niger

Z. Bertin
Attache de recherche
INERA
03 B.P. 7192
Ouagadougou, Burkina Faso

S. Bonkoungou
Phytopathologiste
INERA
03 BP 7102
Ouagadougou, Burkina Faso

S.R. Boye-Goni
Breeder
IAR. Ahmadu Bello University
PMB 1044
Zaria. Nigeria

P. Cattan
Chercheur
CIRAD/CA INERA
Kamboinse, Burkina Faso

J.W. Demski
Professor
Dept of Plant Pathology
University of Georgia
Griffin, GA 30223 U.S.A.

M.X. Diagne
Interpreter
PO Box 5138
Dakar. Senegal

I.O. Dicko
Universite de Ouagadougou
IDR
Ouagadougou. Burkina Faso

A. Djidji
Institut des Savanes
O1 BP 635
Bouake. Cote d'lvoire

M. Diourte
IER/DRA/SRCVO
Sotuba
B.P. 438
Bamako. Mali

M. Dollet
Division Virologie
CIRAD/IRHO
B.P. 34032
Montpellier cedex 01. France

B. Essomba
IRA
P.O. Box 2067
Yaounde, Cameroun

D. Fatondji
Research Assistant
ICRISAT Sahelian Center
B.P. 12404
Niamey. Niger

S. Fofana
Vulgarisation B.F.
B.P. 7028
Ouagadougou. Burkina Faso

N. Garba
Secretary
ICRISAT Sahelian Center
B.P. 12404
Niamey. Niger

J. Gautreau
Ingenieur Agronome
INERA
03 B.P. 7192
Ouagadougou. Burkina Faso

R.H. Gottfried
Regional Information Officer
ICRISAT Sahelian Center
B.P. 12404
Niamey. Niger

G. Konate
INERA
B.P. 7192
Ouagadougou. Burkina Faso

K. Kpodo
Food Research Institute
PO Box M20
Accra. Ghana

R.G. Lynch
Supervisory Research Entomologist
Peanut CRSP
USDA-ARS, PO Box 748
Tifton. GA 31793-0748 USA

A. Madougou
Translator
ICRISAT Sahelian Center
B.P. 12404
Niamey. Niger

L.J. Marenah
Regional Plant Protection
Officer
FAO
PO Box 1628
Accra. Ghana

K.O. Marfo
Food Legumes Breeder
Agr. Experimental Station
PO Box 52
Tamale. Ghana

S.M. Misari
Deputy Director
IAR. Ahmadu Bello University
PMB 1044
Zaria. Nigeria

A. Mounkaila
INRAN
B.P. 240
Maradi. Niger

B. Nambou
INCV
Cacaveli
Lome. Togo

N. Ndilo
Selectionneur
Centre de recherche agronomique
B.P. 28
Loudima. Congo

O. Ndoye
Se1ectionneur
ISRA
Station de Nioro
B.P. 17
Nioro-du-Rip, Senegal

P.A. Nikiema
Universite de Ouagadougou
B.P. 7021
Ouagadougou, Burkina Faso

B. Noudjalbaye
Bureau de la recherche agronomique
Ministere de l'Agriculture
BP 441
N'Djamena. Tchad

B. Ntare
Principal Breeder
ICRISAT Sahelian Center
B.P. 12404
Niamey. Niger

N. Okugbue
Interpreter
06 BP 1274
Abidjan. Cote d'lvoire

A.P. Ouedraogo
Professeur
Universite de Ouagadougou
IDR
Ouagadougou. Burkina Faso

C. Renard
Executive Director
ICRISAT Sahelian Center
B.P. 12404
Niamey, Niger

R. Schilling
Agronome
CIRAD/IRHO
II Square Petrarque
75116 Montpellier. France

A.M. Schubert
Texas A&M University
PO Box 755
Yoakum. TX 77995. USA

A. Sesay
Associate Scientist
Njala University
PMB 540
Freetown. Siera Leone

R. Simde
Universite de Ouagadougou
B.P. 9820
Ouagadougou, Burkina Faso

O.D. Smith
Professor
Soil and Crop Science Dept
Texas A&M University
College Station. TX 77S43. USA

B. Singh
Professor
Alabama A&M University
PO Box 264
Normal Alabama 35762, USA

P. Sossou
Senior Accountant
ICRISAT Sahelian Center
B.P. 12404
Niamey, Niger

P. Subrahmanyam
Principal Pathologist
SADC/ICRISAT
PO Box 1096
Lilongwe. Malawi

A. Tapsoba
SOFIVAR
B.P. 4390
Ouagadougou, Burkina Faso

A. Traore
Research Assistant
ICRISAT Sahelian Center
B.P. 12404
Niamey. Niger

S. Traore
Attache de recherche
INERA Station de Saria
B.P. 10.
Koudougou. Burkina Faso

H.D. Upadhyaya
Groundnut Breeder
ICRISAT Center. Patancheru PO
Andhra Pradesh. 502324. India

F. Waliyar
Principal Groundnut Pathologist
ICRISAT Sahelian Center
B.P. 12404
Niamey, Niger

J.H. Williams
Principal Physiologist and
Groundnut Team Leader
ICRISAT Sahelian Center
BP 12404
Niamey, Niger

R.P. Yakende
Chef de Station de Poumbaidi
Departement des recherches
B.P. 122
Bangui Lokouanga
Republique Centrafricaine

RA - 00236