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A Regional Approach to Groundnut Improvement

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Summary

The paper outlines in brief the objectives of the ICRISAT Regional Groundnut Program, describes the geographical diversity in the region and summarizes the constraints to increased groundnut production. It further discusses the breeding strategy adopted in the program and the results obtained so far.

Résumé

***Une approche régionale de l'amélioration de l'arachide**: Les auteurs donnent un aperçu global des objectifs du Programme régional de l'ICRISAT pour l'arachide. La diversité géographique constatée dans la région, ainsi que les contraintes à l'accroissement de la production de l'arachide sont résumées. L'article expose en détail la stratégie de sélection adoptée dans le programme et les résultats des travaux obtenus jusqu'à présent.*

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Regional Groundnut Program for Southern Africa, established in July 1982, at Chitedze Agricultural Research Station near Lilongwe, Malawi and funded by the International Development Research Center, Canada, became effectively functional with the arrival of a groundnut breeder in September 1982. Subsequently a groundnut pathologist joined the program in December 1983, thus completing the senior staff.

This action was taken by ICRISAT in response to a 1980 request for such regional assistance by Heads of State of the nine Southern African Development Coordination Conference (SADCC) member countries.

Goals and Objectives

The goal of the program is to increase groundnut production, mainly by small farmers throughout Southern and Eastern Africa, particularly in SADCC member countries. To achieve this goal, three general objectives are being pursued with the cooperation of the national programs in the region.

- To develop and introduce high-yielding breeding lines and populations adapted to the region's different agroecological zones and containing resistance to the main factors presently limiting production at the small farmer level.
- To train scientists from the region and thus help to establish strong national groundnut research and development programs in conjunction with ICRISAT scientists in Hyderabad and other centers and programs in the region.
- To organize workshops and symposia to evolve regional research strategies and disseminate up-to-date research information in the region.

SADCC Region

The region covered by SADCC member countries, Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe is very large and diverse. It lies between the Atlantic

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(11° E) and Indian Oceans (41° E) and stretches from near the equator to about 30° S and has a total area of 4.9 million km² The elevation of the region ranges from sea level to mountains over 3500 m, with the major area on a plateau between 900 and 3000 m.

Although 95% of the region is in the tropics, the whole of Lesotho and Swaziland, one third of Botswana and a small portion of Mozambique lie outside the tropics. These differences in location and physiography are reflected in the wide range of climates, soils, and photoperiods found within the region. Well over 75% of the region is semi-arid as defined under ICRISAT's mandate

Groundnut Production in SADCC Member Countries

Groundnut is an important cash and food crop in the region Table 1 shows the FAO estimates of area and production of groundnut in the SADCC member countries Malawi and Zimbabwe are the biggest producers, but the crop is not grown in Lesotho. Mozambique also has a substantial area under groundnuts but total production is low

Table 2 gives the average yield of groundnut in SADCC member countries Almost the entire groundnut crop is grown on small farms with low average yields

Yields of over 4 t/ha have been grown on research stations and large scale farms in the region. The record groundnut yield (9 6 t/ha) was reported from Zimbabwe from the cultivar Makulu Red grown on a large farm (Hildebrand 1975)

There is great potential for increasing yields and total production in the region provided existing constraints are reduced

Table 2 Average yield of groundnut (kg/ha) in SADCC countries

Countries	1981	1982
Angola	500	N/A
Botswana	395	N/A
Malawi	720	720
Mozambique	471	471
Swaziland	481	N/A
Tanzania	596	604
Zambia	600	600
Zimbabwe	955	479
SADCC Region	710	-
Africa	804	738
North and Central America	2573	2630

N/A - Figure not available Source FAO Production Year Book Volume 35 1982 and FAO Monthly Bulletin of Statistics 1983 6(1)

Constraints to Increased Groundnut Production

Constraints to groundnut production in the region have been identified at all stages from sowing

Table 1. Area and production figures for groundnuts in SADCC countries.

