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

International Crops Research Institute for the Semi-Arid Tropics

Abstract

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Representatives from 13 countries as well as regional and international organizations concerned with groundnut improvement in West Africa attended the meeting to discuss the problems of groundnut production in the region and ways to overcome them through collaborative projects.

Presented in this volume in English and French are the welcome and opening addresses, summaries of 29 papers, and the recommendations. These cover diseases, pests, drought and nutrient stresses, agronomy, postharvest technology, and international cooperation.

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

13-16 Sep 1988
ICRISAT Sahelian Center
Niamey, Niger

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

1990

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Contents

Preface

The objectives of the meeting were:

1. to provide an opportunity for participating scientists to share experiences on the status of groundnut production and improvement in various countries in the region, and
2. to define areas within which collaborative research could be developed.

The following countries and institutions were represented: Benin, Burkina Faso, Cameroon, Chad, the Gambia, Ghana, Guinea, Mali, Niger, Nigeria, Senegal, and Togo. Also represented were the Peanut Collaborative Research Support Program (Peanut CRSP),Institut de recherches pour les huiles et oleagineux (IRHO), Institut francais de recherche scientifique pour le developpement en cooperation (ORSTOM), the African Groundnut Council, Food and Agriculture Organization of the United Nations (FAO), Centre regional de formation et d'application en agrometeorologie et hydrologie operationelle (AGRHYMET), the UK Overseas Development Administration (ODA), the University of Niamey, ICRISAT Center, SADCC/ICRISAT Regional Improvement Program, and ICRISAT Sahelian Center.

The participants visited trials at Bengou and Sadore as well as the new facilities at Sadore. Recommendations from the working groups (Agronomy, Breeding, and Pathology and Entomology) were received, considered, and approved at the plenary session.

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

Welcome Address

R.W. Gibbons

Executive Director, West African Programs, and Director, ICRISAT Sahelian Center

Honorable Minister, Colleagues, Ladies and Gentlemen,

It is my pleasant duty today to welcome His Excellency Mr Abache Chaibou, Minister of Higher Education, Research, and Technology, and to ask him to officially open the First Regional Groundnut Meeting to be organized by ICRISAT in West Africa.

It is fitting that this first meeting should be held in Niger, as it is the host country for the ICRISAT Sahelian Center which conducts regional research in West Africa on pearl millet, groundnuts, and resource management. We also have sorghum scientists based in Kano, Nigeria, and Bamako, Mali, and a small bilateral program also in Mali. The Center at Sadore is almost complete and you will have the opportunity to see these impressive facilities during the week.

The West African Regional Groundnut Program is only 2-year old, but already it has developed contacts with many of the West African national, regional, and international programs to help in raising groundnut production in West Africa.

We welcome here today ICRISAT groundnut scientists from our very large headquarters program in India, and from our regional program in southern Africa based in Malawi. Their expertise will help our program in West Africa. We welcome our colleagues from Peanut CRSP of the USA Title XII program, who work in West Africa, the Far East, and the Caribbean. We also welcome the African Groundnut Council (of which Niger is a member), the French scientists working for IRHO and ORSTOM, and FAO. And last, but certainly not least, the scientists from national programs in West Africa with whom we collaborate.

Your Excellency, we thank you and the Government of Niger for your continued support to ICRISAT. We also thank the national research program in Niger, INRAN, for their support and the facilities they give us in southern Niger.

I now ask Your Excellency to deliver the opening address.

Opening Address

Abache Chaibou

Minister of Higher Education, Research, and Technology
Republic of Niger

Honorable Ministers, Director of the ICRISAT Sahelian Center, Distinguished Representatives of Research Institutes, Ladies and Gentlemen,

It gives me great pleasure to welcome our eminent guests from Africa and elsewhere who have come to Niger to attend the First ICRISAT Regional Groundnut Meeting for West Africa. I wish to express my appreciation for having chosen our country as the venue for this meeting.

This honor not only highlights our excellent scientific and technical cooperation ties but also pays tribute to the efforts made by our country in the difficult domain of research into self-reliance in food production.

I can assure you that we shall, from the outset, follow the deliberations of this First ICRISAT Regional Groundnut Meeting with the greatest interest and shall look very closely at your recommendations.

Before the 1973 drought, groundnut production in Niger ranked third after millet and sorghum. Groundnut cultivation was supported by the establishment of the "Societe nationale de commercialisation" (SONARA), three dehulling factories with a capacity of 82 000 t and three oil mills able to process 105 000 t of shelled groundnuts into crude oil for export.

Subsequent droughts in the last few years have changed considerably that situation. Areas under cultivation have declined and production has plummeted from 260 000 t in 1972 to 77 000 t in 1973. The production figure for 1987 was only 40 500 t. Groundnut production is now almost completely destined for the domestic market.

Our national agricultural research policy has therefore placed special emphasis on boosting this crop. We have to find solutions to the problems which beset groundnut production. It is for this reason that in our Long-Term Plan (LTP) specific projects have been formulated and will be discussed and finalized during the Round-Table Meeting on Agricultural Research which is to be held shortly in Niger.

National efforts alone will not suffice to achieve our objectives. A multi-disciplinary approach, with improved cooperation between institutes in the exchange of germplasm and production techniques, better dissemination of information as well as improved training is also vital.

I keenly hope that this meeting will give participants the opportunity not only to discuss the experience gained in groundnut production improvement but that it may also serve to pinpoint problems which are common to the region and which may need regional rather than institutional or country-specific solutions.

I am confident that given the eminence of the participants at this meeting and your respective expertise in this field, your work will be most valuable.

May I once again thank the management and scientists of the ICRISAT Sahelian Center most sincerely for their most valuable contribution to our agricultural research and in particular our research programs on groundnut.

I wish all our honored guests a pleasant stay in Niger. With the assurance that your deliberations will be most rewarding, I hereby open the First ICRISAT Regional Groundnut Meeting for West Africa.

Thank you.

ICRISAT Activities

Groundnut Diseases in West Africa and their Management: Research Problems, Priorities, and Future Strategies

P. Subrahmanyam[1]

West Africa is the largest groundnut-producing region of Africa contributing about 60% of the total groundnut production region. However, the major groundnut-producing areas are located around 12° N latitude. Senegal and Nigeria are the largest groundnut producers in West Africa followed by Cameroon, Ghana, the Gambia, and Mali. The average yield of groundnut in West Africa is about 730 kg ha^{-1}. Some of the major constraints to groundnut production in West Africa are erratic rainfall patterns, poor agronomic practices, and high incidence of pests and diseases. Aflatoxin contamination lowers the quality of produce.

Groundnut Diseases in West Africa

Disease is considered to be one of the major yield-limiting factors of groundnut in West Africa. Information presented in this summary has been obtained through systematic disease surveys in some countries, personal contacts with groundnut scientists, and a literature search. Almost all countries consider leaf spots, rust, rosette, and seedling diseases to be the most economically important diseases, and that aflatoxin contamination is a serious quality problem. Crop growth variability is one of the major yield-limiting factors in the sandy soils of the Sahel. The strategies for the management of the major diseases are briefly discussed.

Leaf spots

Both early leaf spot *(Cercospora arachidicola)* and late leaf spot *(Phaeoisariopsis personata)* are common in West Africa wherever groundnut is grown. However, the relative importance of each of these diseases varies in different geographic locations and seasons. In general, early leaf spots are the most predominant and destructive in high rainfall areas (Guinea Savannah). However, there can be both short- and long-term fluctuations in relative proportions within geographic locations.

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Rust

Groundnut rust caused by *Puccinia arachidis* was recorded in the mid 1970s in almost all groundnut-growing areas in West Africa. Rust is very severe in southern parts of West Africa where rainfall is usually high (over 1000 mm). It is believed that the humid tropical zones of the Gulf of Guinea serve as reservoirs of rust inoculum in West Africa.

Rust and leaf spots are regarded as the most important diseases of groundnut in West Africa. Yield losses are generally substantial when the crop is attacked by both leaf spots and rust. Eradication of volunteer groundnut plants and 'ground-keepers' is important in reducing the primary sources of rust and leaf spot inoculum. Crop rotation is useful in avoiding early season infection. Leaf spots and rust can be controlled by the application of certain fungicides. Developing resistant cultivars is one of the best means of reducing crop losses from these diseases. Almost all groundnut varieties that are currently grown by farmers in West Africa are susceptible to leaf spots and rust. Some of the sources of resistance to rust and late leaf spot identified at ICRISAT Center were evaluated through multilocational trials in some locations in West Africa and the resistance was found to be stable. Transferring resistances to these diseases into agronomically acceptable varieties is being carried out at ICRISAT and a large population of breeding material and high-yielding cultivars with acceptable levels of resistance to rust and leaf spots have been assembled and are being multiplied at the ICRISAT Sahelian Center for regional trials in West Africa.

Rosette

Groundnut rosette is apparently restricted to the African continent, south of the Sahara. Green rosette is prevalent in West Africa and chlorotic rosette is more common in East and Central Africa. Rosette is recognized to be one of the major constraints to groundnut production in West Africa. Although rosette epidemics in West Africa are sporadic, yield losses are substantial whenever the disease occurs in epidemic proportions. The 1975 rosette epidemic in some West African countries is a good example.

Groundnut rosette can be managed by controlling its vectors with insecticides. Early planting at high plant density can significantly reduce disease incidence. Sources of resistance to rosette were first discovered in 1952 at Bambey, Senegal. Breeding lines with acceptable levels of yield and rosette resistance were developed in Burkina Faso, Senegal and other countries. Most of the rosette-resistant cultivars developed earlier were long-cycle Virginia types (e.g., RMP 91, RMP 12, 69-101, and 59-426). However, in recent years short-cycle (90 days) Spanish types (e.g., KH 149 A, KH 241 D, and KH 243 C) were developed for cultivation in low-rainfall areas of West Africa. Unfortunately, most of these rosette-resistant cultivars are highly susceptible to leaf spots and rust. Combining these resistances into agronomically acceptable cultivars is urgently required to achieve stability in groundnut production in West Africa.

Seedling diseases

Young seedlings are attacked by a variety of seed- and soilborne fungi resulting in preemergence mortality. Postemergence seedling diseases include collar-crown rot

(Aspergillus niger), aflaroot *(A. flavus)* and root rot *(Rhizoctonia solani, Macrophomina phaseolina* and *Pythium* spp). Seedling diseases are present throughout West Africa wherever groundnut is grown. Yield losses from seedling diseases are substantial in low-fertility areas and when the crop is subjected to drought resulting in poor crop growth.

Seedling diseases can be controlled by using high-quality seed for planting. Deep planting should be avoided as etiolated seedlings are highly susceptible to these pathogens. Field trials were conducted in many locations in West Africa and a number of fungicides were found to be useful. Recommendations have been made to farmers on the use of seed-protectant fungicides or mixtures of fungicide and insecticide. Sources of resistance to collar rot (e.g., U4-47-7) and aflaroot (e.g., J 11) are also available.

The Aflatoxin Problem

Contamination of groundnut by aflatoxins, the secondary toxic metabolites produced by fungi of the *Aspergillus flavus* group, is a serious quality problem in many parts of West Africa. Invasion of *A. flavus* and aflatoxin production can be minimized by certain crop production and postharvest management practices. However, from the consistently high levels of contamination reported especially from countries in the semi-arid tropics (SAT), it appears that farmers have not yet been able to adopt these recommendations. It has therefore become necessary to investigate the possibility of developing genetically resistant cultivars with seed which *A. flavus* cannot invade, or which if invaded, do not support aflatoxin production.

In recent years, several genotypes with resistance to *A. flavus seed* invasion have been reported. Some genotypes support only very low levels of aflatoxin production when seeds were invaded by *A. flavus.* Progress has been made in utilizing this resistance in breeding. Lines with stable resistance to seed colonization and with acceptable yield and quality have been developed.

Crop Growth Variability

Variation in crop growth is one of the major limiting factors of groundnut production in the Sahel. During our surveys in Niger in 1986 and 1987, large variation in crop growth in farmers' fields was observed in all groundnut-producing areas of the country. Affected plants were usually present in random patches among apparently healthy plants.

The factors contributing to variation in crop growth are not fully elucidated.

Occurrence of Peanut Clump and Parasitic Nematodes

Peanut clump virus (PCV) was present in ultra-thin sections of leaves collected from bushy, dark, green, stunted plants present in patches. It was serologically related to the Indian and West African peanut clump isolates. Analysis of soil samples collected in the rhizosphere and geocarposphere zones and the roots of the affected plants showed high populations of various plant parasitic nematodes. Peanut clump and plant parasitic nematodes seem to be major contributing factors to crop growth variability in groundnut. However, the relative importance of these two biotic factors in crop-growth variability in groundnut in the Sahel needs to be established.

Effect of Pesticides

Soil treatment with carbofuran was very effective in reducing the nematode populations and the variation in crop growth. There was a substantial increase in pod and haulm yields in carbofuran-treated plots. Further trials conducted at Sadore indicated that soil treatment with a mixture of carbofuran and farm-yard manure was extremely effective in reducing nematode populations and variation in crop growth, and in increasing yields. Dibromochloropropane was most effective in reducing nematode populations and variation in crop growth, and in increasing pod and haulm yields under irrigation. Aldicarb was most effective under rainfed conditions. It is interesting to note that both nematodes and peanut clump can be controlled by using pesticides such as carbofuran.

Conclusion

Surveys are required to determine the distribution and importance of various diseases of groundnut in West Africa. Development of agronomically acceptable cultivars with resistance to leaf spots, rust, rosette, and aflatoxins should receive high priority. Further testing of stability of resistance to these diseases should be carried out through multilocational trials in West Africa. Agronomic practices should be developed to combat losses due to crop growth variability.

The ICRISAT Sahelian Center Groundnut Breeding Program

D.C. Greenberg[1]

The main aim of the ICRISAT groundnut improvement program is to produce breeding lines and cultivars which overcome some of the constraints to production in the main groundnut-producing areas, particularly in developing countries. The program is aimed particularly at satisfying the requirements of small farmers who are the main groundnut producers in the developing world. The ICRISAT groundnut program adopts a multidisciplinary approach combining the work of breeders, pathologists, entomologists, agronomists, physiologists and scientists of several other disciplines. Program scientists work in collaboration with scientists of many disciplines from national research programs and from international research organizations.

A promising cultivar or breeding line must show good adaptation to the area of production and must yield well under the agronomic practices of that area. The cultivar 55-437, which is probably the most successful cultivar in the short-season Sudano-Sahel belt and is recommended in Senegal, Mali, Niger, Nigeria and Chad, comes from material introduced into Senegal from Argentina via Hungary without further crossing. 55-437 is also a recommended cultivar in Botswana and the Malagasy Republic.

Germplasm Evaluation

Evaluation of a range of germplasm lines from most of the world's groundnut-producing countries in Niger in 1987 showed good performance of lines from several countries, notably Argentina, China, India, Malagasy Republic, Swaziland, USA and Zaire. Evaluation of further material from some of these countries is planned.

Approach to Specific Problems

Diseases and pests

We will attempt to combine the following disease resistances into adapted high-yielding material.

1. Late leaf spot and rust resistance with rosette resistance in medium-long cycle material (120-140 days) for the wetter Guinea Savannah regions. Likely parents for

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this combination are the ICG(FDRS) breeding lines from ICRISAT Center, which have late leaf spot and rust resistance in reasonable agronomic types of 120-130 days to maturity and RMP 12 or 69-101 as source of rosette resistance. RG 1 is another possible source of rosette resistance in late material; its seed type is more acceptable as an edible nut than RMP 12. The ICG(FDRS) lines include some interspecific hybrids between *Arachis hypogaea* and *A. cardenasii* which gave excellent yields in a preliminary evaluation at Gaya, Niger, in 1987.

2. Rosette resistance (possibly with late leaf spot and rust resistances) in short-medium cycle material (90-115 days). Selecting such combinations will obviously be extremely difficult and has certainly already been attempted. The early lines from the IRHO program at Niangoloko, Burkina Faso, such as KH 149A, would probably be used as sources of rosette resistance; lines such as ICGS(E) 13 or 55-437 as sources of earliness and adaptation and the ICG(FDRS) lines for foliar disease resistance.

   Some of the crossing and the initial screening for rosette resistance may be done by the ICRISAT program in Malawi, where a rosette incidence greater than 98% can be reliably achieved in the field. Seeds from healthy F_2 plants will be transferred to West Africa to be screened for adaptation and other characters in subsequent generations.

3. Aflatoxin resistance. Of the groundnut lines showing reasonable levels of resistance to aflatoxin production, J 11 and AH 7223 have shown reasonable agronomic performance in ICRISAT preliminary trials in Niger. 55-437 also possesses fairly good aflatoxin resistance. Groundnut breeding lines from the aflatoxin resistance breeding program at ICRISAT Center are being tested for adaptation at ISC and 55-437 is being crossed with J 11 as the start of a breeding program for aflatoxin resistance at ISC.

4. Nematode resistance/tolerance. Groundnut lines with some tolerance or resistance to some nematode species have been identified in Texas and at ICRISAT, but the effectiveness of this resistance/tolerance is not yet known in West Africa. We are planning to develop screening techniques for resistance to the important nematode species in the region and setting up a breeding program to incorporate this into acceptable breeding lines.

5. Termite resistance/tolerance. The world germplasm collection has been screened at ICRISAT for resistance to pod scarification by *Odontotermes spp* and some 10 lines have been identified as having reasonable levels of resistance. These lines are currently being multiplied and evaluated at Sadore. If any of them show promise, they will be incorporated into breeding programs for termite resistance.

Drought

Drought-resistant lines of two basic types are required: short-cycle lines (85-95 days) with resistance mainly to late-season drought for the Northern zones and longer-cycle lines (110-130 days) with resistance to mid-season drought for the southern zones where there is a tendency toward bimodality in the rainfall pattern. The longer cycle lines would also need to be resistant to foliar diseases. Several of the ICG(FDRS) lines possess mid-season drought resistance. There is also a strong possibility of dry periods at any time during the rainy season even when the annual rainfall totals are adequate.

We are attempting to develop a screening method to identify tolerance to such gaps in the rainfall pattern.

Quality and adaptation

We will be testing a range of confectionery types from other ICRISAT programs for adaptation particularly to the Guinea Savannah zone and may initiate a crossing program to incorporate foliar disease resistance into confectionery type.

Preliminary observations and surveys have shown that many small farmers grow groundnut as an intercrop with millet, sorghum or maize. It might be beneficial to select breeding material in an intercrop system rather than as a sole crop.

Regional Cooperation

The existing regional trials networks could be strengthened and extended to include Francophone and Anglophone countries in the region in one network.

Regional trials should probably be divided into zones of adaptation; three trials divided on an approximate north-south basis to cover differences in rainfall might be sufficient to cover the main agroecological zones.

Segregating populations could also be supplied or exchanged on request by international organizations and by national programs to be selected for general adaptation or for specific characters. Crosses might be made for particular requirements.

The general nature of collaboration and cooperation in research in groundnut improvement should be decided by the region as a whole and not by individual organizations or countries.

Groundnut Agronomic Research at ICRISAT Sahelian Center

B.J. Ndunguru[1]

Agricultural production in the Sahelian countries is done mainly by small-scale farmers. Where crop production has increased it has been due to an increase in area cultivated. With increasing population in the Sahel there is a need to intensify crop production in the region. Consequently the goal of the ICRISAT Sahelian Center (ISC) is to develop sustainable crop varieties and cropping technologies giving higher yields, and to improve soil fertility.

Groundnut forms an important part of the cropping system in the West African region which produces about 60% of the total groundnut production in Africa. In the past, the Sahelian countries were the major exporters of groundnut but production has been declining in recent years.

This summary deals with the constraints associated with agronomic aspects and cultural practices in groundnut production and describes the work that has been initiated at the ISC.

As a result of extensive research carried out in various parts in West Africa, recommendations exist on various aspects of groundnut production. There is a need to establish to what extent farmers have incorporated these practices into their farming activities.

Groundnut Agronomy Research at ISC

Agronomic research at the ISC seeks to improve individual crops as well as the cropping systems. To achieve this we have initiated on- station research which will later be followed by on-farm research in close cooperation with the national programs and farmers.

Survey of groundnut agronomic practices in Niger

In our attempt to find out how groundnut is produced by the farmers in Niger, we carried out surveys in 1986, 1987, and 1988 in the major groundnut-growing areas. Details of field area, soil type, sowing dates, groundnut variety, fertilization, cropping systems, and occurrence of weeds and various diseases were recorded.

Groundnut is grown largely on sandy soils which are low in organic matter with poor

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buffering capacity. Only one crop is grown per year. The crop is normally planted in June after pearl millet *(Pennisetum glaucum)* and harvested in Sep-Oct. Groundnut is grown in rows (40-60 cm apart) either as a sole crop or as intercrop with pearl millet (1 row of millet : 3 to 10 rows of groundnut). Groundnut is also grown in more complex mixtures with pearl millet, cowpea (*Vigna unguiculata),* kenaf *(Hibiscus cannabinus),* and other crops. An improved early maturing Spanish type, 55-437, is commonly grown throughout the country. In Gaya, a virginia bunch type, 28-206, is widely grown. Fertilizers are rarely used and rotation is commonly practiced with groundnut following millet, sorghum or an intercrop. Farmers obtained their seed either from their own stocks, cooperatives or the markets.

Intercropping

Most farmers have to grow a number of different crops for a variety of reasons. Some work on intercropping millet and groundnut was initiated at ISC in 1986. Early maturing groundnut cultivars from ICRISAT Center were evaluated as a sole crop or an intercrop with millet at ISC Sadore. We are also evaluating groundnut cultivars of different growth habits to assess their tolerance to interplant competition.

Groundnut mixtures

In harsh environmental conditions such as those found in the Sahel, farmers may be interested more in stability than maximization of yield. Hence, mixing groundnut cultivars with different growth habits and duration (a practice adopted by farmers) may exploit the available growth resources more fully than the best-adapted cultivar in pure stand.

We evaluated the performance of two groundnut cultivars (28-206 and 47-16 at Bengou, and 55-437 and 47-16 at Sadore) when grown as mixtures or in pure stands. These groundnut mixtures had no effect on yield at Bengou or Sadore, but yields significantly increased with an increase in plant population at both locations.

Soil and water management

Rain in the Sahel comes in the form of heavy short-lived storms which are preceded by sandstorms, particularly early in the planting season. The accompanying sand can cause serious damage (sandblasting) to the plants, especially at the seedling stage.

We initiated a trial to evaluate various soil-management practices on the yield of groundnut. We evaluated the performance of two groundnut cultivars (28-206 and ICGS (E) 30) under three cultivation methods at Bengou: tied ridging, broadbed, and flat cultivation. Tied ridging was superior to both broadbed and flat cultivation. The trial is being repeated at Gaya and has also been initiated at ISC, Sadore.

Plant nutrition

Phosphorus: Phosphorus is a major nutrient which is deficient in large areas of West Africa. Several countries in West Africa have phosphate deposits and the potential does exist for these countries to exploit them. We have initiated studies whereby the performance of groundnut is being evaluated in response to various sources of rock phosphate compared with the commercial sources of phosphorus. At Sadore, we compared three sources of rock phosphate, Parc-W rock phosphate (PRP), Tahoua rock phosphate (TRP), and Parc-W partially acidulated phosphate (PARP), with single superphosphate (SSP) and triple superphosphate (TSP) at three different application levels (0, 20, and 40 kg ha^{-1} P_2O_5) on two cultivars of groundnut (55-437 and ICGS (E) 30). Increasing the phosphorus application from 0 to 40 kg P_2O_5 ha^{-1} did not result in any increase in pod yield when the phosphorus was applied as TRP or PRP. However, when SSP, TSP, or PARP were applied at a rate of 20 kg P_2O_5 ha^{-1}, there was an increase in pod yield over the control.

Calcium: In acid, coarse textured soils, such as those present in the Sahel with low exchangeable cation-exchange capacity, calcium can become an important yield limiting factor. Gypsum is readily available in most parts of West Africa and like phosphate the potential exists to exploit it. We have initiated studies to compare the effects of lime and gypsum on the yield of groundnut.

Weed control

We have initiated studies to investigate the effectiveness of preemergence herbicides in controlling weeds, with the objective of assessing the potential of this method of weed control and/or integrating with hand weeding.

Crop growth variability

This problem has received particular attention in the Groundnut Improvement Program at Sadore. Factors contributing to variation in crop growth have not been fully elucidated. Lack of organic matter, nutrient imbalance, and soil biotic stress factors were considered to be possible causes. Hence, we initiated some investigations on the role of various factors, both abiotic and biotic, on crop growth variability at Sadore.

There is very strong evidence to suggest that nematodes are one of the major factors influencing crop growth variability at Sadore. As it stands chemical control is well beyond the reach of the farmers. We plan to screen for nematode resistance and to set up a breeding program. We are also planning rotation trials whereby crops in the rotation will be carefully selected; those crops that can reduce nematode populations will be grown before the groundnut crop.

Looking Ahead

As new cultivars are developed, we will endeavor to develop agronomic practices that will, with these cultivars, fit into the existing farming system. At ISC, the Operational Scale Research (OPSCAR) has been in operation since 1986 and groundnut will also be included in future work. In collaboration with economists, national programs, the African Groundnut Council, and other regional and international agencies, we hope to tackle some of the regional problems that will need attention.

Seasonal Abundance and Population Density of Groundnut Pests in Niger

M. J. Lukefahr and M. Abdoulkarim[1]

A program to monitor the groundnut pest complex was begun in 1987. The study aimed to identify the composition of the pest complex, and to determine their seasonal abundance and density. This study was carried out by using yellow sticky traps to monitor leaf-hoppers, aphids, thrips, and white flies and by destructive sampling of areas of 1m^2 of soil, excavated to a depth of 15 cm and sifted through a coarse mesh screen. The number of millipedes, wire worms and other pests were recorded. On each sampling date four samples were taken.

There were more than 500 000 millipedes per hectare at the peak population and over 10% of the developing pods were destroyed by this pest. The high populations and their resulting damage to pods continued until the pods matured. Millipedes and termites damaged over 80% of the pods and are probably the greatest constraints to groundnut production.

Leaf-hoppers were present throughout the growing season but never developed to pest status. Aphids were present on most of the sampling dates but only two of the sampling dates showed populations which caused concern as migrants appeared in large numbers.

Based on the 1987 data we are confident that the yellow sticky traps can be used to reliably monitor leaf-hopper densities. We also believe that the pest complex attacking groundnut pods is probably the greatest production constraint in the Gaya area and should receive high research priority.

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An Update on Groundnut Improvement at ICRISAT Center

S.N. Nigam, D. McDonald, F. Waliyar, D.V.R. Reddy, J.A. Wightman, J.P. Moss, and J.H. Williams[1]

Since 1976, when groundnut became the fifth mandate crop of ICRISAT, research focused on major constraints to groundnut production in the semi-arid tropics. These are: diseases, insect pests, drought, poor nutrition, and lack of high yielding varieties with specific adaptation and requirements. Within these major areas, specific research goals have been identified. Genetic exploitation and improvement are considered to be an integral part of the many approaches that need to be merged into a single management package.

Diseases

Rust and late leaf spot are serious diseases of groundnut. A germplasm collection of more than 11 000 accessions of cultivated groundnut and wild *Arachis* species has been screened and several sources of resistance to rust and late leaf spot have been identified. Components of resistance to rust and late leaf spot have been studied, and the inheritance of rust resistance determined. In general, the resistances have proved to be stable. Sources of rust and late leaf spot resistances have been used in a breeding program. Lines combining resistances with good agronomic characters have been developed and are now in multilocational trials in SAT countries. Two cultivars, ICG(FDRS) 4 and ICG(FDRS) 10 are likely to be released soon in India. Screening for resistance to early leaf spot has commenced and several sources of resistance have been identified in field trials in India and Nepal. This is of particular significance to southern Africa where early leaf spot is a serious problem. Wild species have shown resistance in trials in Malawi; these are being used in crosses at ICRISAT Center. Field screening of germplasm at ICRISAT Center has resulted in the identification of genotypes with moderate resistance to pod, root and stem rots caused by *Sclerotium rolfsii.* Several genotypes with resistance to pod rot caused by species of *Fusarium, Macrophomina phaseolina* and *Rhizoctonia solani* have been identified. Several of the genotypes also have resistance to preharvest seed infection by A *flavus.* In Indonesia, collaborative research program is being initiated on screening for resistance to bacterial wilt caused by *Pseudomonas solanacearum.*

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Virus diseases cause severe losses in groundnut yield in many regions of the world. Bud necrosis disease (BND) caused by tomato spotted wilt virus (TSWV) is economically important in South and East Asia and in the USA. Several high-yielding germplasm and breeding lines with resistance to the thrips vector of BND were tested for resistance to TSWV. ICGV 86029 and 86031 were tolerant to TSWV. Peanut mottle virus (PMV) disease is of worldwide distribution and can cause significant yield losses. Several germplasm and breeding lines showing nonseed transmission and tolerance to PMV have been identified. Serological tests for the detection of groundnut clump virus have been developed. Solarization was found to be effective in controlling groundnut clump disease. Peanut stripe virus (PStV) is currently recognized as one of the most important groundnut diseases in southeast Asia. In Indonesia, screening for resistance to this disease is under way, with international cooperation. Groundnut rosette is the most important virus disease of groundnut in Africa. International research on groundnut rosette is being coordinated by ICRISAT, and research on the epidemiology of the disease and resistance breeding is being carried out at the ICRISAT Regional Groundnut Program for Southern Africa in Malawi. Wild *Arachis* species have been screened for rosette resistance and are being used in breeding programs.

Aflatoxins

Contamination of groundnut seed and products with aflatoxins is a serious quality problem in most groundnut-producing countries. Several genotypes with resistance to seed invasion by *Aspergillus flavus* and/or aflatoxin production have been identified and are being used to develop *A. flavus* -resistant cultivars with good agronomic traits. Some of the breeding lines with *A. flavus* resistance are being tested in multilocational trials. Use of these genotypes in combination with recommended crop-handling practices should help to reduce aflatoxin contamination. The interaction of *A. flavus* resistance and drought is being used to improve the efficiency of resistance-screening techniques. An enzyme-linked immunosorbent assay is being developed for estimating aflatoxin contamination in groundnuts.

Pests

ICRISAT research on the insects living on groundnut plants and stored groundnut products covers a wide spectrum of activities with emphasis on the development of pest-control strategies that include no pesticides or that include minimal pesticide application. Our prime aim is to introduce pest-resistance into zonally adapted varieties. Germplasm lines with resistance to the major pests that attack the leaves and stems (jassids, thrips, and leaf miner) and some soil insects (termites and pod borers) were identified. The breeding aspects are well advanced with many promising varieties in the pipeline. Progress has been made on defining the characteristics of pest-resistance. Investigations on combining host-plant resistance and natural control by the use of parasites and predators are under way to keep the pest populations at levels that do not reduce yields. Effects of cropping patterns—monocrops, multicrops, and intercrops—on pest populations are also under investigation. Studies are under way to determine the damage thresholds of *Spodoptera litura.* Collaboration between entomologists and virologists has led to an increased understanding of the role of thrips as the vector of TSWV.

Surveys carried out in five countries in the SADCC region of southern Africa showed that foliage insects were not a problem, but soil pests such as termites, millipedes, wireworms, false wireworms, and ants were often causing serious yield losses.

A bruchid *(Caryedon serratus)* is a serious storage pest of groundnut throughout Africa and in peninsular India. We screen all lines that are prepared for release against this pest.

We are helping the national programs in Asia to think in terms of integrating all aspects of pest management so that insecticide application is rationalized. Similar activities will be extended throughout Africa.

Drought

Research establishing the physiological basis for genetic differences in drought response has had considerable impact on drought screening at ICRISAT Center. Lines with tolerance to drought have been identified and were used in breeding programs to improve drought resistance. Fortunately some of the lines originally identified for resistance to foliar pathogens also had drought tolerance. We found that the greatest opportunity for improving genotypes for use in drought-prone areas lies in the recovery from mid-season drought and this attribute is being used to screen breeding materials. Research is focused on root respiration and growth, mechanisms determining recovery from drought and water-use efficiency. Photoperiod was found to influence drought responses and genotypes are being screened for photoperiod insensitivity.

Nutrient Stress

Biological nitrogen fixation is usually not a limiting factor to groundnut production in locations with a long history of groundnut cultivation. We found that genotypic differences in the rate of nitrogen fixation are dominated by leaf-area effects (90% of variance) and differences attributable to genotypes are small (2-6%). Groundnut intercropped with nitrogen-fertilized millet, maize, or sorghum fixed less nitrogen than did a sole crop. It was found that application of inoculum directly into the furrow just before sowing was effective. Deep sowing resulted in the development of an elongated hypocotyl, poor nodulation, and reduced nitrogen fixation, especially in Spanish cultivars. Earlier research had identified *Rhizobium* strain NC 92 as having a beneficial effect on crop growth and improving yields, but after a great deal of research we have been able to show that these benefits are probably not due to direct effects on biological nitrogen fixation, and we have now moved the resources to other areas of research.

Iron chlorosis has been shown to be caused by two mechanisms, high soil pH and periodic waterlogging. Genotypic differences exist in susceptibility to iron chlorosis and limited screening of breeding lines has been initiated.

Calcium deficiency is a major limiting factor for groundnut production in many parts of the world. Research was initiated to investigate reported genotype differences in calcium-uptake efficiency of pods. Consistent and significant genotype x drought x gypsum interactions were demonstrated.

Breeding for Adaptation to Specific Environments and Requirements

This is the major breeding activity at the ICRISAT Center. Most of the progress so far has to do with the development of varieties under nonstress situations, or where stresses could be overcome by management practices. Using this, and other improved breeding lines with resistance/tolerance to single-stress factors as base material, we are now aiming at developing lines with multiple resistances.

Early maturing varieties are advantageous in areas where the growing season is short, or the crop is grown in a residual-moisture situation, or in multiple cropping systems. Maturity period is largely dependent on temperature regime, solar radiation, moisture and other factors during the growth period. Use of cumulative heat units (degree days) was found to be effective to determine the maturity. Several early maturing cultivars were developed and are being evaluated in many countries in the SAT.

Considerable progress has been made in the development of medium- and late-maturing cultivars. ICGS 11 (ICGV 87123) and ICGS 44 (ICGV 87128) have been released for the postrainy-season cultivation in India. Other varieties awaiting release for the rainy season cultivation are ICGS 1 (ICGV 87119), ICGS 5 (ICGV 87121), and ICGS 11 (ICGV 87123). Progress was made on development of groundnut cultivars for confectionery purposes. Several confectionery varieties showed good performance in multilocational trials in the SAT.

Utilization of Wild *Arachis* sp

About 100 accessions of wild *Arachis* species are being maintained at ICRISAT Center. All these accessions were screened for desirable characters, with particular emphasis on resistance to leaf spots and to diseases where resistance has not been found in A *hypogaea,* so that these desirable characters could be transferred to the cultivated groundnut. Only the species in the section *Arachis* are cross-compatible with cultivated groundnut, and others cannot be crossed by conventional means. Many species have been analyzed cytologically. The sterility in crosses within the section *Arachis* has been successfully overcome by ploidy manipulations. Progress has been made in overcoming barriers to intersectional hybridization through the use of growth hormones. Tissue culture technology has been applied to the culture of young ovules from wide crosses.

International Cooperation

The ICRISAT Center program interacts with the national programs either directly or through the ICRISAT regional programs and networks. The two regional groundnut programs in Africa have direct responsibility of West and southern Africa. The Center program largely concentrates on Asia, East and Central Africa, the Americas, and other regions. It contributes newly developed material to regional programs in the form of trials and other breeding populations. Many ICRISAT varieties have been released or identified for release in various countries. Other cooperative activities include organization of workshops, meetings, and specialized training courses.

SADCC/ICRISAT Regional Groundnut Improvement Program

G.L. Hildebrand, K.R. Bock[1], and S.N. Nigam[2]

The Southern African Development Coordination Conference (SADCC)/ ICRISAT Regional Groundnut Improvement Program was established at Chitedze Research Station near Lilongwe, Malawi in 1982 in response to an invitation by the Southern African Heads of State at the Lusaka Summit Conference in 1980.

In 1984, the SADCC Consultative Technical Committee for Agricultural Research approved the subsuming and the future expansion of the ICRISAT Regional Groundnut Program into a regional Grain Legume Improvement Program (GLIP), with ICRISAT retaining responsibility as executing agency for regional groundnut research. Cowpea and bean make up the other components of GLIP with the International Institute of Tropical Agriculture (IITA) and the Centro Internacional de Agricultura Tropical (CIAT) acting as the respective executing agents. The program is presently staffed by a pathologist and a breeder. The program serves the nine SADCC Member States including Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe, covering an area of 4.9 million km^2.

Agroecological conditions and production constraints are many and varied. Two of these affect all countries and are the most amenable to improvement by a modest regional program. These are early leaf spot and groundnut rosette virus disease, and the lack of cultivars suitably adapted to the varied agroecological conditions. More than 75% of the region is semi-arid.

Objectives

We acknowledge the smallholder farmer as our principal target. These farmers have limited financial and other resources. Our research is therefore conducted under conditions of low input. Our experiments are grown rainfed, without any form of crop protection. To ensure a reasonable substrate for growth we apply a minimal level of phosphorus.

We recognize also that national programs are our immediate clients and that their needs are of paramount importance. At our regular workshops and group meetings, steering committees discuss the needs and priorities of the region and make recommendations for regional program inputs.

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Research Activities

Breeding

Germplasm evaluation. We have built up and continue to broaden our genetic base and have evaluated about 3500 accessions over the six seasons since the program began.

Hybridization. We are concerned by the lack of adaptability to southern Africa of much of the germplasm introduced from elsewhere and we consider the generation of segregating populations locally to be a priority. We have trained 20 field assistants who have assisted in making more than 800 crosses for yield and quality, adaptability, early leaf spot tolerance, and for rosette resistance. The team will soon be expanded and we plan to make 150-200 crosses each year. We have responded to requests by national programs for specific hybridizations and to date have made crosses for Malawi, Mozambique, and Zimbabwe. We continue to offer this service to national programs.

Breeding for disease resistance. We continue to place major emphasis on selection for yield under severe and uniform early leaf spot pressure, a condition that occurs every year at Chitedze.

We have evaluated material from our own program and from ICRISAT Center for resistance to foliar diseases. This material has included populations from crosses made for early leaf spot resistance and from crosses made at ICRISAT Center involving late leaf spot and rust-resistant parents. Interspecific derivatives were also included.

We have perfected a technique to screen breeding populations for rosette resistance, which has reduced the exercise to a routine procedure. With this, it is possible to induce an overall incidence approaching 99% in susceptible genotypes. We have selected symptomless plants from these nurseries for further evaluation.

We have investigated the inheritance of resistance, previously reported to be determined by two recessive genes, and are satisfied that the resistance available to us and which has been exploited in Malawi is controlled by duplicate recessive genes. We have now purified a West African source of resistance in short-season material.

Breeding for high yield and quality. We have evaluated populations from crosses between high-yielding and bold-seeded genotypes. A number of crosses involving indigenous cultivars and promising ICRISAT material performed poorly. We see great need for the development of, and selection from, locally generated segregating populations.

We recognize the need voiced at the Third SADCC Regional Groundnut Workshop for assistance with quality assessment and for setting up a facility within the program for regional quality assessment.

Early maturity and drought resistance. We have identified a few promising early maturing lines from ICRISAT Center and have noted the performance of 55-437 in trials in Niger and Botswana. We plan to use these genotypes in crosses in 1988/89 to generate segregating populations for possible screening in Botswana.

If phytosanitary regulations permit we intend to strengthen cooperation between the SADCC and Sahelian Center Programs in order to undertake off-season multiplication, and evaluation for adaptability.

Pathology

The regional pathology program is concerned largely at this stage with research on early leaf spot and rosette, although some effort has recently been directed toward groundnut streak necrosis disease (GSND).