	Area (000 ha)		Production ('000 t)	
Countries	1981	1982	1981	1982
Angola	40	N/A	20	N/A
Botswana	4	N/A	2	N/A
Malawi	250	250	180	180
Mozambique	170	170	80	80
Swaziland	3	N/A	1	N/A
Tanzania	94	96	56	58
Zambia	50	50	30	30
Zimbabwe	240	240	239	115
SADCC Region	851	--	608	--
Africa	6470	--	5201	--

N/A - Figure not available. Source FAO Production Yearbook, 1982, FAO Monthly Bulletin of Statistics, 1983 6(1) through marketing. The constraints and their order of importance vary with the countries The major constraints to increased production in the region are:

- Low soil fertility.
- Poor cultural practices
- Nonavailability of good quality seed
- Lack of suitable cultivars for different agroecological areas.
- Lack of labor and draft power
- Damage from diseases and insect pests
- Drought stress.
- Low prices

Of the various constraints listed, only those which fall within the competence of the regional ICRISAT team are elaborated further This, however, does not belittle the importance of other constraints

Damage from Diseases and Insect Pests

Disease spectra vary not only from country to country but also within countries. For example, rosette and early leafspot (*Cercospora arachidicola*) are important in the central region of Malawi, whereas in the southern region rust (*Puccinia arachidis*) and late leafspot (*Cercosporidium personatum*) are important in addition to rosette.

Of the fungal diseases, leafspots (early and late), rust, web blotch (*Phoma arachidicola*), pepper spot and leaf scorch (*Leptosphaerulina trifolii*), pod rots, and *Aspergillus flavus* are important on a regional basis. Recent studies in Tanzania have shown 37.6% yield loss caused jointly by rust and leafspot and 26.1% by rust alone (Anon 1983). Similarly, at Chitedze Research Station yield increases ranging from 31-75% were obtained in a 1982/83 experiment on economic evaluation of fungicides for control of foliar fungal diseases Rust has become so serious in southern Mozambique that it has almost destroyed the groundnut crop there.

Among the virus diseases, groundnut rosette virus (GRV) is the most important and is capable of causing almost 100% loss in late-planted crops grown with wide spacing. Peanut mottle virus (PMV) is another common disease, however the extent of losses caused by it are not known.

Among the insect pests, Hilda (*Hilda patruelis*), aphids, and termites are frequently encountered and sometimes cause serious damage to the crop. Aphids also act as vectors for GRV and PMV. Other insect pests such as jassids and thrips can also occur in serious proportions in some fields No efforts have been made to quantify losses caused by these insect pests

Lack of Suitable Cultivars

With the exception of Malawi and Zimbabwe, the varietal picture in the region is not very encouraging Even in these two programs, development of improved short-season cultivars has received little attention Disease resistance breeding, with the exception of Malawi, has only very recently been started in the region The Malawi Program successfully developed a rosette resistant cultivar, RG1, but did not make much progress in developing cultivars resistant to important foliar fungal diseases

Drought Stress

The importance of drought as a factor limiting groundnut production varies within the region In Malawi and Zambia, it is less important, but in other countries uneven rainfall is a major problem Mid-season droughts of 2-3 weeks are common in the region

Research Program

Because the mandated area of the Regional Program is very large and diverse, so are the problems associated with groundnut production For a regional program to function effectively in cooperation with national programs, present activities are concentrated on:

Breeding for resistance to the diseases of regional importance, and
Breeding for increased yields, seed quality, and earliness.

Breeding Strategy

Breeding strategy depends on the nature of available breeding material and the specific breeding objectives. The breeding material is obtained either from germplasm lines and breeding populations imported from ICRISAT Center and other organizations, or material generated at the Regional Center.