Early leaf spot. Genotypes which showed promise in India for early leaf spot resistance were screened at Chitedze in 1987/88 but none were worthy of exploitation. We intend to repeat the screening of some of the ICRISAT Center germplasm over the next few seasons.

In 1985/86 we intercrossed several lines which appeared to retain their leaves longer under conditions of severe disease pressure. None showed any promise for resistance but several were selected for other desirable characteristics.

Research in the Zambia national groundnut program has shown that one fungicide application at about 75 days after planting has resulted in economic control of early leaf spot. We have investigated responses to a factorial combination of up to five sprays at varying dates with encouraging results.

Groundnut rosette virus (GRV). Field screening for rosette resistance continues, greenhouse reared, rosette infected, and heavily aphid-infested seedlings are transplanted into susceptible spreader rows. Single spreader rows are sown after every pair of test rows and infector plants are introduced into spreader rows at 2 m intervals. In 1987/88 we screened 15 000 F_3 plants in a nursery where we were able to induce a 99% incidence of rosette.

We collaborated with the Scottish Crop Research Institute in further studies on groundnut rosette assistor virus (GRAV). All rosette resistant varieties are susceptible to GRAV but infection is symptomless or inapparent. The seasonal origins of rosette remain obscure. We cannot rule out the possibility of long-distance immigration but the possible importance of resident dry-season populations and alternate vector and virus hosts warrants continued investigation.

Groundnut streak necrosis disease (GSND). We have confirmed that this disease, hitherto assumed to be caused by tomato spotted wilt virus, is caused by sunflower yellow blotch virus (SYBV) transmitted by *Aphis gossypii*.

Regional Cooperation

Regional trials. We have supplied new material in the form of regional trials for the past five seasons and, in all, 36 alternately branching and 79 sequentially branching breeding lines have been entered in regional trials for testing against locally recommended varieties. More recently, Valencia types have been entered in a separate trial.

These trials have provided useful data on varietal adaptability and a number of selections have shown good potential and wide adaptability across the region. ICGMS 42 has been approved for prerelease evaluation in Zambia.

Hybridization. We have made crosses for Mozambique for leaf spot tolerance and adaptability; for Zimbabwe for leaf spot tolerance and rosette resistance; and for

Malawi for confectionery quality. We will continue to provide this service to national programs.

Training. We offer specialist training in breeding and pathology methodology at the technician level.

Funding. ICRISAT Center has made funds available for the past two seasons for direct allocation to national programs. This year we assisted Tanzania, Zambia, Mozambique, Swaziland, and Zimbabwe. Funds are spent on the management of field experiments but are also used for the purchase of equipment and supplies.

Networking Activities

We have developed an effective regional network, linking together groundnut scientists of the SADCC countries. We organized three multidisciplinary workshops, the first and third in Lilongwe in 1984 and 1988; the second in Harare in 1986. These have been most successful and have afforded close and sustained professional contact between all research scientists engaged in groundnut research programs. These workshops function effectively as Steering Committees where national program scientists are able to discuss problems and priorities and formulate recommendations for regional program action. We supplement these workshops every alternate year with specialist group meetings. We have initiated a newsletter in order to facilitate exchange of information on research results, experimental techniques, and methodology.

Country Reports

Groundnut Cultivation in the People's Republic of Benin

M. Adomou[1]

Groundnut Production

Groundnuts are highly placed amongst cash crops in Benin and rank after cotton and palm oil. They are grown throughout the country, from the coastal area (north of the Lokossa-Porto Novo line) up to the northernmost part of Benin.

There has been a gradual increase of the area under cultivation and production since 1983; in 1986/87, 86600 ha were sown to groundnut and a total yield of 57 600 t was obtained. Yields are low and fluctuate between 500 and 1 000 kg ha^{-1}.

In the southern part of the country, characterized by two rainy seasons, the most frequently used cultivars are local short-duration (90-95 days) Spanish and Valencia types which are grown during the two rainy seasons.

The MOTO variety is widely grown. TS 32-1 is currently being released in the region. First-season sowing is carried out in April, and the second in mid-August.

In the North, with its single rainy season, virginia-type varieties are grown. Their growing period is medium to long (120-135 days) to coincide with the rainy season (5-7 months). These varieties are: 48-37, formerly released RMP 12 and RMP 91 in the lower North, for their growing period (135 days) and, since 1980, variety 69-101 (125 days) in the Upper North. There are also some local spanish-type varieties with a shorter growing period (less than 100 days). Groundnut is often grown without fertilizers and is intercropped with other food crops (maize, sorghum, cassava, etc.). Areas devoted to sole cropping of groundnut do not amount to more than 40% of the total groundnut-growing region.

Production Constraints

The major problems of groundnut farmers in Benin are low crop productivity and unremunerative producer prices. Reasons for low yield are various:

- Most farmers still use local low-yielding varieties. Currently-recommended improved varieties for the central and southern parts of the country do not seem to adapt to the high humidity of the region.
- Often there are dry spells of up to three weeks during the rainy season. As the southern has two rainy seasons, the first season harvest cannot be easily dried. The relatively dry season which occurs between the end of the first rainy season and the

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beginning of the second, is too short for harvesting and drying. The groundnut harvest of the second season has therefore a better chance of being sold, although this is not to the grower's advantage because the second crop yields less than the first.

- The main diseases affecting the crops are rust *(Puccinia arachidis)* and early leaf spot *(Cercospora arachidicola),* peanut clump in the North and groundnut rosette in the South.
- Recommended cultural methods to maximize groundnut production are incorrectly used by farmers. Since the onset of the rainy season varies greatly from year to year it is difficult to follow appropriate recommendations. Most farmers still use the "daba" in farming and fertilizers are scarcely used on groundnut crops.

Research Work

Due to Benin's varied climate, research into groundnuts is carried out by two research stations. The Niaouli station in the South, at 70 km north of Cotonou, studies the regions with two rainfall regimes and the Ina station, at 70 km north of Parakou, studies the regions with one rainfall regime.

Fertilization

20 to 40 units of P_2O_5 are needed for a good yield. 15 kg ha of sulfur on newly cleared land improves plant performance.

High-yielding varieties

On-going trials show that the RMP 12, RMP 91 and the 69-101 varieties are resistant to rosette and yield more than the 48-37 variety which was formerly released in the North. Given the relatively short rainy season in the south and in the extreme north of the country, short-duration varieties have been tested. The more promising of these are: TE 3, TS 321, KH 149 A, and KH 241 D for oil-type groundnuts and GH 119 20 and Florispan for confectionery groundnuts.

Tests undertaken at the Niaouli Station in the South have shown that some extra-early varieties, such as ICGV 86015 and ICGV 86092, give good results. Other tests also show that varieties CN 94 C^3, CN 115B and TS 32 1 perform well.

Research Objectives

Short- and medium-term objectives

- To select early oil-type varieties and medium-to long- duration varieties resistant to rust, rosette, leaf spot and insects through survey and evaluation of local varieties, recording and identification of pests and the development of appropriate control measures.

Long-term objectives

- To develop varieties which are able to survive occasional dry spells without serious damage. For the southern region, with its two rainfall regimes, to select long-duration varieties which, if planted in the first season, can survive the short dry season and can be harvested at the end of the second rainy season.
- To develop simple drying techniques for the first season's crop for the southern part of the country.
- To improve production quality by selecting varieties with a low aflatoxin level.

Groundnut Production and Production Areas in Burkina Faso

P. Sankara[1] and A. Minoungou[2]

Groundnut is grown throughout most of Burkina Faso. Production is estimated at 100 000 t of unshelled groundnuts per annum. The national average yield is very low (482 kg ha^{-1}). It is only in the south-west that yields approach 620- 780 kg ha^{-1}.

Production is high in the south-western, central, east-central and eastern regions. These are regions that have rainfalls of 700 to 1200 mm, covering north-Soudanian and south-Soudanian climates. In the central region, very often, dry spells during the growing season can seriously hamper the growth of some varieties.

Varieties Grown and Agricultural Practices

Through groundnut research, three series of cultivars have been identified and released in the different regions. They are the late varieties RMP 12 and RMP 91; medium-duration varieties 59-426 and 69-101; and early varieties KH 149-A, KH 241 D, TE 3, TS 32-1, 90 Saria, and CN 14.

In different parts of the country and in accordance with the varieties planted, the recommended sowing dates are early June for the late varieties, at the latest mid-June for the medium-duration varieties and end June for the early varieties, with a planting density of 0.80 m x 0.15 m.

Production Constraints

Burkina Faso has enormous potential for increasing groundnut production. However, production is low for various reasons: outdated implements and methods are used by farmers (daba, mattock, etc.); groundnut, like most other food crops, is not grown intensively; irregular rainfall in some years is a serious handicap which is the reason behind research into extra-early varieties; many sorts of parasites (diseases, insects and weeds) greatly reduce production; the lack of a clear groundnut marketing policy does not encourage farmers to increase production. Burkina Faso exports little of its groundnut crop.

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Research Work

Much research has been carried out into groundnut since the establishment of the Institut de recherches pour les huiles et oleagineux (IRHO) in Burkina Faso in 1949. Most of the work has focused on varietal improvement and cultural methods so as to increase yields substantially.

Varietal improvement

Rosette-resistant varieties for the southern region

In 1956, rosette-resistant varieties, such as 48-37, were introduced. They were released in regions which were affected in 1959.

Crossings of the 48-37 variety or the 1036, from local collections with a high-yield potential cultivar, Mani Pinter, from South America, have resulted in varieties of the series RMP 12 and RMP 91 which have very long growing periods (135-150 days). Other resistant varieties with a shorter growing period (90 days) have been selected for areas with less rainfall and occasional rosette problems i.e., varieties KH 149 A and KH 241 D.

Early varieties for the central and northern regions

Varietal improvement for the central and northern regions started in 1953 by the establishment of a collection of local germplasm and select introductions.

After ten years of trials and result tabulation, the most stable and productive genotypes were retained and distributed, TE 3 and 90 Saria.

From 1966 onwards, wide-ranging breeding was carried out by crossing. For oil extraction, the variety TS 31-1 was not released since its yield was not significantly higher than the existing varieties. This breeding process also produced a new series of hybrids which became the CN series which has shown better results both as far as yield and drought resistance are concerned.

The QH series, both resistant and moderately high-yielding, was released to the central region, whilst series BS and JS, which are more susceptible varieties but with good agronomic potential, were extended in the North. All varieties recommended for release (with the exception of 59-426) had at least one local parent.

Fertilization

Early groundnut varieties respond to nitrogen in the North and, in the South, the effect of calcium on the late varieties is striking. On the other hand, phosphorus and sulfur have similar effects in both regions. Organic manuring at doses of 2.5 t ha^{-1} has a beneficial effect on yield, but doses higher than 5 t ha^{-1} have a depressive effect.

On-going Programs

Research is presently being carried out on three aspects: varietal improvement, cultural methods and crop protection.

Varietal improvement

The national program has two main objectives: breeding of various types (late, medium-duration, early, oil-type, and confectionery groundnuts) which are resistant to the main leaf diseases (rust, rosette and leaf spot) and breeding short- duration varieties for the central and northern regions (drought adaptation).

Agronomy

Tests with phosphate fertilizer

Comparison is made of the effect of soluble phosphate (triple super), of partially soluble phosphate and that of rock phosphate (Burkina-Phosphate).

Calcium trials

The effect of calcium is considered from two angles: as a means of raising pH, and as a fertilizer, which together with other elements, will serve to feed the plant. Tests are carried out on two types of lime application: one as a basal dressing, or at flowering as a top dressing.

Since 1960, at Niangoloko, experiments with intensive crop rotation have been carried out to examine groundnuts in different combinations using organic and mineral fertilizers.

Crop protection

The biological and epidemiological effects of rust, leaf spot and rosette on crop yield, and use of chemicals to combat disease have been studied.

In addition, complementary trials for disease resistance are carried out in the laboratory and in the field to identify potentially rust-resistant varieties.

Groundnut Production and Research in Cameroon

N.B. Essomba, T. Mekontchou[1], and R.N. Iroume[2]

Groundnut Production in Cameroon

Groundnut, like maize and rice, is one of the rare crops that is grown in all of Cameroon's ecologies. Groundnut is mainly grown as a subsistence crop, although a part of the produce is marketed. Haulms are commonly used as cattle feed in the northern part of the country, where it is actively traded during harvest.

Since 1970, the total annual production is of the order of 130 000 t of unshelled groundnuts, from a total average planted area of 300 000 hectares. From these figures, it is estimated that the average national production is approximately 400 kg ha^{-1}. Naturally, production varies from one region to another. The southern-central region produces an estimated 360 kg ha^{-1}, the eastern region 650 kg ha^{-1}, the north between 520 and 735 kg ha^{-1}, and the western region between 300 and 500 kg ha^{-1}.

These production figures seem to reflect marketed quantities rather than actual production quantities. Since we know that the traded proportion of production represents less than 30% of total production, it becomes clear that the figures reflect far less than the actual output.

Physical Environment

Cameroon can be divided into two large groundnut production areas. The first, situated in the northern part of the country has only one growing period. The second, to the south, can permit two growing periods. A third zone, located in the foothills of Mount Cameroon and on part of the coast, could easily bear three growing periods due to its abundant year-round rainfall. The area comprised in the latter zone is negligible when compared to the other two, and therefore can be considered as part of the second zone.

The north of Cameroon can be subdivided into three agro- climatic systems based on rainfall. In the Sudano-Guinean zone, which is located more to the south, annual rainfall ranges from 900 to 1500 mm. In the Sahelo-Sudanian zone, rainfall ranges between 600 and 900 mm. In the extreme north, the Sahelian region has less than 600 mm of annual rainfall.

To the south, the climate is equatorial, with two dry seasons and two rainy seasons a year. The average temperature is constant throughout the year and ranges from 23-26°C with little annual variation, about 1-2°C. Rainfall is about 1500-2000 mm, with two peaks, one in May and the other in Sep-Oct. The two dry seasons occur in Dec-Feb and in Jul.

In the flatlands of the central, southern and eastern parts of the country, flat sowing or

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small mound sowing is the norm. In the mountainous areas, large mound, ridge, or strip sowing techniques are used.

Sole cropping of groundnut is very rare. Most of Cameroon's crops, whether annual or perennial, can be or are intercropped with groundnut. Cropping varies from one region to the next. In the west, for example, maize, taro and cowpea are most frequently intercropped with groundnut. In forest areas, cassava, cocoyams and plantains are most frequently intercropped. In the savannah to the north, sorghum, millet, cotton, and beans are the usual intercrops.

Production Constraints

Weeds are among the greatest constraints of this crop. Rosette and fungal disease of leaves seem to be very common. Rust is prevalent in the northern regions. Cases of damping *(Rhizoctonia* sp) or *(Fusarium* sp) have been reported. The major pests are: armyworms, various rodents, birds, millipedes, crickets, thrips, and *(Peridontopyge* sp). During storage, weevils *(Caryedon serratus)* and molds (due to *Aspergillus flavus)* have been reported in the northern region.

Breeding trials have mostly tended to compare introduced lines with local varieties. In northern Cameroon, variety 28- 206 has become popular ever since it was introduced from Senegal in the '50s. To a lesser extent, GH-119-20 and 48-115 A have also been recommended. New varieties (55-437, IB-66, M 513-77- I, K 1332-78-I, and RMP 91) have recently been suggested in order to cover the different ecological regions of the area. 28-206 seems to be unsuited to the high plateaus to the West. In this region better results have been seen with different varieties, such as GH 119-20 and two local varieties: A 65-7 (from Ebolowa) and A 65-13 (from Dschang). Variety A 68-9, bred in the center, has been recommended for hotter climates than the Dschang variety.

In forest areas, maize-groundnut intercropping may decrease the rate of propagation (percentage of leaf damage) by leaf spot *(Cercospora arachidicola)* and *(Phaeoisarh opsis personata)* whereas it may have no effect on the extent of disease (ratio of leaf area with necrosis to total leaf area).

The interaction *Rhizobium* x groundnut variety was demonstrated in the Sudanian-Sahelian region. Thus, a mix of RMP 12 x strain FLO-1A and 28-206 x strain NC 92 gave remarkable yield increases under trial. Inoculation of groundnut plants with a suitable strain of Rhizobium might even produce as high a yield, if not higher, than that obtained with the application of 160 kg ha^{-1} of urea.

In North Cameroon, phosphorus, sulfur and nitrogen seem to play a vital role. Tests have compared single super phosphate, triple super phosphate and di-calcium phosphate and have found the first to be most effective. For the supply of P and S, this fertilizer is therefore recommended in doses of 100 kg ha^{-1}.

In the long run, varietal improvement will aim at the creation of new varieties, through a hybridization and breeding program using local germplasm and new selected introductions. Apart from yield, adaptability, earliness and resistance to fungal disease and to rosette, special emphasis will be placed on nutritional aspects (i.e. protein and fat content and quality, and Vitamin B content) in selected varieties. Intensive production with low input and emphasis on preserving the environment are recommended. In order to achieve this, research will focus on mineral fertilization, symbiotic fixation, plant technology, phytosanitary protection, light machinery, and agro-forestry.

Future Needs in Groundnut Research

In the medium term, minimum manpower requirements are: two plant pathologists, two entomologists, two physiologists, one biochemist and two breeders. Cooperation with existing local bodies such as the Centre de nutrition de I'lnstitut de recherches medicates et d'etudes des plantes medicinales (IMPM), the Centre universitaire de Dschang (CUDS), the Mission de developpment des cultures vivrieres (MIDEVIV), the Projet national de recherche sur les cereales et de vulgarisation (NCRE), the Conseil international sur la recherche en agroforesterie (ICRAF), Office national de commercialisation des produits de base (ONCPB), and others will be necessary. Contact will be made with any foreign institutions which, like ICRISAT, have a groundnut research program and links will be established with other programs and institutions with a view to promoting valuable exchanges.

Groundnut Improvement, Production, Management, and Utilization in the Gambia

S. Drammeh[1]

Area, Production, and Yield of Groundnut

Groundnut accounts for 87% of the Gambia's earnings and occupies about 59% of the total cultivated land. During the period 1974/75-1986/87 the total annual groundnut cultivation varied between 65 900 ha (in 1985/86) and 110 000 ha (in 1983/84) with an average area of 96 000 ha. The corresponding average annual yield was 1243 kg ha^{-1} and average production, 112 484 t.

Groundnut production over the past decade has declined. Although the decline has been attributed to drought, other factors such as insufficient and delayed supply of fertilizer, shortages of good-quality seed, inadequate mechanization, and ineffective farmer training and extension have been equally important contributors. The overall impact of all these forces in terms of farm-level resource allocation has been a shift from groundnut production to rainfed upland cereal crops. The temporary groundnut price increase of about 100% in 1986/87 aimed at revitalizing production seemed to signal a reversal of the deteriorating trend of groundnut production.

Soil and Rainfall Characteristics

Groundnut is grown in all divisions of the Gambia. However, the North Bank and the Upper River divisions are the major producers. Most of the crop is grown on the colluvial slope soils and the soil pattern is closely related to topography. Rainfall in the Gambia is highly variable. Higher rainfall has been experienced nearer the coast. August is the wettest month of the rainy season and coincides with the period during which the groundnut crop flowers.

Varieties and Agronomic Practices

For many years Philippine pink (an early-maturing cultivar) and Senegal 28-206 (a late-maturing cultivar) have been the most popular groundnut cultivars in the Gambia. However, 73-33 (an intermediate duration introduction from Senegal) might eventually replace Senegal 28-206. 55-437 (an early-maturing cultivar) also from Senegal is being considered as a replacement for Philippine pink. Groundnut is mainly sown on the flat, often is an intercrop, and is rotated with sorghum, millet, maize, and cotton.

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The recommended seed rate for Senegal 28-206 is 75 kg ha^{-1}. A spacing of 50 cm x 12 cm is generally recommended. Seeds are treated with Aldrex T before planting. Two seeds are planted per hole and farmers apply single superphosphate at the first weeding. Harvesting is often done by hand using the short-handled hoe. Few farmers use animal traction. The lifted crop is left in the fields to dry in windrows, after which the crop is stacked on specially constructed platforms.

Production Constraints

The difference between actual yields on research stations, field trials, and farmers fields remain considerable. The major constraints include inadequate moisture, pests and diseases, and poor soils. In recent years both the total amount and distribution of the rainfall have been inadequate for optimal development of the crop. Over the years both early and late drought became prevalent, as a result of which crop establishment and maturity were hindered.

The major pests and diseases are millipedes and crown-rot, leaf spots, rosette, and mammalian pests. The notorious *Caryedon serratus* (bruchids) and fungi such as *Aspergillus flavus* are mainly postharvest problems.

The most important socioeconomic factors limiting production are the low educational level of the farming communities, poor and inefficient input and credit supply systems, and low level of farm mechanization.

The major institutional constraints to groundnut production are inadequate institutional support services of extension, research, crop protection, credit, and seed multiplication.

Utilization

Groundnut serves as an important food item for the Gambia. Groundnut oil produced by the Gambian Produce and Marketing Board (GPMB) for domestic consumption averaged out to about 2300 t per year over the last decade. Substantial amounts of groundnut are processed under traditional methods for domestic consumption, and significant amounts are also consumed as condiment, and for confectionery. The groundnut haulms are used as feed.

Marketing

The GPMB has a monopoly over the purchase and export of groundnut in the Gambia. The domestic marketing of groundnut is carried out by both the public and private sector. The Gambian Cooperative Union (GCU) purchases about 80% of the crop through its member societies. The other 20% is purchased by licensed buyers and traders. The GPMB also fixes producer prices, subject to the approval of the Minister of Finance and Trade. All traders are required to pay farmers the officially announced producer price. The GPMB has subsidiary in London, which arranges for the sale of the board's groundnut products to the international market.

Storage

Threshing of the crop is carried out in two separate operations. First the portion of the crop to be reserved for seeds is threshed, bagged and transported to the national seed stores where they are treated with insecticides and stocked. The second threshing operation takes place between the second week of December and any time up to the end of February. This portion of the crop goes for local consumption and marketing. The portion for marketing is transported to the buying stations, where the nuts are screened to minimize foreign matter.

Research Activities

Most of the work done has been on varietal evaluation. Other research activities include fungicide trials, fertilizer trials, seed dressing, time of planting and spacing, and a moisture gradient trial.

Three sets of groundnut variety trials have been conducted since 1980. The national groundnut variety trial, an international early maturing cultivar trial, and a germplasm evaluation trial, the last two in cooperation with ICRISAT.

Seven groundnut cultivars were evaluated in the national groundnut variety trials between 1985 and 1986 in both Sapu and Yundum. At Sapu 55-437 out-yielded 28-206 by 56%. Averaged over sites and years, pod yield was highest for 73-33.

The international early maturing groundnut variety trial consisted of 24 progenies. All the cultivars were considered earlier than 28-206, and Robut 33-1 and ICGS(E)-52 yielded as well as the standard variety.

ICRISAT germplasm material was also evaluated at Yundum in 1986 using single-row observation plots. Yield per plant varied from 10.0 g to 37.1 g with several of the lines although maturing up to three weeks before the standard giving similar yields to the standard 28- 206. However, a striking feature of this trial is the generally poor shelling percentage observed.

During the 1987 rainy season, four early-maturing varieties, ICGS(E) 20, ICGS(E) 30, ICGS(E) 52, and Robut 33-1 performed well in comparison with the early-(55-437), medium-(73-33), and late-maturing (28-206) varieties.

Data obtained from a "yield-gap" study conducted on farmers' fields in 1986 and the groundnut stand survey in 1987 showed not only that plant population is important in determining yield, but that seed viability may be a nationwide problem. The objective of the seed viability studies this year is to determine the viability of farmers' seed, to obtain measurements of seed vigor, and to determine to what extent seed with improved viability and vigor can contribute to improved plant populations.

Groundnut will remain the dominant export crop of the Gambia in the foreseeable future. Given the unfavorable prospects of world market prices, improvements in the declining and oscillating, groundnut export revenue must come from improved production and productivity. The strategy will include the following : development and/or screening and introduction of groundnut varieties of a duration appropriate to the climatic circumstances of major agricultural zones; investigation of the institutional, socioeconomic, and physical constraints to the widespread adoption of known labor-saving devices to alleviate labor bottlenecks in groundnut production; promotion of appropriate integrated pest-control measures and biological technologies; promotion of the introduction of mechanical threshing of groundnuts and efficient methods of field drying to reduce crop losses and aflatoxin contamination by *A. flavus;* maintaining the vigor and purity of the seed in circulation through developing an efficient production and distribution system of seed multiplication; encouraging the adoption of simple soil and water management practices and structures such as construction of contour bunds and contour plowing, and judicious application of conservation tillage; improving the efficiency of groundnut marketing and processing by according GPMB greater autonomy in marketing decisions through performance contracts and encouraging increased private participation in groundnut trading.

Groundnut Production and Improvement in Ghana

G. Atuahene-Amankwa[1], M.A. Hossain[2], and M.A. Assibi[3]

Ghana lies between 4° 45' and 11 ° 10' N latitude and 1 ° 12' E and 3° 15' W longitude.

Groundnut is grown in all agroecological zones. About 85% of the area under groundnut and the bulk of groundnut production is from the Guinea savannah and Sudan savannah zones in the north. These two zones have a unimodal erratic rainfall regime and the rains usually start in May and continue up to October. The Guinea savannah zone has an average rainfall of 1070 mm while that of the Sudan savannah is about 990 mm. The annual production is about 115 000 t of unshelled nuts, with a national average yield of 0.91 ha^{-1}.

Soils

Soils in the Guinea savannah and Sudan savannah zones are characterized by gentle undulating land with isolated iron pan, sandstone or granite capped hills. More diverse soils are found in the Guinea savannah than in the Sudan savannah. Phosphorus and nitrogen are deficient in most of the soils, which are also intensely leached. They are generally sandy and prone to sheet and gully erosion. The pH of most soils ranges between 5.3 and 7.0.

Agronomic Practices

Groundnut is mostly produced by subsistence peasant farmers. Planting is done on ridges both in the north and south, while planting on the flat is commonly practised by farmers in the Upper West Region in the north. Generally, groundnut is intercropped with other crops such as sorghum, pearl millet, maize, and cassava. In the northeastern part of the country, groundnut is grown in pure stand on ridges.

Production Constraints

The major production constraints include : unreliable rainfall, often characterized by drought and/or excessive rains; high temperatures, especially during the dry spells; diseases, especially rosette, leaf spots, and wilt caused by *Sclerotium rolfsii;* insect pests, particularly aphids; lack of improved varieties and competition of weeds; and

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soils characterized by poor physical properties, inherently low fertility, and low water retention capacity. The lack of agricultural credit facilities for acquiring inputs such as improved seeds, fertilizers and agricultural machinery by the farmers are also important constraints. Small farm size and fragmentation of holdings tend to cause scarcity of land for groundnut. These are further exacerbated by unfavorable land tenure system, lack of ability to maintain farm equipment, poor transportation and communication facilities, poor marketing facilities, and pricing structure.

Storage and Utilization

Mature groundnut kernels, following harvesting and drying, are stored in jute bags and kept in barns built of mud or thatch. The bulk of the groundnut produced is processed by local women for vegetable oil. The cake is fried to make a local food known as "Kuli-kuli". A flour made from roasted maize and small quantities of roasted groundnut is used for the preparation of weaning food. Groundnut paste from ground roasted kernels is used in making stews and soup. Salted nuts are roasted or fried in oil and served at various functions.

Marketing

Groundnut is marketed locally. The Ghana Food Distribution Corporation (GFDC), a government marketing and distribution organization buys groundnut from the rural areas, stores, and later resells them to the public. GFDC handles only a small proportion of the groundnut produced and therefore, most farmers depend on middlemen for the ready market.

Research Program

The objective of the groundnut research program in Ghana envisaged the development of varieties and management practices suitable for various ecologies to increase production to a self-sufficiency level. The bulk of the groundnut research in the country is carried out by the Crops Research Institute (CRI), which was formed in 1963. Inadequate funding and lack of trained personnel are the major problems which often resulted in lack of continuity in research programs. This picture began to change in 1980 when two foreign-aided projects affiliated to the CRI, the Ghana-GTZ (German) Project and the Ghana Grains Development Project (GGDP) started active research work on a number of food crops. The Ghana-GTZ Project, based at the Nyankpala Agricultural Experiment Station (northern sector of the country) is primarily concerned with the development of production technologies suitable for the north. The GGDP, started research on groundnut in 1986 with the aim of developing technologies suitable for the maize-based cropping system. The varieties Spanish 207-3, MK 383, 146 and Mani Pintar were released for production before the end of 1960. More introduced varieties were evaluated in the 1970s. These released varieties were Florispan Runner, Natal Common, Shitaochi, Tirik, Phillipine Red and Kumawu. The yield potential of these varieties ranged from 710 to 1922 kg ha^{-1} with a maturity period ranging from

90-130 days. Mani Pintar with about 54% oil and Shitaochi still appear to be popular. In 1985, a 115-day variety F MIX with a yield potential of 1600 kg ha^{-1} and oil content of about 46% was released for production in the north. In 1988, two full-season ICRISAT lines, ICGS 113 and ICGS 114 underwent testing in the farmers' fields.

The objective of the current groundnut breeding program is to develop improved varieties with the following specific characteristics: high and stable kernel yield, high oil content and/or good table quality, resistance to major diseases and insect pests, different plant types and maturity period (90-100 days and 110-120 days) to fit into various cropping systems, resistance to drought, and improved field dormancy.

The approach involves multilocational testing of exotic lines/varieties and selection of superior germplasm for the breeding program or immediate release. Mostly, these exotic materials have been received from ICRISAT Center, and some materials were introduced from the national programs of Senegal and C6te d'Ivoire.

In 1986, three sets of groundnut trials received from ICRISAT, namely, International Groundnut Pest Resistant Varietal Trial, International Groundnut Early Maturing Varietal Trial, and the International Varietal Trial for Adaptation, were conducted at Kwadaso/Fumesua in the forest zone. Six lines, ICGS 26, ICGS 66, ICGS 11, ICGS 30, ICGS 76, and JL 24 were selected for a multilocational yield trial in 1987. None of the lines appeared to be superior to the local check, Shitaochi but the stability analysis revealed that ICGS 30 and ICGS 26 were the most stable lines.

The current recommended plant populations are 13 3000-16 7000 plants ha^{-1}. Suggested spacings are 2 plants per hill at an interrow spacing of 75 cm with intrarow spacing of 15 cm or interrow spacing of 60 cm with intrarow spacing of 20 cm.

In the north, mid-May planting was found to be optimum. While April and early September were found to be the optimum times of planting for the south. Weed control is very important during the first four weeks of the crop growth.

The recommended fertilizer is 10 kg N ha^{-1} as 'starter' nitrogen, 40 kg P_2O_5 ha^{-1} and 10 kg K ha^{-1}. Current studies on cropping sequences at the Nyankpala Agricultural Experiment Station indicated that growing groundnut after a groundnut crop or even after a maize/groundnut intercrop resulted in low yield compared with sorghum, yam, or maize as preceding crops. In contrast, groundnut has been shown to be a suitable preceding crop for both maize and sorghum.

Future research plans include : development of pest- and drought-tolerant, high-yielding varieties suitable for mixed as well as sole cropping, development of genotypes with high nitrogen-fixing ability, improved field dormancy, and storability. Also planned are determination of varietal and crop compatibility, spatial and chronological arrangement as well as weed control, and fertilization, for various cropping systems, and on-farm research for the verification and transference of technologies.

Groundnut Extension

Extension activities on groundnut are confined mostly to seed production and seed supply. Currently, seeds of Shitaochi and Mani Pintar are being multiplied by the Ghana Seed Company for distribution to the farmers.

Groundnut Production in the Republic of Guinea

N.B. Tounkara[1]

Groundnut is the top-ranking food legume grown in Guinea, both for area under cultivation and number of farmers in comparison to others of the same type such as beans, cowpeas, pigeonpeas, and bambara groundnut.

Amongst other food crops, groundnut-growing area ranks third (146 000 ha), after rice (547 000 ha), and fonio *(Paspalum longiflorum)* (375 000 ha), but comes before maize (141 000 ha), cassava (107 000 ha) and others.

Groundnut is mostly grown by traditional small farmers which is the reason for the low production, estimated in 1985 at 75 000 t from 130 000 ha, i.e. an average yield of 577 kg ha^{-1}.

There are one to two cropping seasons a year. The first falls during the rainy season (from mid-Jun to Aug-Sep and the second in the off-season from Dec-Jan to Mar-Apr). During the second season, sowing is usually practiced on the lowlands used for irrigated rice so that the groundnut plants can benefit from the residual moisture in the soil.

Groundnut is either planted sole or intercropped with maize, cassava, okra, etc.

Physical and Human Environment and Groundnut Production

Lower Guinea or Coastal Guinea

Annual rainfall ranges from 2000-4000 mm. In this area groundnuts are planted in the foothills in the rainy season and in the lowland of irrigated rice in the off-season.

The crop varieties grown (Maressi and Labiria) have a short growing period (90 days).

Leaf diseases (particularly early and late leaf spots and rust), weeds, rodents and the lack of high-yielding varieties are all factors which hamper groundnut cultivation in this area. An additional problem is that since first season harvesting is carried out in the middle of the rainy season, drying is difficult and leads to aflatoxin problems.

Middle Guinea

This region comprises a series of plateaus with altitudes ranging from 600 to 1500 m. Average yearly rainfall fluctuates between 1500 and 2000 mm.

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Middle Guinea is the main groundnut-producing region in the country, particularly the great plains of Gaoual and Koundara.

Groundnut varieties grown are: Tyoporo, Labiria, Dare, Tiga laye (names in Pular regional language). Leaf diseases (leaf spot and rust), rosette, weeds, and the lack of improved varieties are the main constraints to groundnut production in Middle Guinea.

Upper Guinea

This is a region of savannah at 200 to 400 m above sea-level. Average yearly rainfall ranges from 1100 to 1700 mm. It is the second most important groundnut producing area in the country.

Groundnut is rainfed. Varieties grown are: Tyagbe, Tyabenin, Tyaoulen (names in Manika regional language). Rosette, collar rot, aflatoxin problems, and the lack of improved crop varieties are all factors which hamper groundnut production in the Upper Guinea.

Forest region of Guinea

This is a rough mountainous region (altitude 1600-1700 m). Rainfall ranges from 1700 mm in the north to 3000 mm in the south.

In this area, groundnut is grown on hillsides which have previously and successively been used for rainfed rice, cassava and fonio.

Crop varieties grown are, among others, Tyansaghan, Tyanhoubouon (names in Kissie regional language). Leaf diseases (leaf spot and rust), weeds, rodents, the lack of improved varieties and the fact that harvesting occurs in the rainy season are all factors that limit groundnut production in this area.

Uses

Even though the practice is not very widespread as yet, groundnut haulms are used as cattle fodder. Groundnut cake and haulms are also used as organic fertilizers.

Research Work

The Guinea national groundnut research program is based at Foulaya, 125 km from Conakry by road and 140 km by train.

1987 can be seen as the year when organized groundnut research actually began, with regular follow-up work.

The current groundnut research program began during the 1987 rainy season when 116 groundnut lines introduced from the ICRISAT Centre were evaluated.

Present work

For the first cropping season, aside from four international ICRISAT trials which are all being continued, we have also carried out the following tests:

- Assessment of three varieties of oil-type groundnuts received from Senegal. To groundnut varieties (69-101, 28-2067 and 57-313) we have added a local Maressi variety and two ICRISAT varieties (ICGV 86053 and ICGV 87119).
- Assessment of two varieties of confectionery groundnut introduced from Senegal. To these two Senegalese varieties (756-17 and GH 119-20) we have added two local varieties, Maressi and Labiria, and two ICRISAT varieties (ICGV 86556 and ICGV 86551).
- Assessment of three varieties of groundnut received from the Cote d'Ivoire. To these three varieties (BS 7, TS 32-1 and TE 3), we added one local Maressi variety and two Senegalese varieties (73-33 and 73-30).
- Assessment of six varieties of groundnut received from Burkina Faso. To these Burkinabe varieties (RMP 91, 69-101, KH 149 A, RMP 12, 59-426 and KH 241D), we added one local Maressi variety and one Senegalese variety 73-30.
- Assessment of four varieties received from the National Seedbank Project (PSN). These varieties (73-33, 73-30, 55-437 and 69-101) are of Senegalese origin to which we added two local varieties, Maressi and Labiria.

Future work

- Continue with the assessment of introduced varieties until varieties adapted to our various ecological zones have been developed.
- Work towards collection and survey of the groundnut genetic resources of the country. This work should start in 1988 (October-November), if the required funding is granted.
- Undertake agro-technical work, nutrition studies and crop protection of the selected varieties both local and exotic.
- Establish groundnut research stations in each of our four ecological zones as soon as is possible.
- Pursue our contacts with ICRISAT, with the Fondation internationale pour la science (FIS), the Reseau franco-africain de la recherche sur l'arachide and attempt to strengthen our contacts with the Institut de recherches pour les huiles et oleagineux (IRHO), the International Board for Plant Genetic Resources (IBPGR), and other organizations concerned with groundnuts, in particular in other African countries which have sufficient expertise in this field.

Research Requirements and Problems of Groundnut Production in Mali

D. Soumano and S. Traore[1]

Groundnut is grown throughout most of Mali, although the main production areas are to the west, the south-west and the centre of the country between isohyets 600 and 1400 mm. In the last ten years the total area established under the crop has declined for several reasons but mainly due to climatic irregularities and the market trend which has made groundnut export irregular. Groundnut production has declined from 145 000 t in 1975-76 to 38 000 t in 1984-85 with an average yield of 700 kg ha^{-1}.

Research and Crop Improvement

Research carried out by the Institut de recherches agronomiques tropicales et des cultures vivrieres (IRAT) and the Institut de recherches pour les huiles et oleagineux (IRHO) during the '60s and '70s attempted to find improved high-yielding groundnut varieties which would adapt easily to the different rainfall conditions in the main groundnut-producing areas of the country.

After the withdrawal of IRHO in 1978, research work and breeding programs were considerably cut back.

The major constraints to groundnut production are:

- Low-yielding varieties, with a growing period unadapted to local climate. The diversity of groundnuts grown in Mali is considerable. Nevertheless, farmers most often plant the older long-duration varieties or the newly introduced early varieties. The early varieties are not always the best performers, but they are nonetheless more widely grown even in ecologies more suited to the later varieties. Yields are low in most cases. The fast-disappearing local varieties could be improved since they have the advantage of being better adapted.
- Climatic conditions, in particular irregular rainfall regimes.
- Diseases and insects: Leaf spot *(Cercospora arachidicola, Phaeoisariopsis personata),* rust *(Puccinia arachidis)* and, to a lesser extent, rosette, are all the main leaf diseases of the groundnut in Mali. Rust and early and late leaf spots are widely prevalent; some fields are entirely diseased. Disease strikes nearly all varieties at present grown in Mali. Termites and storage insects are also a severe problem as well as infestation by molds *(Aspergillus* spp) and development of mycotoxins in the groundnuts.

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Mention must also be made of the market situation for groundnut which discourages farmers.

Cropping Techniques

Virginia-type varieties, such as 28-206, are sown at distances of 0.60 m x 0.15 m, whereas spacings of 0.40 m x 0.15 m is recommended for spanish-type varieties (e.g., 47-10). Seeds are treated with thioral (thiram x heptachloride) at a dosage of 2%. Usually 65 kg ha^{-1} of single super phosphate is spread during soil preparation or just after emergence. Treatment with herbicides (Gesatene or Cotodon by Ciba-Geigy) reduces the workload and serves to increase groundnut yield. This is a practice which farmers have quickly adopted.

Groundnut is sole cropped as well as intercropped with cereals, especially millet and sorghum. The relative importance of these two systems varies greatly from one farming area to the next. Sole cropping is mostly found in the main groundnut-growing regions (Kolokani, Kita, and Kayes), whereas intercropping with cereals is more common in other parts of the country where groundnut is of secondary importance.