In the first season exotic material undergoes preliminary evaluation either in replicated trials or in observational plots In the first season of evaluation or selection, emphasis is placed on characters such as disease resistance, seed size, and quality Selection pressure for yield per se is not kept high This is mainly done to give the exotic material at least a season to "tune in" to the local conditions Experience has shown that quite often exotic lines improve their performance under local conditions as time passes From the second year onwards, selection pressure based on yield per se is generally kept high, although the intensity of this pressure varies from early to advanced generations

The breeding material generated at the Regional Center passes through rigid selection pressure for yield and other specific characters from the F_2 generation onwards Sometimes, depending upon the population size in F_2 or F_3, it might be slightly relaxed

Most of the time the bulk pedigree method is followed to retain enough variability in the selected populations to permit in situ selection at other locations by cooperating scientists Occasionally highly promising individual plant selections are also made Quite often phenotypically similar sister lines are bulked

Selected populations are supplied to the national programs for further selection under local conditions Advanced breeding lines are included in Regional Yield Trials for evaluation under different agroecological conditions These trials are intended to be kept fairly dynamic and flexible, permitting easy deletion or addition of test entries for rapid dispersal of breeding material

Introduction, Evaluation, and Documentation of Germplasm

Introduction or "reselection" in the introduced germplasm has played a significant role in the development of new groundnut cultivars in the region (Hildebrand and Smartt 1980) Of the seven cultivars released in Zimbabwe, five are the result of introduction or of "reselection" in the introduced material, as were five of the six cultivars released in Malawi

1982/83 Season. Introducing varietal improvement either directly or indirectly by enriching the available variability is important The Regional Program acquired new germplasm from the beginning In the 1982/83 crop season, 488 germplasm lines, mostly of South American and African origin, and 111 elite parental lines of proven good combining ability and resistance to diseases and insect pests were evaluated in 6 m long by 60 cm wide unreplicated one-row plots Nine important cultivars of the region were included as controls

All 599 lines were evaluated for various morphological characters, reaction to early leafspot and yield These lines have been assigned ICRISAT Groundnut Malawi Numbers (ICGM) and have been documented in the Germplasm Accession Register Performance of some of the promising germplasm lines and selected controls is presented in Table 3 From the preliminary evaluation it appears that some of the valencia types (*Arachis hypogaea* subspecies *fastigiata* var *fastigiata*), particularly those of South American origin perform well under Chitedze conditions With the exception of Zimbabwe where they are now being phased out, it seems that valencia types have n received the attention they deserve

During the first season Dr P Subrahmanyam, ICRISAT Center Groundnut Pathologist, was seconded to the Regional Program from January to April 1983 to assist the breeder in evaluating the germplasm and breeding material for disease resistance His observations on disease reaction are included in this paper

None of the lines tested showed any appreciable level of resistance to early leafspot All of them were rated 9 on a 1-9 scale (1 = no disease, and 9 = extensive damage to foliage) with defoliation ranging from 80 to 100% when assessed some 10 days before harvest In some cases of severe defoliation, the lesions on the retained leaflets were small with sparse sporulation (Table 4) One such germplasm line was ICGM 189, which was selected independently on the basis of yield performance

Some of the lines [NC 3033, ICG 6340 (PI 350680), ICG 4747 (PI 259747), and ICG 7882 (PI 270608)] reported resistant to early leafspot in the USA (Sowell et al 1976, Hassan and Beute 1977) did not maintain their resistance under Chitedze conditions

The germplasm lines could not be screened for rust and late leafspot at Chitedze because these diseases appeared very late in the season, by which time early leafspot had already caused severe defoliation

1983/84 Season. In the current 1983/84 season, two plantings of germplasm material have been made.

Table 3. Performances of some promising germplasm lines compared with selected control cultivars, Chitedze, 1982/83 (unreplicated trial).

ICGM No.[1]	Origin	Final stand	Pod yield (kg/plot)	Seed yield (kg/plot)	100 seed weight(g)	Cultivar group[2]
336	Bolivia	34	1.41	0.83	58.3	Nambyquarae
471	--	32	1.12	0.83	34.9	Spanish/ Valencia
437	Brazil	39	1.09	0.80	41.7	Spanish
48	Brazil	41	1.16	0.79	35.0	Valencia
197	Bolivia	30	1.25	0.78	36.3	Valencia
177	Brazil	35	1.13	0.78	35.2	Valencia
189	Brazil	34	1.03	0.73	34.4	Valencia
Control						
Chalimbana	Zambia	33	0.62	0.38	75.9	Virginia
Mani Pintar	Bolivia	35	0.90	0.65	50.9	Nambyquarae
Egret	Zimbabwe	23	1.09	0.56	48.2	Virginia
Spancross	USA	40	0.70	0.48	29.4	Spanish