Future Programs

Varietal improvement

Since the withdrawal of IRHO in 1978, the groundnut breeding program has faced serious difficulties.

New varieties and new breeding lines were introduced from the ICRISAT Center, in India, from the University of Georgia and the University of Texas A&M (USA). In 1986, the collection was enhanced by 143 entries which comprised local genetic resources collected by the ICRISAT-IER Mission. Samples of this collection are very varied. It would be particularly interesting to study the local germplasm in order to identify genotypes which could be immediately used in the varietal improvement program. Special emphasis should be laid on the breeding of varieties which are resistant or tolerant to drought and leaf diseases (rust and leaf spot). Confectionery groundnuts could be of interest since they are more profitable.

Crop protection

The distribution of the different diseases, their prevalence and varietal/parasite relationships should be studied, as should the protection of stored produce against insects. Existing varieties could be screened to determine resistance to infestation by *Aspergillus* spp at the Aflatoxin Laboratory at the Zootechnical Research Centre at Sotuba.

Agronomy and cropping systems

Information regarding varieties improved through breeding should be included in the data for agronomic studies (dates, planting density, and manuring) in order to study new plant material. Evaluation of these varieties' role in cropping systems to improve the systems themselves is also crucial. Intercropping of groundnut/millet and groundnut/sorghum is of particular importance in the varied agricultural and climatic conditions which exist in Mali.

Development of Groundnut Production in Niger

M. Oumarou, H. Hamma, A. N'Diaye, and A. Mounkaila[1]

Groundnut production in Niger has gone through three stages of development: a crop extension phase lasting from 1930 to 1959; an upsurge between 1960 and 1972; and a regressive period which started in 1973.

Groundnut Crop Extension in Niger

It is not clear when this phase actually began. Well before 1930 the Magaria and Tarna regions exported groundnut to Nigeria: with exports of less than 100 t in 1914, these exports grew to 1500 t in 1924.

Positive action to enhance production was taken early: Senegalese varieties were introduced when the Experimental Station was established in Tarna in 1927; manual shelling machines were distributed; an oil mill was built in 1942 at Maradi (Siconiger); and cropping plans and the use of animal traction for cultivation were tested.

At the end of this stage, the areas under cultivation comprised approximately 300 000 hectares. However, despite increased production, exported volumes did not increase significantly because prices remained invariably low.

Upsurge in Groundnut Cultivation in Niger

The boom in groundnut cropping, which started with the establishment of the Groundnut Marketing Corporation (SONARA) in 1962, brought with it striking results and set national records:

- Cultivated areas reached 432 000 ha in 1968;
- Production reached a high of 312 000 t in 1966;
- Yield reached a record 880 kg ha^{-1} in 1966. Average yield, between 1962 and 1972, rose to 635 ± 130 kg ha^{-1}, i.e., more than 15% above the yield recorded between 1950 and 1959.

Research contributed greatly to this phase, since with the formulation of the Four-Year Plan (PQ4) 1965-1968, estimates for increased production were of the order of 300, 100 and 40 kg ha^{-1}, thanks to the use of phosphate fertilizers, improved crop varieties and fungicides respectively.

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ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1990. Summary Proceedings of the First ICRISAT Regional Groundnut Meeting for West Africa, 13-16 Sep 1988, Niamey, Niger. Patancheru, A.P. 502 324, India: ICRISAT.

Use of Improved Seed

Of the ten crop varieties recommended for wider distribution, in fact only three have been grown in farmers' fields: 28-204, a Spanish variety suited to the North with its light rainfall (less than 500 mm); 40-16, a spreading Virginia type for sandy areas with medium rainfall (500-600 mm); and 28-206, an erect standing Virginia variety for the wetter southern areas (with more than 600 mm).

Wider extension of the 48-37 was attempted, since it was resistant to rosette, a disease which had been reported in Gaya for the first time in Niger in 1960. But the attempt was abandoned because 28-206 performed better, and rosette only broke out sporadically. The 55-437 variety (Spanish) and 57-422 (Virginia erect) were released only in 1971 in order to cover areas where 28-204 and 47-16 were grown respectively. 57-422 suffered the same fate as 48-37. 55-437 became more popular because it was more drought-resistant and had a shorter growth duration in comparison to 28-204, which it finally replaced completely in about 1980.

An agricultural survey carried out in 1960 found that 24% of the areas under groundnut cultivation were sole cropped with 76% used for intercropping. Groundnut was often intercropped with millet, in sandy soil (south of Zinder) and with sorghum, in heavy soil (central south of Maradi).

Seed Treatment

Between 1963 and 1974, 14.6 t of fungicides were distributed on average per year which allowed 7 300 t of seeds to be treated. In 1974, 86% of farmers from the Zinder Basin, indicated that they were familiar with the product and 67% said that they had treated their groundnut seeds.

Phosphate Fertilizers

Groundnut was found to respond to certain treatments: 6-20-10, 15-15-15. single super, and triple super. Between 1963 and 1973, with an average availability of 256 t per year, 20% of all areas under cultivation could be fertilized. The share of fertilizer falling to groundnut crops was negligible.

Regressive Stage

Unforeseen circumstances, such as drought and rosette, brought about this stage, which wiped out all the efforts to develop and maintain crops.

Poor Groundnut Sales

Since 1960, France has guaranteed the purchase of only a certain quota of production. The quota amount is fixed every year. This procedure came into effect in 1967, which saw the beginning of a decrease in export volumes. Since SONARA had as little hope of selling its groundnuts abroad as did the oil mills, it started on reconversion.

Drought

Drought is, without doubt, the groundnut's worst enemy in Niger. If poor sales served to cut back exports, drought served to wipe out the remaining production.

Realistically, any improvement now would require the return of regular normal rainfall patterns, expertise in irrigation methods (as a supplementary measure) or else appropriate extension of varieties which can survive unpredictable climatic conditions. The latter seems to be the best way to combat drought and has been one of the solutions studied by the National Agronomic Research Institute of Niger since 1976.

Rosette

Since its first appearance in 1960, rosette has always been a problem in Niger. Even though it is endemic, 1975 and 1987 were the only two years with rosette epidemics in Niger. In 1975, harvests in the eastern and central basins were practically wiped out.

Rosette-resistant crop varieties RMP 12 and KN 149 A can produce a fairly high yield but only under normal rainfall conditions.

Conclusion

Unfortunately, the closure of the French market and recent natural disasters (drought and rosette) allow scant hope of a complete revival of this crop.

There is no chance of bringing groundnut production to its former peak in 1960; now it is just a question of sustaining an appropriate level of self-reliance in food production.

Groundnut Improvement, Production, Management, and Utilization in Nigeria: Problems and Prospects

S.M. Misari, S. Boye-Goni, and B.K. Kaigama[1]

The major groundnut-producing areas of Nigeria are located in the Sudan and Northern Guinea ecological zones where the soil and agroclimatological parameters are most suited for groundnut. About 0.8 to 1.2 million ha are grown annually in Nigeria. The crop is grown usually as a component of a variety of crop mixtures including sorghum, millet, cowpea, and maize.

Groundnut production in Nigeria steadily rose to a record high of about 1.2 million t in the mid-1960s. From this period, there was a gradual decline in production up to the early 1970s and then a sharp decline thereafter.

The problems facing the groundnut industry in Nigeria are many and complex. The solution lies not only in the increase of hectarage but also in increased yield per hectare.

Production Constraints

Climatic conditions

The decrease in total annual rainfall coupled with the rosette outbreak of 1975 resulted in very poor yields. As a result of the drier weather the Sudan Savannah zone is no longer so well suited to groundnut production. This has resulted in a southward shift of the suitable climatic zone for groundnut production. However, while the sandy soils of the Sudan Savannah allow easy harvesting even when dried, the heavier soils further south can set hard and make harvesting extremely difficult. Late rains in this zone could also damage the harvested crop.

Pest and diseases

Diseases such as the groundnut rosette virus (GRV), transmitted by *Aphis craccivora* Koch, and groundnut foliar diseases, notably early leaf spot (*Cercospora arachidicola),* late leaf spot *(Phaeoisariopsis personata)* and rust *(Puccinia arachidis* Speg.) have been on the increase.

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Poor cultural practices

Farmers have inadequate supply of improved seeds and pesticides. This, coupled with late planting at low population with inadequate use of fertilizers, has led to a further decline in yields.

Other limiting factors include: (1) inadequate attention given to the agricultural sector in favor of mineral oil; (2) low prices and inappropriate government policy in the past which encouraged the importation of vegetable oils and dampened local production interests; (3) scarcity and high cost of labor and lack of cash to pay for labor and other inputs; (4) poor supply and distribution of inputs such as fertilizers; and (5) rapid increase in human populations coupled with greater domestic demand for groundnut oil and cake.

There are two main varieties grown in Nigeria. Long-season varieties (Virginia types) mature in 130 to 145 days. Yields obtained using local farmers practices range from 0.7-2 t ha^{-1}. Short-season varieties (Spanish and Valencia types) which mature in 90 to 129 days are usually grown under rainfed conditions in drier areas. Yields of 2.8 t ha^{-1} have been achieved. The national average yield is 972 kg ha^{-1}.

The varieties which are currently available for commercial production include: Samnut-1 (MK 374) and Samnut 2 (Samaru 38) (120- 130 days), rosette-susceptible Virginia types with semi-erect growth habit; Samnut-3 (M 25.68), a rosette-resistant high-yielding cultivar; Samaru-13 (Spanish 205), a moderately high-yielding short-season, rosette-susceptible cultivar with erect growth habit.

Six new varieties have recently been considered for official release. They are: RMP 12 (Samnut-10), RMP 91 (Samnut-11), 554-76 (Samnut-16), 55-437 (Samnut-14), 48-115B (Samnut-17), and RRB (Samnut-18). The first three are rosette-resistant, long-season Virginia bunch types. The last three are rosette-susceptible, short-season Spanish types. They are drought resistant and are therefore, suited for production in drier areas.

Variety Improvement

The first attempt towards groundnut breeding was made in 1928. Preliminary work involved the collection of local cultivars and until 1963 emphasis was the improvement of these local varieties.

During the same period about 600 introductions from India, other parts of Africa, and the USA were also grown for selection and assessment. From these selections, variety recommendations were made.

Breeding work after 1963 was directed towards the production of high-yielding, disease- and pest-resistant, and drought-resistant varieties with a range of growth cycles.

Rosette-resistant cultivars 55-460, 55-464, 55-465, 55-468, and A 1367, and crossbred rosette-resistant lines 69-101, KH 149, RMP 12, and RMP 91 were obtained from Senegal and Burkina Faso. Crossing and selection continued to try to develop improved cultivars for production in the various ecological zones in Nigeria. Current work on foliar diseases is restricted to leaf spots and rust since they constitute the most damaging disease complex on groundnut apart from groundnut rosette virus. Collaborative work on leaf spot resistance, using wild *Arachis* species was undertaken with

North Carolina State University, USA, Reading University, UK and recently with ICRISAT Center, India and Peanut CRSP, USA.

Recently more intensive searches within the cultivated groundnut germplasm have shown sources of resistance/tolerance to leaf spots and rust. A number of potential leaf spot and rust-resistant lines have been identified. These lines are further being screened to establish their levels of resistance and to obtain some indication of their yield potential.

Groundnut varieties which mature earlier than currently released cultivars and having high yield potential together with good quality would be extremely useful in the Sahel and Sudan ecological zones. Breeding work was initiated by using Chico, spanish 205 and Natal Common. A number of selections have been made and are being further evaluated for their yield potential and other agronomic characters.

Breeding for drought tolerance has become imperative for the Sahel and Sudan ecological zones. A number of crosses have been made using 55-437 and 59-127 as sources of drought resistance, and selections have been made.

Our current and future goals include the development of cultivars with multiple disease resistance. At the present, two such breeding lines, MDR-8-15 and MDR-8-19 have been developed. The lines MDR 8-15 and MDR-8-19, both long-season types, are resistant to rosette, rust and/or leaf spots.

Agronomic Practices

The recommended production practices for obtaining high yields include selection of good quality seed for planting, a weed-free seedbed, timely planting, maintaining a high plant population, application of fertilizers, weed and disease control, and timely harvesting. Management of the obnoxious phanerogamic root parasitic weed, *Alectra vogelii* Benth which is becoming a serious threat to groundnut production is by cultural methods of destruction before seeding, burning and rotation with cereals.

Utilization

The greater part of production is used domestically for human food and an enormous quantity for oil extraction. Domestically, groundnut oil is used extensively for cooking, as an illuminant in rural areas, for making margarines, soaps, cosmetics, paints, ink, plastics, and varnishes.

Groundnut cake is used in the manufacture of compound feed and for supplementary feed programs. Groundnut cake is often deep fried or dried to form snack food locally referred to as "Kuli-kuli". Groundnut flour made by milling the cake or whole kernel is used as an ingredient in soups, sauces, sweets, confectioneries, puddings and in the manufacture of weaning foods. The whole seed is eaten fresh, dry, roasted, or boiled as a snack food.

The groundnut husk or shell is used as a fuel, roughage, and energy source or absorbent in livestock feeds, animal litter, mulch, manure and soil conditioner. The haulms are utilized as valuable livestock feed.

Storage

Groundnut is generally stored in shell with little or no use of pesticides. For long-term storage the containers are sealed with mud after the addition of ashes, ground pepper or other local herbs to control storage pests.

The major problems in stored groundnut in Nigeria include weather, insects, rodents, and infestation by toxicogenic fungi. The most important insect pest of unshelled groundnut is the groundnut bruchid, *Caryedon serratus* (Olivier).

Marketing

The last institutionalized marketing of groundnuts was handled by the defunct Nigerian Groundnut Board which was established by Federal Government Decree in 1977 and was abolished in 1986. Groundnut marketing is now completely liberalized.

Research Activities

Improved production needs to be stimulated through short- and long-term research. There is the need to breed for high-yielding, short-season and drought-resistant varieties for the drought-prone semi-arid ecological zones of Nigeria. Breeding for resistance to foliar diseases especially for the more humid Guinea Savannah ecological zone, needs to be intensified. Rosette-resistance breeding with a view to determine the nature of resistance so as to incorporate the genes for resistance into both short- and long-season varieties cannot be overstated. The question of the phanerogamic root parasitic weed *Alectra vogelii* Benth control should be pursued through screening so as to identify sources of resistance for breeding purposes. The cause of crop failures in the Sahelian zones especially with regard to blind nuts ("pops") need to be investigated. The epidemiology of rosette which, has eluded science, needs to be elucidated through the study of the bio-ecology of the aphid vector, *Aphis craccivora.* The development of labor-saving devices to make farmers less dependent on hired labor for planting, weeding, and harvesting is urgently needed.

The actual economics of groundnut production needs detailed study. There is the need to study or diagnose the farmers' practices as a basis for research and development of new technological packages for their use.

There is a need to marshal the resources of national research institutes, Universities, and Polytechnics engaged in and interested in groundnut improvement to improve research effectiveness by pooling the available resources and to increase the interaction and communication among scientists through the exchange of information.

Concurrently, cooperative regional trials need to be encouraged through the establishment of a groundnut research network which should be multidisciplinary in outlook.

Groundnut in Senegal: Production, Related Operations and Research

A. N'Diaye[1]

Areas under Groundnut Cultivation, its Production and Yield

Approximately one million hectares are given over to oil-type groundnut in Senegal. From 1961 to 1983, more than a million hectares were under cultivation (with the exception of 1969) reaching a peak of 1 312 612 hectares in 1975.

From 1984 onwards, the area under cultivation started to decrease (594 388 ha in 1985). Groundnut production has varied from one year to the next, mostly due to rainfall conditions affecting oil-type groundnuts (record levels were reached in 1975 with 1 434 147 t).

Oil-type groundnut yield is in constant fluctuation. The highest yield was recorded in 1987 (1140 kg ha^{-1}) and the lowest recorded was in 1977 (440 kg ha^{-1}). For confectionery groundnut, the highest yield obtained was in 1987 (1175 kg ha^{-1}) and the lowest in 1979 (148 kg ha^{-1}). Groundnut is grown in Senegal in "Dior"-type soil (i.e. tropical, ferruginous, with little leaching).

Senegal has only one, usually short, rainy season, with dry spells.

In recent years, as in most other Sahelian countries, worsening rainfall patterns have caused a shift of isohyets from the North to the South and a shorter rainy season.

Varieties and Agricultural Practices

Oil-type groundnuts

55-437 : Originating from a breeding stock from the Bambey Agronomic Research Centre (CRA) from plant materials received from Hungary in 1955 which was probably originally South American; Spanish type, drought-resistant with a 90-day growth duration, resistant to *Aspergillus flavus.*

73-30: Progeny F_8 of a Spanish x Virginia cross obtained in 1973; Spanish type, 95-growth duration, dormant, drought- resistant, tolerates *A. flavus.*

73-33: Virginia type, 105-110 days, good drought-resistance, tolerates *A. flavus.*

57-422: CRA Bambey selection from a hybrid collection from the Tifton Station, Georgia; Virginia type, 105-110 days, drought-resistant.

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28-206: CRA Bambey selection from a collection from Bamako (Mali), Virginia type, 120-day cycle.

57-313: CRA Bambey selection from a collection from Burkina Faso in 1957, Virginia type, 125-days.

69-101: 28-206, rosette-resistant, CRA Bambey selection; Virginia type, 125-day cycle.

Confectionery groundnut

GH-119-20: Bred at the Tifton Station, Georgia, virgina type, 110 days.

756-A: Bred from a local plant population in south Senegal circa 1958; Virginia type, 125 days.

73-27: Progeny F_8 from 756-A x GH 119-20; Virginia type, 120-125 day growing period.

Agronomic practices

The usual practice is a biennial rotation of groundnut-cereals (most often millet). The farmer sows on the flat without any tillage. Fungicides are applied to the seedlings.

Row sowing and harvesting (lifting) as well as hoeing are now mechanized in the field. Usually small machinery is drawn by animals (donkeys or horses). In the central-southern regions and the south, cattle are sometimes used. The Super Eco sower is used for sowing; hoeing and weeding are done with the hand hoe or the western hoe. Arara, Firdou and handmade lifters are used in harvesting.

Mineral fertilization of groundnut crops is widespread, but since small amounts are applied, as in the last few years, there is no way of ensuring a balanced mineral supply.

Production Constraints: (Physical, Biological, etc)

- Lack of water is the most serious problem at the moment.
- Collar rot due to *Aspergillus niger,* damage caused by *Sclerotium rolfsii, Macrophomina phaseoli,* and leaf spot are widespread in Senegal. Contamination of the seed in the field and during storage is also of concern.
- The most common insects are: aphids, thrips, *Amsacta moloneyi,* termites or "Wangs" (Ligacidae).
- Nematodes can cause losses of up to 50%.
- Myriapodes or millipedes can also cause yield loss of 10 to 20%.

Utilization

The greater part of the produce is processed into oil. Oil-seed varieties 73-33 and

57-422 are also used for confectionery purposes. Confectionery groundnut is almost all exported.

Research Activities

Groundnut research is one of the longest-running agronomic research programs in Senegal because work dates back to the 1920s. It remains the program with the most scientists in the Directorate of Research on plant production.

Previous research

Research promoted the release of late spreading varieties to the north, central north and central regions: in 1935, release of varieties 29-24 and 2956; in 1936, varieties 29-70 and 30-86; in 1940, variety 31-33; and in 1958, variety 47-16.

For the south and south-east, an erect bunch-type groundnut was required which brought about the extension of 28-206, among others. In 1946, studies were initiated on the oil content and shell thickness. Fertilization testing started in 1956. With the widespread outbreak of rosette in 1952, a breeding program was started, stopped and resumed which finally resulted in the release of 69-101 to replace 28-206 in the southern region.

From 1957 onwards there were a series of outbreaks of leaf spot and rust.

In 1960, there was a requirement for a 90-day drought- resistant variety which led to the development of 55-437 in 1967. The requirement for an erect, 100- to 110-day, drought-resistant, dormant variety resulted in the release of 73-30 and 73-33 in 1978.