1. All the ICGM's and control Spancross took 124 days to mature as compared to the 139 days of the other 3 controls
2. As per Gibbons et al. 1972

Table 4. Reaction of groundnut genotypes to early leafspot (*C. arachidicola*), Chitedze, 1982/83

	Components of resistance			
Genotypes	Defoliation (%)	Infection frequency (lesions/cm²)	Lesion diameter (mm)	Sporulation[1]
Germplasm				
ICGM 189 (ICG 5216)	80	15.1	2.0	1.8
ICGM 291 (ICG 8528)	85	19.2	2.2	2.0
ICGM 292 (ICG 8529)	80	20.5	2.5	1.5
Breeding populations				
F_4 (NC Ac 17133-RF x TMV2) F2-B1-B1	90	1.2	9.2	5.0
F_7 (TG 3 x NC Ac 17090) F2-B2-B1-B2-B1-B1	55	2.3	9.0	5.0
Control Chalimbana	85	3.0	8.5	5.0

1. Scored on a 5-point scale where 1 = no sporulation and 5 = extensive sporulation.

Germplasm Yield Trial

Fifty-one of the germplasm lines selected on the basis of 1982/83 performance and 13 control cultivars have been planted in an 8 x 8 simple lattice design with 6 m long two-row plots

Preliminary Germplasm Evaluation

Single 6 m rows of 270 germplasm lines (108 new and 162 old acquisitions of large seed size) along with 9 control cultivars have been planted in an augmented plot design

Breeding for Disease Resistance

Foliar Fungal Diseases. Of the various fungal diseases prevalent in the region, only rust and early and late leafspots merit our present attention

Chitedze provides an ideal location to screen for early leafspot resistance, but it is not suitable to screen for rust or late leafspot due to their restricted and very late occurrence To overcome this problem and to combine resistance against these pathogens, rust- and late leafspot-resistant populations derived from stable resistance sources (Subrahmanyam et al 1983) are obtained from ICRISAT Center in Hyderabad These populations are then screened for early leafspot resistance at Chitedze

The major emphasis in selection is yield and seed quality under severe and uniform disease pressure (artificial or natural) This should ideally result in three kinds of selected populations.

- high yield and a high resistance level,
- high yield and a moderate or low level of resistance, and
- low yield and a very high resistance level

The latter populations usually end up in hybridization blocks, but the other two are advanced further and evaluated in diverse environments That is the ideal let us now see how far we have gone in Malawi

1982/83 Season

Breeding Material. In the 1982/83 season a total of 338 breeding populations (F_1-F_9 generations) were planted in varying numbers of rows. Early leafspot caused extensive defoliation (75-100%) of all populations except one, resulting in a maximum disease score of 9. Only two populations, one with somewhat less defoliation and another with a low infection frequency were identified as possessing any degree of resistance (Table 4) The breeding population TG3 × NCAc 17090 though sustaining less than average defoliation had large lesions with extensive sporulation The other population NCAc 17133-RF × TMV 2 had severe defoliation and large lesions with extensive sporulation, but its infection frequency was low It is hoped that by intercrossing these populations and germplasm lines such as ICGM189, ICGM291 and ICGM292, populations with high levels of early leafspot resistance can be developed by combining the various components of resistance

On the basis of yield and pod and seed characteristics 161 bulk selections were made Of these only six were rated as good (Table 5) and a further 27 as average to good The rest were average or below average The average and below average selections were retained for further evaluation at Chitedze and other locations where rust and late leafspot are the predominant diseases

Yield trial. Twenty advanced rust-resistant breeding lines were evaluated along with nine control cultivars The highest yield was from the control cultivar, Mani Pintar (*A hypogaea* subspecies *hypogaea),* which matured in 132 days (Table 6) Among the breeding lines, Nc-Fla-14 × PI 259747 yielded highest, but it was not a significantly different yield than that from Mani Pintar It took only 118 days to mature Many breeding lines, when compared with Spancross, a control cultivar of similar growth habit (*A hypogaea* subspecies *fastigiata*), had higher yields but the differences were not sig-

Table 5 Pedigree of six good selections made in the Foliar Fungal Disease Resistance Program, Chitedze, 1982/83

Generation	Number of selections	Pedigree
F_1	1	(ICGS 21 x (SM 1 x EC 76446 (292)) (F2 B2 B1 B2-B1-B1)
F_4	1	(EC 76446 (292) x 87/4/7 (2))F2-B1-B1
F_5	2	(Robut 33 - 1 x NCAc 17506) F3-B1-B1
F_6	1	(Starr x NCAc 17090) F2-B1-B1-B1-B1
F_8	1	(HG 1 x NCAc 17090) F2-B1-B1 B2-B1-B1-B1

Table 6. Performance of some of the high-yielding breeding lines and control cultivars in the Rust Yield Trial, Chitedze, 1982/83.

Identity	Branching pattern	Days to maturity	Yield (kg/ha)	Shelling (%)	100 seed weight (g)
Mani Pintar	A[1]	132	2939	72	51.3
(NC-Fla-14 x PI 259747)	S[2]	118	2596	75	26.7
(TC x EC 76446 (292))	S	118	2471	71	35.9
(NCAc 2190 x NCAc 17090)	S	118	2408	63	40.7
(Florigiant x NCAc 17090)	S	118	2323	62	31.2
Spancross[3]	S	118	2254	75	30.0
NCAc 17090[4]	S	118	1902	68	37.0
Chalimbana[3]	A	137	1565	68	82.3
SE ±			131		
CV (%)			12.5		

1 Alternate branching (*A. hypogaea* subspecies *hypogaea* var *hypogaea*).
2 Sequential branching (*A. hypogaea* subspecies *fastigiata*).
3 Control cultivar
4 Control, rust resistant parent

nificant. At Chitedze, however, the advantage of these rust resistant lines could not be exploited fully because of the severity of early leafspot and the very late and restricted rust occurrence. Under conditions of heavy rust attack they should significantly outyield Spancross. Four of these breeding lines, ICGMS Nos 27, 28, 29, and 30, were further purified and included in the Regional Yield Trials.

New Crosses. Twenty-three new crosses were made between the important cultivars of the region and lines resistant to rust and late leafspot.

1983/84 Season

Breeding Material. A total of 274 breeding populations starting from F_1 to F_{11} generations have been planted in plots of varying sizes. They are selections made in the 1982/83 season, newly acquired populations from ICRISAT Center, 20 *Phoma* resistant populations obtained from Zimbabwe, and 23 new F_1 hybrids developed at the Regional Center.

Yield Trials. Three yield trials are currently being conducted to evaluate performance and reaction to early leafspot.

- Interspecific material yield trial. Forty newly obtained interspecific lines and nine control cultivars are being evaluated. The interspecific lines have shown high yield potential and high levels of resistance to rust and late leafspot under Indian conditions.
- Rust yield trial (F_6-F_{11} generations). Sixteen newly obtained populations are being evaluated along with four control cultivars.
- Rust yield trial. A total of 18 entries from the 1982/83 yield trial and selected breeding populations are being evaluated with seven control cultivars.

Virus Diseases

Groundnut rosette is the most devastating virus disease in the region. The Malawi national program has successfully developed and released a resistant cultivar, RG1. There are many more breeding lines in the pipeline. However, all of these are of long duration and belong to the subspecies *hypogaea*. No efforts have been made to incorporate rosette resistance into the short-season cultivars belonging to the subspecies *fastigiata*. The regional program intends to develop short-season rosette resistant cultivars and to incorporate resistance to the important foliar fungal diseases. Successful screening for rosette resistance at Chitedze can be carried out by planting disease nurseries late in the season.