The selection for the central and northern-central areas was a 105-to 110-day, drought-resistant variety which led to the release of 57-422 in 1970. Work on aflatoxin started in 1973.

With the outbreak of rust in Sahelian countries in 1976, a breeding program for rust resistance was set up.

The market demand for confectionery groundnuts in 1977 was catered for by existing varieties (55-437, 73-33 and 57-422). In 1979, work was started on the oil composition and fatty acids.

Present research activities

We shall focus on the study into drought resistance. Fluctuating rainfall patterns have led ISRA to formulate a special drought resistance research program, which has two aspects:

- Shortening growing periods to less than 90 days by using Chico as parent material to induce earliness.
- Increasing innate drought resistance by appropriate trials carried out by physiologists on the varieties to be grown in the central region.

Agronomy

Research, resumed in 1985, aims at identifying techniques which can be extended and can provide better yields and a better return for the farmers.

Plant pathology and crop protection

Since leaf spot is the most serious foliar disease of groundnuts in Senegal at present, work is being done to screen varieties in use, or likely to be used, for effectiveness of fungicide treatment for leaf spot. Apart from pathology studies, work is directed towards various pests, nematodes and seed dressings.

Control of *A. flavus*

The main thrust of research is to develop cultural methods which minimize on-field contamination as well as to develop groundnut varieties which are resistant to the penetration of fungi into the seed in the field.

Technology

Action is being taken on the following fronts: technological screening, studies on treatment, packing and storage procedures; skinning; ready prepared seeds; electronic sorting, etc.

Future research

The main objectives are to breed plant material best adapted to climatic conditions (drought), to diseases (rust, leaf spot), *A.flavus* etc., and to diversify more towards confectionery groundnut in order to have more remunerative producer prices.

To protect the groundnut and its by-products, parasite distribution areas must be defined and effective and least costly pesticides to control them must be found; classification of plant material for tolerance to *A.flavus* should be undertaken; identification of the most susceptible and critical stages of plant growth be made; infestation sources should be studied and selected varieties should be tested in natural surroundings.

Groundnut Production in Chad

M. A. Djaya[1]

Groundnut covers 25,000 ha in the Sahelian region (rainfall of 300-600 mm) and production is estimated at 15 000 t. Farming is traditional (hoe).

In the Sudanian region (rainfall of 700-1000 mm), animal traction is used for cultivation. The area under cultivation is about 125 000 ha and production is estimated at 80 000 t.

The soil is, for the most part, hydromorphic having a layer of sand 5 to 20 cm deep on the surface, crop varieties are mostly local or lines introduced by non-governmental organizations.

Production Constraints

Production is limited by: drought (existing varieties are slightly resistant or not at all); disease problems; traditional methods of production; and problems with storage and marketing (lack of adequate infrastructure).

Research Activities

Until 1987 research was limited to studying varietal performance. The varieties studied are: De'li Rose, 55-437, and TS 32-1.

The aim is to develop groundnut varieties for areas which are unused, or no longer used, for cotton. Marketing groundnut and its by-products is ensured through the supply to the oil mill run by "Coton Tchad".

The Centre at Gasi will continue its variety trials, breeding, and the multiplication of seeds suitable for the Sahelian region.

To improve production, the Agronomic Research Bureau intends to: supply the farmer with improved, early high-yielding varieties which are stable and resistant to disease and insects; develop improved cropping methods for use by the smallholder; encourage production; and improve conservation techniques.

Agronomy and fertilizer trials are scheduled for the 1989/90 cropping seasons.

Training Requirements

There can be be no complete and effective program in Chad without qualified manpower to carry out trials.

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Chad requires: training in various disciplines or on specific subjects for national scientists who can then be assigned groundnut research; help in national breeding programs; exchange of information and expertise between researchers and experimental programs (need for cooperation).

Groundnut Research in Togo

S. Dogbe and Y. Atitso[1]

Togo has five agricultural regions: maritime region (6-7°N); plateau region (7-8°N); central region(8-9°N; Kara region (9-10°N); and the savannah region (10-11°N). Practically no groundnuts are grown in the maritime region.

Plateau Region

Rainfall is fairly evenly spread and the annual average is between 1300-2000 mm.

Groundnut is planted twice a year in the plateau region: the first covers April until the end of July and the second, mid-August through to November.

Groundnut is often grown as a sole crop, sown on the flat. Sometimes it is intercropped with maize, but at very low plant density.

Ridge planting is usual in areas with poor soil. Single superphosphate at the rate of 150 kg ha^{-1} is recommended as fertilizer. The average production during the last five years in this region has been 6 300 t with an average yield of 700 kg ha^{-1}.

The following crop varieties are usually grown: regional local variety, 61-24, and TS 32-1.

Central Region, Kara Region, and Savannah Region

These three regions have almost identical rainfall patterns, soil characteristics, and agronomic practices. The rainy season occurs from April to October, with the highest rainfall in July-August. Rainfall varies between 1200 and 1500 mm.

Groundnut is grown once a year in this region where it is planted on ridges as a sole crop. Average production during the last five years has been 21 642 t with a yield of 600 kg ha^{-1}. The crop varieties grown are the following: RMP 12, Georgia, the local regional, and TE 3.

Uses

Groundnut is used in Togo for: groundnut oil through home processing, paste, and grilled nuts. Since coming on stream the "Goutte d'Or du Togo" factory has aimed at processing on average 40 000 t of groundnut into refined oil per year, i.e. most of Togo's groundnut production.

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ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1990. Summary Proceedings of the First ICRISAT Regional Groundnut Meeting for West Africa, 13-16 Sep 1988, Niamey, Niger. Patancheru, A.P. 502 324, India: ICRISAT.

Research Work

Research has been *limited* to variety trials to select best local acceptable lines.

Experts at the agronomic research center are, at present, collecting all local cultivars. This will, undoubtedly, be the *first* step towards the setting up of a groundnut improvement *program.*

Special Contributions

The African Groundnut Council: Purpose and Achievements

B. Coulibaly[1]

AGC and the Groundnut Industry

The African Groundnut Council (AGC) is an African inter-governmental organization created in 1964 for economic and technical cooperation by six countries: the Gambia, Mali, Niger, Nigeria, Senegal, and Sudan. The organization's activities are totally funded by contributions by Member States who have assigned the following duties to the body: to establish a common front to protect groundnut and its by-products and to ensure remunerative prices for them on the international market; to promote the production and consumption of groundnut and its products; to promote the exchange of scientific and technical information relating to the research, production, marketing, and use of groundnut and its by-products; to establish permanent links between Member States with a view of creating a forum for concerted efforts to solve common socioeconomic problems of Member States; to promote solidarity among Member States especially those faced with natural or accidental handicaps in the groundnut sector.

Institutional Structures

The AGC established the following bodies which carry out its duties:

1. A Council of Ministers, the highest body, whose duty is to draw-up policies annually and decide adjustments to be made on the policies and guidelines of the organization. This council appoints the senior officers of the organization and approves the budget; 2. A Council of Representatives which sees to the smooth running of the organization, prepares, and implements the decisions to be taken. It supervises the execution of duties assigned by the Council of Ministers through three specialized committees (Finance and Administrative, Economic and Commercial, and Scientific and Technical). This is to ensure that in-depth studies are carried out on specific issues in the various sectors of interest to the organization. This body submits a draft program of action and a budget to the Council of Ministers; 3. A permanent Executive Secretary which is the organ that handles administration and manages the day-to-day affairs of the organization.

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Working Infrastructures

There are several installations in member States of the AGC which have been either wholly or partially financed by this organization:

1. There are six laboratories (one in each country) equipped and manned by staff trained by the organization to supervise and carry out quality control of groundnut and its by-products. These laboratories are also used as training centers; 2. There are two industrial detoxification factories (in Senegal and Sudan) for the large-scale purification of groundnut cake contaminated with aflatoxins, and a mobile aflatoxin supervision unit in the field based in Wad-Medani (Sudan) where results of research findings in the laboratories are put into practice; 3. National agricultural research stations, extension services (seed multiplication and storage centers, farms and pilot farms in member countries) serve as national facilities and/or support units that assist the implementation of the programs of the organization.

Research Activity

Two research projects exist: one on aflatoxins, and the other on a Regional Variety Trial. These projects are executed in collaboration with each member state and with the technical and/or financial assistance of national and international institutions (ICRISAT, IRHO, Georgia, USA, FOSFA, EEC, UNDP and FAO).

To encourage research, the necessary tools were procured and supplied. The AGC equipped and trained technical personnel for six laboratories to carry out research on the prevention of mycotoxin contamination.

The AGC awards a prize called "Council's Prize" to compensate in kind institutions and research workers who carry out research work on groundnut. The AGC in collaboration with the UNCTAD and FAO drew up 19 research development projects. The ARSO and Codex Alimentarus are collaborators for the setting up of the AGC standards for groundnut and its by-products.

Information, Training, and Extension

The AGC publishes a Groundnut Review, Groundnut Bulletin and a Groundnut Statistical Bulletin, and has organized three international symposia on groundnut: in Nigeria in 1973, in Senegal in 1976, and in Gambia in 1982. AGC organized sales promotion activities between 1977 and 1984 for groundnut and its products in Western Europe and Africa.

AGC organizes various forms of training for scientists and technicians through the award of scholarships and group training on the job and abroad. From 1977 to date, about 40 officers have benefited from this program.

Technical notes such as : the fight against *Aphis craccivora, Puccinia arachidis,* insecticides used on groundnuts, and pesticide residue in groundnut have been prepared and distributed.

Marketing

In this area, AGC standardizes the price and sales policies in member states through consultative meetings between marketing agencies, establishes a common sales front for member states in order to ensure remunerative prices for groundnut and its by-products on the international market, and searches for ways and means to develop speedy intra-African trade in groundnut and its by-products.

Recommendations

The AGC recommends:

1. The creation and running of a regional documentation centre for quick dissemination of information on groundnut; 2. Speedy dissemination of available research findings to producers and users of groundnut; 3. Development of well-adapted and high-yielding varieties with multipurpose functions; 4. The improvement of family farming, processing, storage, and handling facilities for groundnut and its products; and 5. The inclusion of groundnut into the group of crops under the controlled watering system.

Overview of Problems of Groundnut Production in Africa

L.J. Marenah[1]

Groundnut is an important crop in West Africa as both a food grain and oilseed legume. It is an important source of cash income to many small-scale farmers and is also a major foreign exchange earner for many West African countries. As an export crop, the groundnut has benefited from considerable agricultural research since the colonial period, but yields per hectare in the sub-region, of around 1 t in shell, are low. Thus, much remains to be done, in the generation and application of improved technologies, considering that groundnut yields are declining.

Groundnut Production in the Region

Groundnut production shows marked fluctuations and a downward trend in production. Wide fluctuations are likely to drive importing countries to look for substitutes if adequate supplies of groundnut or its products cannot be guaranteed.

Though important, drought is not the only factor responsible for reduced yields and production. The total area established under the crop, depending on seed supply, labor availability in the rural areas and farmers' switch to other food crops for economic reasons, is another important factor. There is evidence of severe outbreaks of aphids and rosette, as well as the spread of groundnut rust and various nematodes in the region. Moreover, in a number of countries shortages of inputs such as fertilizers, seed-dressing chemicals, and implements have increased, and the situation is worsened by poorer credit facilities, withdrawal of input subsidies, unremunerative producer prices and relaxation of extension supervision.

Short fallow periods or their virtual elimination have undoubtedly also contributed to the impoverishment of the soil through the depletion of soil nutrients and erosion and possibly the build-up of pests and diseases harmful to groundnuts.

Drought most severely reduces yield when it occurs during the critical stages of flowering, pod-formation, and filling. It is rare for a good year for groundnut production to follow a poor one in a given zone since both yield and quality of seed are poor in the drought year. Under poor rainfall conditions only mediocre seeds are produced which give rise to weak seedlings whose performance is poor even if environmental conditions are favorable. Furthermore, the uptake of calcium, which is important for proper kernel development, is restricted by drought.

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Control of Aflatoxin Contamination

Aflatoxins are toxic substances produced by the *Aspergillus flavus* group. Aflatoxin contamination poses a great threat to the groundnut industry. In recognition of this, FAO collaborated with member countries of the African Groundnut Council to control aflatoxin during the period 1980-86. Laboratories for aflatoxin analysis were set up in all member countries, nationals were trained in techniques of sampling and analysis for aflatoxin, and pilot plants were also set up for the chemical detoxification of groundnut cake.

The EEC has set very low acceptable levels of aflatoxins in groundnut and groundnut products. Meanwhile, the FAO Inter- governmental Group on Oilseeds, Oils and Fats is pursuing the establishment of internationally agreed limits for aflatoxin contamination which would be uniform and reasonable, together with recognized methods of sampling and analysis.

The adoption of improved cultural methods to avoid damage to pods combined with improved harvesting, rapid drying and storage of groundnut will help avoid or reduce aflatoxin contamination. The incorporation of resistance to *A. flavus* in acceptable commercial varieties would be a major breakthrough in the control of aflatoxin.

Saving Labor in Production

Many small-scale farmers regard the groundnut as a very labor- intensive and high risk crop. The high labor input into weeding, harvesting, drying, threshing, and shelling makes the crop economically unattractive to the younger generation of farmers.

The development and extended use of simple implements suitable for small-scale farmers, to alleviate hard manual work for some operations are desirable. Farm mechanization limited to plowing creates bottlenecks in timely weeding and harvesting. The use of a combined fertilizer distributor and seed drill to improve plant stand and the efficiency of small quantities of fertilizer is strongly recommended in the groundnut-growing areas of West Africa. Wherever economical and practical, suitable chemical weed control may be preferred to interrow cultivation.

Improving Cropping Systems

Production packages developed by research for high productivity include: selected varieties, the use of seed dressing, early sowing, high planting density, fertilizers, and proper weed control.

Varieties

There is a continuing need for the extended use of adapted varieties aided by effective seed programs. In many countries, procedures for the maintenance of varieties are lacking. Most cultivars lack specific genetic resistance to diseases and insect pests.

Plant breeding has a major role to play in the development of low- cost technologies. Priority attention should be paid to drought tolerance and short-cycle varieties and resistance to important diseases such as leaf spots and rust, and aflatoxin contamination. In view of the susceptibility of groundnut to certain soil-borne pests and diseases which are common to a number of crops, a cost-effective integrated pest management system is desirable. Such a system involves rotations, improved cultural practices including field sanitation, resistant cultivars, and the possible use of biological control.

Fertilization

Groundnut requires considerable amounts of nutrients for high yields. For every tonne of unshelled nuts and two tonnes of hay removed by a groundnut crop about 63 kg of N, 11 kg P_2O_5, 46 kg K_2O, 27 kg CaO, and 14 kg MgO are removed. In West Africa, the main fertilizers applied contain phosphorus, calcium, and sulfur. Groundnut is, therefore, an extremely soil exhausting crop. Yet its response to fertilizers is very erratic. Green manures have been found largely ineffective in increasing yields. Supplying adequate nutrients for rotation through fertilization of other crops is more effective than direct fertilization of groundnut. This highlights the additional importance of suitable fertility in the overall attempt to maintain soil fertility and crop yields. In West Africa, cotton and upland cereals are good preceding crops for groundnut, provided they are well-fertilized.

Mixed cropping

Mixed cropping of cereals and groundnut is a widespread practice. This traditional cropping system has many advantages including insurance against crop failures, higher output and returns, more efficient utilization of a limited water supply; better control of weeds and erosion; often the provision of a highly balanced diet and possibly reduced crop damage by pests. In spite of these advantages, studies on mixed cropping in the region to see how improved varieties and production technologies increase productivity in the system have been rather limited.

Mixed cropping has certain disadvantages, but so long as the hoe is the main agricultural implement, the introduction of rotational systems of agriculture based on pure stands may be difficult. It will be most useful for West African countries to share their research experience on mixed cropping.

Inter-Country Cooperation

West Africa has scarce trained manpower, financial, and material resources for research, development, and training. It makes sense economically to pool the available resources to solve common technical problems on a priority basis. The dissemination of information and transfer of technologies will be important components of any cooperative effort.

FAO, as a priority policy, has always promoted Cooperative Projects in Research and Development and this is well demonstrated in its practical support to various intergovernmental organizations in West Africa, including river basin development and regional pest-control organizations.

A cost-effective mechanism has to be found for promoting and coordinating cooperation among national programs on the basis of each participating country being actively involved in policy-making, planning and execution of projects, and collective self-reliance.

The success of research networks to generate a critical mass of scientific capacity largely depends on a clear perception of the problems, an understanding of the means to solve them, a concentration of efforts over a reasonable period, external funding, the organization of multilocational testing, and provision of a forum for exchange of ideas.

The Peanut Collaborative Research Support Program: a Global Perspective

D.G. Cummins[1]

Groundnut is grown in most tropical, subtropical, and temperate countries between 40° N and 40° S. Estimated production is about 18 million tonnes on 18 million hectares. More than half the production is in developing countries, and yields are erratic and often much lower than the world average.

The US Congress provided funds to assist in solving food-production problems in low-income countries through the "Title XII Famine Prevention and Freedom from Hunger" under the "International Development and Food Assistance Act of 1975". Part of this effort was implemented through the Collaborative Research Support Program (CRSP) to link US and host-country research institutions in a mutually supportive mode to solve food production and utilization problems. These institutions also share the costs of research efforts.

Groundnut received high priority from the US Agency for International Development (USAID) for funding under the CRSP because of its importance as a food in developing countries and because of the many constraints to a fuller utilization of its potential as a food crop. The Peanut CRSP was funded in July 1982 and is presently funded through June 1990.

Features of the Peanut CRSP

Goal

To develop a groundnut research base in both the US and host countries that can relieve the constraints to groundnut production and utilization and improve the availability and consumption of food, increase incomes, and maintain and enhance the natural resource base.

General objective

In a mutually beneficial way, to enhance host-country and US research programs through : an increased focus on development of cultivars, management practices, and utilization processes that would lower costs and enhance groundnut use as a food source; support of programs in terms of equipment, supplies, travel, and personnel; offering short-term and degree-oriented programs for host-country staff at US institu-

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tions and degree training for US students to orient them toward problems facing developing countries; and providing on-site consultations in the host countries by US scientists.

Global perspective

Collaboration was developed with countries in three major regions: Semi-Arid Tropical Africa, Southeast Asia, and the Caribbean.

Specific host countries include Antigua, Belize, Burkina Faso, Jamaica, Mali, Niger, Nigeria, Philippines, Senegal, Thailand, and Trinidad. Linkages would be sought to extend research results to non-host countries.

Collaborating US institutions are Alabama A&M University, University of Georgia, North Carolina State University, and Texas A&M University.

Constraint alleviation

The Peanut CRSP was designed around primary constraints, each addressing specific technological needs in developing countries. Research projects and objectives (in both host countries and the US) were aimed at these needs. Benefits also accrue to the US due to the collaborative nature of the research. Constraints are: low yielding cultivars, mycotoxin hazards to health, pest damage to crops, inadequate food supplies and soil microbiological barriers.

Resource management

The CRSP participants interact collaboratively to: emphasize coordination, communication, and resource utilization to assure adequate program linkage, complementarity of research, and efficient utilization of physical and human resources. The program provides scientist interaction through an annual average of about 1.25 man-years of senior US scientist time spent with collaborators at host country sites and some 15 host country scientists visiting US locations annually (about 75 over the life of program); graduate-level degree training for host-country students at US universities (about 25 over the life of program) and in addition some 34 US students received support for graduate programs. Program focus and maximum utilization of resources is ensured with the guidance of a Technical Committee, Board of Directors, Management Entity, External Evaluation Panel, and USAID Project Management, and coordination with ICRISAT programs.

Technology transfer

Dissemination of research information is done through publications and workshops and interaction of scientists with extension counterparts in their respective countries. Program impact is accelerating with the release of superior cultivars, improved cultural and pest-management practices, and better methods for harvesting, handling, storage, processing, and utilization with primary focus on groundnut as a food source.