1982/83 Season

Rosette Screening In the 1982/83 season 300 advanced interspecific lines were screened for rosette resistance by planting them late in January A total of 48 selections, mostly single plants, were made which did not have typical rosette symptoms

West African germplasm Resistance of the West African germplasm lines such as RMP 40, 48-37, 48-36, and 48-21 was reconfirmed under field conditions in Malawi

F_1 Crosses Seventy-one new F_1 crosses were made for rosette and multiple disease resistance

1983/84 Season

Plant Selections Forty-eight plant selections were sown at the normal time for seed increase Some of them have already gone down with rosette

F_1 Crosses Seventy-one F_1 crosses were planted in the field They are being regularly sprayed against aphids to avoid rosette

Rosette resistance A 6 × 6 diallel (48-36, RMP 40, and RG1 as resistant parents and JL 24, ICGM 48, and Mani Pintar as susceptible parents) for studying inheritance of rosette resistance has been completed in the field hybridization block

Breeding for Increased Yield, Seed Quality and Earliness

Development of early-maturing high-yielding breeding lines with good seed quality is an important activity of the program These lines do not possess disease resistance and are intended principally for areas where some of the diseases may not occur or could be contained by other means However, since these lines are selected and evaluated under nonprotected conditions, they apparently have the ability to yield well under disease pressure without possessing any obvious disease resistant characteristics These lines are also useful parental material to use in disease resistance programs

1982/83 Season

Breeding material. Some 645 populations representing F_1 to F_{10} generations were grown in varying plot sizes under nonprotected conditions Days to 75% flowering ranged from 21-35 and to maturity from 108-138 All the populations were highly susceptible to early leafspot Selections were made visually on the basis of yield and pod and seed characteristics, and 219 populations were rejected Of the remaining 426 populations, 443 selections, mostly bulks, were made A total of 58 good selections were identified Three of these selections ICGMS Nos 31, 32 and 47, were included in the Regional Yield Trials Various station trials also included 102 other selections with good or average performance The remaining were replanted for further selection

Yield trials Seven yield trials with entries ranging from 19-64 were planted in appropriate experimental designs The mean yield of trials varied from 1710-2277 kg/ha The control cultivar Mani Pintar wherever it was included generally performed the best, and few lines exceeded its yield However, Chalimbana, the predominant confectionary cultivar of Malawi did not fare well in any of the trials Tables 7 and 8 give the performance of some of the breeding lines vis-a-vis the highest yielding control cultivar of the same botanical type

Of the 226 test entries 121 were retained because they performed as well or better than the control cultivars of similar botanical types ICGMS numbers were assigned to 37 high-yielding breeding lines which were included in the Regional Yield Trials The remaining entries were included in various station trials according to their botanical types

F_1 crosses Ninety-three F_1 crosses were made among the important high-yielding cultivars of the region and exotic material of good combining ability

1983/84 Season

Breeding material. In addition to the 93 F_1 crosses, 547 populations (F_2 to F_{11}) were planted in the field in varying plot sizes under nonprotected conditions These include 117 newly acquired populations, many of which include African cultivars in their parentage

Yield trials. Nine yield trials with entries ranging from 16-64 are being conducted in appropriate experimental designs These include two Regional Yield Trials, one each for spanish and virginia

Table 7. Performance of some of the selected entries in various yield trials, Chitedze, 1982/83.

Trial	Identity	Yield (kg/ha) Unadjusted	Adjusted	Shelling (%)	100 seed weight (g)
Early Population	(JH 89 x Chico) F2-B1-B1-N1B1-B2-B1-B1-B1	2775	--	77	32 1
	Malimba[1]	2463	--	75	32 7
	SE ±	189	--	--	--
	CV (%)	18	--	--	.
High yield and quality F9 (S.B)	JL 24	2389	2368	74	40 6
	(Tifspan x Robut 33-1) F2-E-B1-B1-B1-B1-B1-B1-B1	2345	2336	72	38 3
	Malimba[1]	2113	2104	65	32 2
	SE ±	106	--	--	
	CV (%)	10	--	.	

1 Control cultivar belonging to subspecies *fastigiata* cultivar *vulgaris*

Table 8. Performance of some of the selected entries in various yield trials, Chitedze, 1982/83.

Trial	Identity	Yield (kg/ha) Unadjusted	Adjusted	Shelling (%)	100 seed weight (g)
HYQF10 (VB)	(Robut 33-1 x NCAc 316) F2-B1-B1-B1-B1-B2-B1-B1-B1	3382	3302	72	41 6
	Mani Pintar[2]	2852	2788	72	51 0
	SE ±	267	--	-	--
	CV (%)	25	--	--	--
HYQF11	(USA 20 x TMV 10) F2-P3-B1-B1-B1-B1-B1-B1-B1-B1	3456	3393	73	64 0
	RG 1	2236	2116	66	46 2
	JL 24	2606	2572	74	36 3
	Spancross[1]	2345	2252	71	29.2
	SE ±	120	--	--	--
	CV (%)	12	--	--	--

1. Control cultivar belonging to subspecies *hypogaea* cultivar *hypogaea*.
2. Control cultivar belonging to subspecies *fastigiata* cultivar *vulgaris*.

bunch groups, an F_2 yield trial and an F_2 line × tester yield trial.

A set of 54 crosses between six released cultivars of the region and nine high-yielding exotic cultivars has been completed in the field hybridization block

Looking Ahead

No major shifts in the program's goal and objectives are seen in the near future However, activities will be intensified in these areas

Germplasm Acquisition. Sources of rosette- and drought-resistance from Senegal and Burkina Faso (formerly Upper Volta), early leafspot resistant sources from the USA and Zimbabwe, and other promising lines from the region will be acquired

Crosses. More new crosses will be attempted as workers' hybridization expertise improves This will considerably increase the proportion of self-generated breeding material in the program

Disease Resistance. Search for stable sources of resistance to early leafspot will be intensified Development of breeding populations with multiple disease resistance will continue to receive our prime attention

Regional Tests. With the cooperation of national programs, the regional network of testing for yield and disease reaction will be further strengthened National programs will be encouraged to make more use of the breeding material generated at the Regional Center

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Discussion on Paper on a Regional Approach to Groundnut Improvement

Gausi: Are you looking for vertical or horizontal resistance in your breeding for resistance to diseases?

Nigam: It depends upon the disease in question In the case of rosette virus disease it is vertical resistance whereas for the foliar diseases it is horizontal resistance

Edje: What is the relevance of breeding for earliness for Malawi conditions given that the cultivar Chalimbana can attain maturity under the existing conditions?

...m: In some areas of Malawi and in other countries of the region the growing season is 110-120 days Chalimbana takes 140-150 days to reach maturity in Malawi This justifies breeding for earliness

Pasley: What are the chances of breeding high-yielding cultivars given that there are at least five diseases reducing yield?

Nigam: Work at ICRISAT Center has shown that it is possible to combine multiple disease resistance with high yield There are several lines with moderate resistance to late leaf spot, rust, and rosette

Chiteka: It is known that there are two types of groundnut rosette, chlorotic rosette, and green rosette Which of these is most prevalent in Malawi? Is the inheritance of resistance similar for ...h types?

Nigam: Chlorotic rosette is predominant in Malawi The inheritance of resistance to the two types of rosette is not known

Bock: There are a few isolated areas where green rosette occurs but by and large the chlorotic rosette is predominant

Ramanaiah: Rosette resistant cultivars are needed for Mozambique

Monjana: Groundnut rust is a problem on research stations in Mozambique but not on farmers' groundnuts in normal years

Nigam: I have seen severe rust damage on crops near Maputo

Sandhu: Some of the ICG lines have resistance to rust and late leaf spot but they are of a different botanical type from the agronomically acceptable cultivars commonly grown What are the possibilities for successful transfer of the resistance across the botanical types?

Nigam. The transfer of resistances from fastigiata to hypogaea and vice versa is possible but it is easier if both parents belong to the same botanical groups

Amin: You seem to have based your conclusion that rust is important in Mozambique on one visit, is this sufficient?

Nigam: More visits are needed to establish the importance of rust and other diseases in Mozambique

Doto: What criteria are used in selecting disease-resistant material from ICRISAT Center for use in your Regional Program?

Nigam: Many factors are considered in the choice of material Special consideration is given to the findings of Hildebrand and his coworkers in Zimbabwe that Bolivian groundnut germplasm is well adapted to the Central Africa region