The CRSP Groundnut Breeding Assistance Program in West Africa

O.D. Smith and G.B. Parker[1]

Increased food production through the development and culture of improved, dependable groundnut cultivars is the goal of the USAID-funded collaborative research effort of the Texas A&M University System (TAMU), the Institut Senegalais de recherches agricoles (ISRA), the Universite de Ouagadougou Institut superieur polytechnique (UOISP), and the Institut national de recherches agronomiques du Niger (INRAN). Collaboration is a key to the success of the program. All participants in the host countries are provided by host-country research units. Encouragement, consultation, and training are important components of the program.

Disease resistance, drought escape and tolerance, and improved yield are the goals of this collaborative program. The goals are being addressed through enhancement of on-going variety development efforts, acquisition and exchange of germplasm, and hybridization and preselection of potentially useful new genetic combinations for reselection in the Collaborative Research Support Program (CRSP) or the host country programs. More than 200 select germplasm lines have been introduced from Texas into the Senegal program for evaluation and selection. In general, the introductions have been equal or inferior in yield performance to the best local cultivars and germplasm. Three breeding lines derived from germplasm in the ISRA program have been selected for multilocation trials of adaptation and acceptability.

Cultivars and breeding lines from the host countries and ICRISAT have been evaluated in Texas for their performance and as an aid in preselection.

Approximately 180 advanced breeding lines and cultivars have been introduced into the testing programs of the UOISP and INRAN. These were derived from US research programs, ICRISAT, and other sources. Three years of multilocation trials have been conducted in Burkina Faso on selected entries. Obvious regional differences in performance were found among entries. Rosette virus and/or rust were important constraints to production in the high-rainfall zone of southern Burkina Faso. Select US introductions have averaged higher in yield than the local check in tests at Tenkodogo, Gampela, and Saria. Yield increases were also recorded for ICRISAT lines included in the tests. Production stability, culture, and local acceptability of these cultivars and lines must be ascertained.

Disease reactions at Yoakum, Texas on several Texas breeding lines and recent collections from South America have been confirmed in Southwest Burkina Faso. Leaf spot disease scores have been no better on the introductions than for RMP 12. Some Texas and South American lines have scored well for rust at Niangoloko.

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Earliness is a primary need at Maradi and other sub-Sahelian locations. Intercrosses have been made among five early germplasm lines (Chico, Tx AG-1, T x AG-2, Tx 851986, and 55-437), and preselection for short duration, phenotypically acceptable lines is being effected. Evaluation in Africa of lines selected through four segregating generations in Texas should begin next year.

Effect of Harvest Date and Termite-Resistant Varieties on Termite and Millipede Damage to Groundnut in Burkina Faso

R.E. Lynch[1], A.P. Ouedraogo, and S.A. Some[2]

In SAT Africa, the groundnut aphid *(Aphis craccivora),* jassids *(Empoasca dolichi* and *E. facialis),* armyworm *(Spodoptera littoralis* (Boisduval)), the groundnut hopper *(Hilda patruelis),* termite *(Microtermes thoracalis),* millipedes *(Peridontopyge* spp.), the groundnut bruchid *(Caryedon serratus* (01.)), and the "Wang" *(Aphanus* (or *Elasmolomus) sorditus* (F.)) are considered major pests of groundnut. Termites, millipedes, thrips, and jassids are potential economic pests in Burkina Faso. Of these, termites are the most serious since they not only reduce groundnut yield but also enhance *Aspergillus flavus* infection. Two types of damage to groundnut by termites have been described, invasion of the tap root and pod scarification. Greater yield loss is attributed to damage by tap root invasion. In turn, tap root invasion results in a linear relationship with yield loss. Pod scarification is also accentuated by late harvesting and irregular maturity. Termite damage to groundnut is greater in periods of inadequate rainfall during the latter portion of the growing season. The major significance of pod scarification and penetration by termites is the enhanced entry and growth of *A. flavus.*

Millipedes attack both seedlings and developing pods. Of the 13 species of millipedes reported to attack groundnut, members of the genus *Peridontopyge* appear to be most important. Yield losses of 10-35% have been reported for millipede damage.

Resistance to termite damage in groundnut has been reported. Field resistance to *A. flavus* invasion and aflatoxin formation has also been recently discovered. Although none of the cultivars evaluated for *A. flavus* invasion were immune, J 11 had both resistances to termite damage and aflatoxin formation.

The research reported in this summary was conducted to evaluate the effects of harvest date on millipede and termite damage to groundnut, *A. flavus and* aflatoxin contamination of kernels, and to screen groundnut cultivars for resistance to termite damage.

Materials and Methods

All research was conducted at the Gampela Research Station in Burkina Faso during 1986 and 1987. Treatments were: (1) groundnut lifted at 70 days after planting (DAP), (2) at 90 DAP, (3) at 110 DAP, (4) at 125 DAP, and (5) with 5.6 kg ha^{-1} aldicarb at

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planting, 7.5 kg ha^{-1} chlorpyrifos at pegging, and 7.5 kg ha^{-1} chlorpyrifos 50 days after pegging for insect control, and lifted at 100 days.

The number of plants killed by termite damage or millipede damage during the growing season, and the number of plants at harvest were recorded. On each harvest date, the number of undamaged, termite-scarified, and termite-penetrated pods were recorded. The percentage of pods with *A. flavus* and *A. niger* was recorded and the aflatoxin content in kernels determined.

Ten cultivars with moderate to high levels of resistance to termites, two susceptible cultivars, and two local varieties were evaluated for their performance against termite infestation in Burkina Faso. Plots were harvested at 100 (normal harvest) and 125 (delayed harvest) days after sowing.

Results and Discussion

In 1986, millipede damage was significantly greater in plants harvested at 70 and 90 days than for plants harvested at 125 days.

Termite damage to plants and pods was very low through 110 days. However by 125 days, termite damage to plants and termite-scarified and penetrated pods had increased substantially (40% or over in all cases). Pod yield in 1986 was significantly heavier for the control, where insecticides were applied to reduce insect damage, than yields from all other harvest dates. Yields increased with longer growing time.

In 1987 the number of plants per plot decreased with the length of the growing period, probably reflecting millipede and/or termite damage. Damage to plants in the control plots was very slight.

Plants harvested before 110 days showed negligible damage; but those harvested at 110 days (3.8%) and 125 days (17.6%) had increased damage. Similar trends were recorded for termite-damaged pods, with the 125-day harvest having 60% damaged pods and 45% scarified pods. As in 1986, yields were heavier for the insecticide-treated control, and increased with time up 110 days for the other treatments. This year the 125 day harvest, although having similar damage to the 1986 season, decreased by 25% compared to the 110-day harvest.

Pod scarification and penetration by termites were enhanced by late harvest, and pod damage was greater on plants where the tap root had been invaded and the plants killed by termites. Inadequate rainfall during the period from 100 to 125 days also favored increased termite damage, especially pod damage.

Delayed harvest also enhanced *A. flavus* invasion of groundnut pods and kernels. Similarly, kernels from the delayed (125-day) harvest had significantly more aflatoxin in both years than kernels from the other treatments.

In the evaluation of groundnut cultivars for resistance to millipedes and termites, millipede damage was significantly greater on QH 243. The lowest millipede damage was recorded for NC Ac 2142 and NC Ac 2243. NC Ac 2142 and Robut 33-1 also sustained significantly more termite damage than several other varieties. No termite damage to plants was noted on Robut 33-1, NC Ac 343, Nc Ac 2240, NC Ac 2242, NC Ac 2243, and NC Ac 10033 for the normal harvest. The entries RMP 40, NC Ac 2240, NC Ac 2243, NC Ac 343, and Bonga, a local cultivar, showed least termite damage to plants and pods while, with the exception of NC Ac 2243, maintaining acceptable yields.

In conclusion, termite damage to groundnut and associated aflatoxin contamination of kernels are among the most serious latter part of the growing season. In Burkina Faso, both the beginning and end of the rainy season pose problems for crop production. If rains are delayed at the beginning of the rainy period, groundnut may not have time to mature, and kernels in immature pods are more susceptible to *A. flavus* invasion and aflatoxin contamination during drought at the latter part of the growing season. Similarly, erratic rainfall during the latter part of the growing season increases the probability of termite damage to groundnut plants and pods, and *A. flavus* invasion and aflatoxin contamination. Research on the relationship of groundnut harvest date, termite damage, *A. flavus* invasion of pods, aflatoxin formation in kernels, and evaluation for termite resistance in cultivars offers potential for greatly reducing this problem in West Africa. Cooperative research among scientists at the University of Ouagadougou, ICRISAT and the USDA-ARS, University of Georgia, on these problems is continuing.

The Current Status of Research on Groundnut Rosette Virus Disease in Nigeria[1]

O.A. Ansa, S.M. Misari[2], C.W. Kuhn, J.W. Demski[3], E. Breyel, and R. Casper[4]

Groundnut rosette is the most important virus disease of the crop in Nigeria. Initial reports ascribed the causal agent to a virus transmitted by A *craccivora* (Koch). It was further shown that the disease consists of a symptom-inducing virus and a symptomless assistor virus. Recent investigations have shown that the symptom-inducing virus was an infective single-stranded RNA with an apparent molecular weight of c 1.55×10^6. The assistor virus was reported to be a luteo virus which could be detected by enzyme-linked imunosorbent assay (ELISA) with antisera against other luteo viruses.

In Nigeria, groundnut rosette virus disease manifests itself in two distinct types of symptoms—chlorotic and the green rosette. Both types appear to be caused by the complex of a mechanically transmissible groundnut rosette virus (GRV) which in nature depends on the groundnut rosette assistor virus (GRAV) for natural spread by the vector aphid. Most of our research has been done using the green rosette variant of the disease.

Peanut CRSP research in Nigeria has been a team effort involving the Institute for Agricultural Research (IAR) at Zaria, Nigeria, the University of Georgia, the Institute for Viruskrankheiten der Pflanzen, Braunschweig, West Germany, and ICRISAT Center. The present report highlights our research efforts with GRAV, some of its properties, its purifications, and greenhouse procedure for screening groundnut lines against GRV.

Groundnut Rosette Assistor Virus

Transmission and detection of GRAV. GRAV was transmitted from groundnut plants infected with both the assistor virus and the symptom inducing agent (SIA), using adults of *Aphis craccivora.* Since the assistor virus shows no symptoms in groundnut plants, its presence was detected by ELISA. Infected groundnut plants gave scores above 1.0 in ELISA. Mechanical transmission did not yield any levels of luteo from these doubly-infected plants.

Host-range and symptomatology. A total of 24 plant species were tested in a host-range study. GRAV did not produce any symptoms in other plants that were tested.

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Apart from groundnut, *Dolichos lab-lab* cv "Highworth" and *Phaseolus aureus* gave low titers of GARV. A total of 24 cultivars of *Vigna unguiculata* were also tested and low levels of the virus were detected in some of these. No species outside the Leguminoseae had detectable levels of the virus. Methods of purification of GRAV have been developed.

Purification of GRAV. Purification was done by grinding green rosette infected tissue in 0.5M PO_4 buffer pH 6.0 containing 0.1M glycine and 0.20% mercaptoethanol. The homogenate was filtered and the filtrate was subjected to low speed contrifugation. The resulting pellet was combined with the fibers from filtration of the homogenate overnight at 37°C in the initial grinding buffer containing 0.5% NaN_3 and 2% Driselase after further homogenization.

The mixture was reground after the overnight incubation then filtered and the filtrate was clarified with 33% chloroform. The virus was obtained by subjecting the aqueous phase from the chloroform clarification to two cycles of differential centrifugation. Resuspended crude virus was further purified in 10-40% sucrose gradient. The gradient was fractionated using an ISCO-UA5 fractionator. An ISCO peak in the gradient tube coincided with the largest concentration of 28-30nm particles as seen in the E.M. It also gave the highest ELISA scores among the gradient fractions.

Greenhouse Screening for Rosette Resistance

Previous work on screening for resistance at the IAR was based on field screening of varieties. A greenhouse-screening procedure based on the SIA alone has now been developed. To be able to infect a high percentage of susceptible test plants a SIA culture was first established and then used to test a number of groundnut lines for resistance to the rosette disease. A total of 20 lines were tested against mechanical infection with green rosette. The varieties with the highest levels of resistance were RG 1, MDR8-15, MDR8-19, M354.81, M590.80I, RMP12, and M343.81. Susceptibility to rosette was also detected by monitoring the presence of a 900 base pair double-stranded RNA that was commonly found in infected tissue.

Aphid Transmission Studies

Transmission studies show that cowpea aphids could acquire the groundnut green within 4 h and the chlorotic rosette virus within 8 h. They could retain inoculativity and infectivity for 14 days with an average retention time of 6.6-6.9 days. Transmission efficiency increased with an increase in number of infectious aphids. Chlorotic rosette was the more easily transmitted of the two strains. Transmission attempts using other aphid species were not successful.

Incidence of Cowpea Mild Mottle Virus (CMMV) in Groundnut

The incidence of CMMV in both field-grown and greenhouse groundnut plants was monitored by ELISA. Typical symptoms were a curling of leaves, systemic leaf chlorosis, and stunting. Symptoms were markedly different from rosette symptoms. A field survey showed that CMMV infections was more likely to occur in plants infected with chlorotic rosette. In purification procedures, leaf samples from the field yielded some rod-shaped particles in addition to spherical particles of GRAV. These rod-shaped particles were shown by ISEM to be particles of CMMV.

"Groundnut Little Leaf" Disease

The disease is characterized by extreme stunting of the plant. The leaves are reduced in size and cupped upward with extremely short internodes. Very low incidence of little leaf was observed on groundnut during the 1986 and 1987 crop seasons. Genotypes such as M 1204-78I which are susceptible to rosette are also highly susceptible to little leaf. Interestingly, rosette-resistant genotypes such as RMP 12 are also resistant to little leaf. It appears that the disease is more associated with green rosette than chlorotic rosette. More efforts are in progress to determine its etiology, transmission, incidence, and relationship with rosette.

Single and Double Infections by GRV and GRAV

Experiments were conducted to determine the effects on growth and yield of rosette susceptible lines when each component of the disease acted alone or in combination with it in the disease complex. Preliminary results indicate that GRAV acting alone shows no symptoms in groundnut plants and there appears to be no significant difference between plants carrying GRAV alone and non-infected plants. The results also indicate that the loss in yield of groundnut may not be due mainly to the effect of GRV acting alone. GRAV appears to act in a synergistic manner with GRV to produce the dramatic losses in yield experienced from the rosette disease.

Future goals

Future research will focus on: production of antiserum specific for the GRAV; isolation and characterization of the components of the little leaf disease; isolation and characterization of the single-stranded and double-stranded nucleic acids associated with the disease; studies on resistance of groundnut lines to GRV and GRAV; and determination of the relationship between chlorotic and green rosette.

Research on Quality, Postharvest Handling, and Processing Aspects of Groundnut in SAT Africa

Bharat Singh[1]

Based on opinion surveys of scientists from groundnut-producing countries, the Peanut CRSP recognized 13 potential constraints to groundnut production and utilization. A project was designed to address the constraints which limit the maximum utilization of groundnut for human consumption in the Semi-Arid Tropics (SAT) Africa. In the first 5-year period of the project, data were collected to determine variations in environment, socioeconomics and food technologies as they constrain the preservation and utilization of groundnut and groundnut products in Sudan, one of the major groundnut-producing countries in SAT Africa.

On the basis of consumption and postharvest surveys in three regions of Sudan, it was recognized that groundnut utilization could be considerably increased if efforts were made (1) to increase utilization of groundnut into more refined/processed forms, (2) to improve packaging of groundnut and groundnut products to increase shelf-life, (3) to utilize flour (after extraction of oil), to increase protein content of cereal-based foods, and (4) to improve the method of storage, postharvest handling and inventory management. Recent observations made in other SAT countries including Burkina Faso, Senegal, Niger, and Mali indicate the existence of similar constraints in groundnut utilization. It has been commonly observed that the most utilized form of groundnut in the SAT region is roasted groundnut followed by groundnut paste, groundnut oil, raw, and boiled groundnut. Studies have been completed on possible methods of improvement of roasting groundnut using ceramic beads rather than sand; the improvement of shelf-life of roasted groundnut by water-and steam-blanching; an improved method of using groundnut paste flour to increase protein in a sorghum-based product ("Kisra"), wheat-based bread and cookies, cassava-based flour "gari", and utilization of groundnut milk to prepare a fermented concentrated yoghourt-like product ("mish"). Recently, a memorandum of understanding has been signed between Alabama A&M University and the University of Ouagadougou, to conduct research on quality, storage, and processing of groundnut in Burkina Faso.

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Detection and Detoxification of Aflatoxin-Contaminated Groundnut Products in West Africa[1]

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The Peanut Collaborative Research Support Program (CRSP) research project "Mycotoxin management in groundnut by prevention of contamination and monitoring" in Senegal and Texas aims to: (1) reduce mycotoxin contamination by prevention through the selection of groundnut cultivars with tolerance to invasion by the aflatoxin-producing fungi *Aspergillus flavus* and *Aspergillus parasiticus;* (2) develop mycotoxin-detection procedures that are rapid, sensitive, user-friendly, economical, chemically stable, and can be used to identify mixtures of mycotoxins; and (3) discover techniques for the detoxification of aflatoxin-contaminated groundnut products.

Progress related to the first objective was summarized at the Aflatoxin Workshop conducted at ICRISAT Center, Patancheru, Andhra Pradesh, India, in October 1987. Progress related to the later two objectives will be discussed in this meeting.

A newly developed mycotoxin detection procedure, termed "Selectively Absorbed Mycotoxins (SAM)", has been developed. It is a modification of the Holiday-Velasco Minicolumn procedure for aflatoxin screening. With the SAM assay procedure, mycotoxins are extracted into a methanol-water solvent. Toluene is mixed with the extract to form a two-phase solution where aflatoxins and zearalenone partition into the upper toluene phase, thus separating them from potential interfering compounds. The toluene sample is passed through a SAM- Aflatoxin Zearalenone (SAM-AZ) tube which removes other interfering compounds in a pre-absorption layer, and selectively absorbs any aflatoxin and/or zearalenone at specific bands in the tip of the tube. Each positive band glows with an obvious blue color under long wave ultraviolet light. The sensitivity of the assay is designed to provide a YES/NO screen at designated levels of aflatoxin and zearalenone.

Detoxification of aflatoxin-contaminated groundnut products has been accomplished by the addition of a high-affinity sorbent (hydrated sodium calcium aluminosilicate) when added at 0.5% by weight. Aluminas, silicas, and aluminosilicates were evaluated for their ability to absorb aflatoxin form groundnut oil and aqueous solution. Sorbents such as boehmite alumina, synthetic xeolite and muscovite silica sorbed less than 50% of the aflatoxin present. Novo Sil (hydrated sodium calcium aluminosilicate, HSCAS), Pyran RG140 pyrophyllite, and Filtrol (acid-activated bleaching earth), sorbed 85% or more of the aflatoxin. When HSCAS was added to chicken feed containing 7.5 mg aflatoxin, the toxicity was reduced so that broiler and leghorn chicks

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appeared normal in their growth pattern and their livers were normal. Chicks fed aflatoxin-contaminated feed without HSCAS exhibited significant growth inhibition and their livers were friable and pale.

The safety and effectiveness of the detoxification procedure was also measured with the Ames Assay. The bacteria *(Salmonella* sp.) tester strain TA 90 was tested for its histidine requirement as evidenced by the mutation rate. When Novo Sil (HSCAS) was added to aflatoxin-contaminated solutions bacterial mutagenic effect was significantly reduced.

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Nematological Diseases of Groundnut in West Africa

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More than fifty different species of nematodes have been identified in the rhizospheres of the groundnut in West Africa. Identification has been carried out mostly through studies by the Institut francais de recherches scientifiques pour le developpement en cooperation (ORSTOM).

With the exception of three species, no readily available data exists on the harmfulness of these nematodes to the groundnut.

Major Nematodes of West African Groundnut

Aphelenchoides arachidis in Nigeria

Bos (1977) describes this nematode and its effect on the groundnut in the Samaru region in north Nigeria. The nematode is ubiquitous in Nigeria. It has also been found in the roots of maize, millet, sorghum, sugarcane, rice and certain wild grasses.

The nematode, an endoparasite, is found in the pod, in the seed coat, in the roots and the hypocotyledon. Crop loss is mainly due to deformation and discoloration of the seed. There is no variation in yield.

The nematode seems to make the plant susceptible to the effects of fungi such as *Rhizoctonia solani, Sclerotium rolfsii, Macrophomina phaseoli,* and *Fusarium* spp because of delayed emergence.

Aphelenchoides arachidis would seem to be, from the economic point of view, a minor parasite, mostly because it is not widespread. It is a parasite that is potentially dangerous to all groundnut-producing regions.

Pest control techniques are based on the application of hot water (5 min at 60°C) to groundnuts after pre-soaking them for 15 min in cold water. Sun-drying the harvest in areas of low humidity such as the north of Nigeria can serve to control infestation by nematodes. In the south, however, this practice is not adequate as a control method.

Aphasmatylenchus straturatus in Burkina Faso

This nematode was identified in the south-west of Burkina Faso around the village of Niangoloko.

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It causes chlorosis of the groundnut: stunted growth, an under-developed root system with only a few bacterial nodules, yellow or pale green leaves where only the primary and secondary veins stay green.

Aphasmatylenchus straturatus seems to act like a migratory endoparasite. Field observations show that the nematode remains in the sheanut tree *(Butyrospermum parkii)* roots during the dry season about 40-60 cm deep. At the beginning of the rainy season, the nematode leaves its host's roots so as to penetrate the roots of the groundnut. 100-110 days after planting, the nematode leaves the roots of the groundnut to return to the sheanut roots.

Nematode-infested areas rose from 4% in 1971 to 25% in 1974. The speed and spread of the infestation, which is geometric in its progression, is of real danger for all legumes in Burkina Faso. Loss in yield is estimated at 30-70% for groundnut alone.

Nematode infestation is controlled by treatment with DBCP at planting time.

Scutellonema cavenessi in Senegal

Found in Nigeria, this nematode was subsequently identified in Senegal and Mali as affecting most crops.

On-farm trials show that, at the end of the rainy season, the soil dries out gradually until it reaches a moisture level lower than 1%. Situated in the upper layers of the soil (at 0-25cm), the nematode dehydrates gradually until it reaches anhydrobiosis and can survive until the next rainy season.

Since infestation by this nematode is spread evenly throughout the groundnut-growing areas of Senegal, it is impossible to assess its economic impact. However, it is worth mentioning that chemical pest control in the last few years in farmer's fields has achieved significant increases in groundnut yields: 20 to 220% for pods, 40-270% for haulms.

Use of Bromide Fumigant Nematicides in Senegal

DBCP and EDB are used in doses of 20 kg ha^{-1} of active ingredient diluted with water in doses of 100 L ha^{-1}. Injection is carried out using a device with a coulter and a peristaltic pump, drawn by donkey or a horse, which sprays a continuous application of nematicide to the soil. The cost of the product is CFA 35 000 ha^{-1}.

Direct and after-effects of DBCP and EDB

Use of these nematicides causes: the decrease (even eradication) of all plant nematode species; increase in pod yield and haulm yield in the groundnut; increase in the number and weight of the bacterial nodules on the roots of the groundnut; increased atmospheric nitrogen fixation; increase in infection by endo-mycorrhiza; and the increase in nitrogen and phosporus levels in the plant. After-effects are seen in rotation crops (groundnuts, millet, cowpeas, sorghum) for at least five years after the first treatment.

Fungal Diseases of Groundnut in Cote d'Ivoire: Present Situation and Outlook

S. Savary[1]

A number of diseases affect groundnut crops in Cote d'Ivoire, with fungal disease at the forefront, as much for the sheer number of pathogens as for the loss it causes. Amongst these diseases, rust *(Puccinia arachidis Speg.)* is particularly harmful. The outbreak of the disease in Africa is, in fact, quite recent, and can be perceived as an effect of a pandemic which has swept through the Tropics. To have a quantitative and prospective analysis of the impact of this new disease, the approach used has combined field trials, laboratory tests, surveys, and computer models.

Survey on Groundnut Diseases

The survey was carried out during three successive years (1983-1985) in Cote d'Ivoire with the following objectives:

- to describe cropping methods, climatic conditions and the severity of the major diseases;
- to correlate disease levels with cultivation and climatic conditions;
- to compare results obtained to those from epidemiological experiments on groundnut rust;
- to analyze future prospects of the risks of this disease in conjunction with other cultivation constraints in the light of agricultural intensification.

Amongst plant pathogenic fungi catalogued, six were frequently found in all regions of the Cote d'Ivoire, and estimates of the impact of the severity of disease were made; the six under study were rust *(P. arachidis),* leaf spots *(Phaeoisariopsis personata* Berk. & Curt.) von Arx = *Cercosporidium personatum* (Berk. & Curt.) Deighton) and *(Cercospora arachidicola* Hori), wilts *(Aspergillus niger V.* Tieg., *Botryodiplodia* sp., *Sclerotium rolfsii,* Sacc,).

Estimated Crop Loss from Rust

A series of experiments were carried out in which the different levels of rust and leaf spot were tested using different fungicide treatments. With yields of approximately

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1700 kg ha^{-1}, losses of up to 70% were recorded, caused either by rust, or by leaf spots or a combination of both. Results obtained show higher losses in proportion to severity of rust infection than of that with leaf spots.

Results illustrate potential yield loss caused by these two diseases. Tests were complemented by on-farm trials in villages which again demonstrated the relationship between the level of intense farming and the risk to plant health that these two diseases represent.

Experimental Studies on the Epidemiology of Groundnut Rust

Rust epidemics take the form of successive uredial cycles, which comprise several stages: the survival of dispersed spores, germination, infection, latency, sporulation during the infectious period, release of spores, and their transportation. Each of these stages and their features were analyzed then put together in a model simulating the dynamics of a rust epidemic.

The release of *P. arachidis* spores was studied during experiments under artificial conditions. Results show that light rain tends to disperse rust, whereas heavy and prolonged rainfall probably has a seriously damaging effect.

There is only circumstantial evidence to prove how groundnut rust disperses at the macro level. Data obtained from on-farm trials show that very serious outbreaks occur in regions where groundnut is not widely grown but is present throughout the year (in the south), or in regions where its cultivation is common and regular (in the north of Cote d'Ivoire). In the south, rust epidemics break out suddenly. The endemic nature of groundnut rust can be attributed to the presence of infected regrowths, and the continuous cultivation of groundnut in these regions. In the north, fairly widespread epidemics occur every year, starting at varied times in the growing period, which could be mainly due to the fact that the source of the inoculant is infected crops in the South.

Groundnut Leaf Diseases in Relation to Rust

Analysis of the survey data can be put in a general, simplified schematic form showing the epidemiology of groundnut rust which can be compared with data on leaf spot. As far as climatic variables go, the worst outbreaks of rust are associated with optimum temperature and rainfall conditions, which confirms experiment findings. This is also true for *C. personatum,* the only difference being the greater flexibility in the needs of this parasite.

A comparative analysis between cropping conditions and plant growth and the degree of severity of leaf disease indicates that, generally speaking, rust thrives in young, sturdy plants rather than in senescent plants or those under stress. This analysis shows the close and positive link between relative growth of the plant and the severity of rust infection. In comparison, high levels of leaf spot due to *C. arachidicola* are found in crops whose growth is stunted by multiple stress, and the presence of weeds appears to play a major role.

Conclusion

P. arachidis can be considered as a new component in a multiple pathosystem, in which leaf parasites, in particular leaf spots, play a predominant role. Despite the great diversity of environment with which it has to deal, the rust parasite has, very quickly, caused losses with considerable economic consequences. Now intensification of groundnut cropping, as scheduled by the authorities in many regions in West Africa, may lead to an increase in the inherent risk of infection by this multiple pathosystem, and one of its components, i.e. rust, may play a significant role in it.

Franco-African Groundnut Research Network

R. Schilling[1]

The Chairman of the Follow-up Committee of the Conference of African and French Agricultural Research Experts (CORAF) defined the main aims of research networks on maize, rice, groundnut, cassava, and drought resistance, in a circular sent to international agricultural research centers (Jul 1987):

"After a series of consultative meetings starting in Mar 1986, African and French agricultural research experts have concluded that a mechanism to promote scientific and technical cooperation should be developed ...through associated research networks.

The major objectives...of those networks emerge from the clear commitment by those concerned in the relevant countries to:

- step up promotion and development of national research systems in African countries by giving them a regional and/or international dimension;
- facilitate access to.....and consultation with international agricultural research centers;
- highlight African research priorities and, within the framework of these networks, submit projects for funding by international donors."

The Conference is constituted of authorities from fifteen African countries: Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Cote d'Ivoire, Gabon, Guinea, Madagascar, Mali, Mauritius, Niger, Senegal, Togo and from France, intends, on the one hand, to throw itself open to other countries which have the same policies and the same commitment to cooperation through research networks, and on the other, to establish close links with ICRISAT.

The Groundnut Network, whose constituent assembly was held in February 1987, operates within these general provisions. A workshop was held in Dakar in January 1988 where the year's activities were reviewed, priorities set, the research program was drawn up and the practical aspects of the operation of the Network were defined.

Organization of the Network

A small permanent Secretariat is entrusted with general coordination and exchange of information, the preparation of meetings, the representation of the Network at other institutions' meetings, in particular international research centers and donors.

The Institut Senegalais de recherches agricoles (ISRA) of Senegal has been desig-

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nated as the "Coordinator". It works jointly with the Institut de recherches pour les huiles et oleagineux IRHO-CIRAD, designated as the "Correspondant", which has the special task of liaising with French and European institutions.

As of September 1988, the following countries are official members of the Groundnut Network: Burkina Faso, Cameroon, Chad, Congo, Cote d'Ivoire, France, Guinea, Madagascar, Mali, Niger, Senegal. The list is open to countries which have the same aims and the same commitments to cooperation.

Priority Areas

A review of national programs reflects common concerns (varietal improvement, agronomy, fertilization, cultural methods, crop protection). Senegal is the only country which has a significant technology program. There are two designated "centers of excellence", because of the importance of the work carried out in them:

- In Senegal, the National Center for Agronomic Research, which runs an important drought-resistance program;
- In Burkina Faso, the Farako-Ba/Niangoloko Station, where work on breeding and plant pathology for resistance to disease is carried out.

Three major subjects can be identified, for which cooperative projects have been drawn up: i.e. varietal improvement, crop protection and post-harvest technology.

Provisions and Operation of the Network

At present the Network provides:

- A general assembly and coordination;
- Two centers of excellence;
- Cooperative projects:
  - Drought resistance
  - Disease resistance
  - Cropping techniques and fertilization;
  - Technology (in preparation).
- National programs and delegates of the network.

The programs are carried out by national institutions which run them and are then coordinated when the general assembly meets (biennially), or at meetings on specific subjects (at least once a year), or through direct contacts between researchers.

The "Lettre du Reseau" (a newsletter and contact sheet whose format, content and number of issues can be adapted to the needs of the moment) is drawn up by the "Correspondant" of the Network. It comprises the following important information: regular updating of a directory of scientists; updated information on cooperative programs; information on meetings, workshops on groundnut; minutes of meetings, visits and missions carried out by members of the Network.

The Network budget is limited to overheads for the small Secretariat which has no permanent executives on the staff. The budget also covers expenses for meetings and publication costs for the newsletter.

Future Prospects

The Groundnut Network meeting held in Dakar on 26-28 Jan, 1988 was an opportunity to set down priorities for groundnut breeding keeping in view the constraints to developing its cultivation. Very practical proposals were submitted.

Guidelines on varietal improvement in the light of production constraints

There are four major constraints to promotion of groundnut cropping, for which breeding should try and find solutions, as soon as possible:

- Nutritional and quality constraints, of which there are two main aspects: problems linked with aflatoxin and the market conditions for confectionery groundnut.
- Climatic constraints, among others: drought, temperature, and problems due to having two rainy seasons (earliness, dormancy, drought resistance and cloudiness.
- Disease stress.
- Constraints due to soil quality (toxicity from aluminium, magnesium and salinity).

Future action and short- and medium-term recommendations

- Admission of Guinea to the Groundnut Network has been approved; Gabon, Benin, Togo and the Central African Republic are eagerly awaited.
- Improvement programs should focus more on the confectionery groundnut.
- The Niangoloko/Farako-Ba Centre, which has been designated a "center of excellence" for its breeding of disease-resistant varieties, should be given greater resources.
- The Network stresses the great importance of seedbanks in order to ensure production.
- An international variety trial aimed at measuring the adaptability of varietal types under a whole range of varied conditions, will be set up as a project which will have three aspects: short-duration varieties (undertaken by Senegal; medium-duration varieties (undertaken by Senegal; breeding lines with tolerance to leaf disease (undertaken by Burkina Faso).
- Countries wishing to start national breeding programs from bulks (segregated material) supplied by centers of excellence, can request to do so, which will serve to assess requirements and the means of meeting those needs.
- First generation projects (drought, agronomy, and leaf disease) which raise no objection in principle have been presented to the EEC under the auspices of the Network, undersigned by the co-contracting parties.
- Second generation projects: early varieties (Burkina Faso) and technology (Senegal); interested countries have received the project documentation from the coordinating bureau which will allow them to confirm their intention to participate and to give details of their contribution.

- Third generation project (to be formulated): a collaborative project for the forest region will be drawn up.
- Organization of short-term training courses within the Network was agreed so as to introduce scientists on site to techniques and methods within their own specializations at centers with relevant expertise. Each of the centers (genetics/physiology—Bambey; plant pathology—Burkina Faso; entomology-nematology—ORSTOM;) will budget the cost of the training that it has to organize (15 days for 6-8 participants), will decide on the basic program and will decide on the best timing.
- The next workshop, on crop protection, may take place in Burkina Faso during the 1989 cropping season. This meeting, following on from the ICRISAT meeting in September 1988, will provide yet another opportunity to strengthen ties and coordinate the work of this organization.

Recommendations

Pathology and Entomology Working Group

It was agreed that diseases are one of the major constraints in groundnut production in West Africa. Leaf spots, rust, rosette, and seedling diseases are common throughout the region and cause substantial yield losses. Aflatoxin contamination is a serious quality problem in West Africa, as mentioned by many speakers during their presentations. The group strongly felt that there was a lack of information on the distribution and economic importance of arthropod pests. Similarly, the importance of plant parasitic nematodes in West Africa is not fully understood because of a lack of specialists in different parts of the region.

The working group carefully considered the pathology, entomology, and nematology research needs in the region and made the following recommendations.

1. A survey of diseases, arthropod pests, and nematodes affecting the crop in all major groundnut-growing areas of West Africa is necessary in order to obtain the current distribution, seasonal abundance, and importance of these problems, and to formulate suitable management strategies. International organizations such as ICRISAT, IRHO, ORSTOM, and Peanut CRSP should undertake these in close collaboration with scientists in the national programs. Pest and disease distribution maps of the region should be developed. This work will facilitate the identification of suitable locations for varietal improvement activities.

2. Crop losses from diseases and pests should be assessed on a regional basis.

3. The current situation of aflatoxin contamination in groundnut in the region, especially in farmers' fields, should be monitored. Information on cultural and agronomic practices that will help reduce aflatoxin contamination should be made available.

4. Exchange of germplasm and breeding material with resistance to various diseases and arthropod pests is important.

5. Team research efforts across disciplines/programs/organizations in West Africa should be emphasized through a centrally coordinated system. Cooperation between programs (both national and international) in the region is necessary to avoid duplication of research efforts.

6. Training of research workers in the national programs by International agencies is extremely important especially at higher levels up to PhD. This will help scientists in the national programs to update their knowledge of crop protection methods, and to undertake meaningful research in their own countries.

7. Literature on groundnut should be made available to all groundnut research workers. A handbook detailing diseases of groundnut would assist extension workers in diagnosis of groundnut diseases. It was suggested that ICRISAT coordinate this activity with the IRHO and Peanut CRSP.

8. Strengthening of research facilities of national programs by the international agencies in the region should be seriously considered since the effectiveness of the international programs will be greatly enhanced by strong, functional national institutes.

Plant Breeding Working Group

1. The working group recommended that more emphasis be placed on early- maturing material adapted to the region. This would include: characterization of early maturity at different locations, calculation of heat units to maturity of a few standard cultivars at various sites, summarization of different methods to determine maturity, development of rosette resistance in early varieties, and cooperation with national programs to obtain this combination in adapted material.

2. Considering that germplasm shipped by ICRISAT did not always reach its destination, e.g. deliveries to Ghana and Benin, the group recommended that ISC investigate the most effective way to send seed. This would include studying import requirements, airline schedules, identifying liaison people, time of year the seed is required, etc.

3. The group recommeded that ICRISAT investigate the possibility of making local landrace collections and evaluations in southern Cameroon and Guinea.

4. Considering the importance of the quality and acceptability of groundnut cultivars, the Group recommended that national programs be requested to provide information on the most acceptable cultivars. This would include information on characteristics such as seed color, seed size, oil content, etc.

5. Recognizing the desirability of resistance to late leaf spot, rust, rosette, and early leaf spot in longer-cycle material, and the importance of resistance to foliar diseases especially in West Africa where groundnut haulms are widely used as animal feed, and the need for rosette resistance in short-cycle material, the group recommended that information be made available on the sources of resistance to the abovementioned diseases and that a handbook be produced outlining methods of scoring for resistance to leaf spots (early and late), and to rust, with photographs of lines showing various scores and a description of the suitable growth stages for scoring.

6. Recognizing that aflatoxin levels were more affected by management practices and growing conditions than by genotypes, the group recommended that ICRISAT pay due attention to selecting material with resistance to aflatoxin production.

7. In view of the need for sustainable agriculture and the importance of national groundnut research programs in developing it, the Group recommended that international institutes and programs give assistance in training both technicians (in-service) and researchers (degree courses) who would then be better qualified to work towards this goal.

8. Recognizing the need for broader dissemination of research results as a means of ensuring greater progress in groundnut research, in a region where both French and English are commonly used, the Group recommended that ICRISAT assist national programs by supplying reprints of relevant scientific papers, reporting on regional research in the ICRISAT publication "The International Arachis Newsletter", and by translating relevant articles into French or at least providing abstracts in French.

9. The Group recommended that a series of regional trials for English- and French-speaking countries be carried out. These trials should include three maturity groups (early = under 95 days, medium = 95-120 days, late = over 120 days according to data from Senegal) and use heat units to standardize results. The trials should involve the best cultivars from each country and some advanced lines from the various breeding programs.

   It was generally felt that financial assistance, e.g. for bags, and labels, would be needed by most national programs and that ICRISAT should provide this support.

Agronomy Working Group

1. The working group recognized that in most countries of the region the quality of seed available to farmers was of poor quality and in some cases seed distribution was a problem. The group recommended that conditions be created to ensure that groundnut farmers receive adequate quantities of good quality seed in time.

2. It was recommended that sustainable cultural management systems be developed that would not only improve agricultural production, but would ensure conservation, soil fertility maintenance, optimum water use, reduced incidence of weeds, diseases and insects, and optimum land use efficiency.

3. The region has an acute shortage of trained manpower at various levels. The group recommended that efforts be made to train researchers (BSc, MSc, and PhD levels) and support staff. The group further recommended intraregional exchange of scientists, information dissemination, and sharing of valuable experience gained in groundnut production.

4. Most national agricultural research systems in the region are very poorly funded. It was recommended that some financial and other material support be provided to national programs whenever they collaborate in conducting regional trials.

5. The group recommended that socioeconomic constraints be taken into consideration wherever agronomic recommendations were made to the farmers and that the role of national institutions and organizations in the region be recognized.

6. The group recognized that considerable losses were encountered after harvest and recommended that some importance be attached to the postharvest technology and proper storage of groundnuts. In view of the difficulties encountered in marketing groundnuts it was recommended that diversification in groundnut utilization be considered.

7. While members appreciated the importance of the first meeting, it was felt that meetings should not be held too frequently. This would give scientists enough time to produce tangible results to report at meetings. It was recommended that regional meetings be held every two years with specialist meetings in between.

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