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National Cereals Research and Extension Project (NCRE)

Annual Report

1990

United States Agency for International Development
(USAID)
Institute of Agricultural Research
(IRA)
International Institute of Tropical Agriculture
(IITA)

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EXECUTIVE SUMMARY

NCRE completed the last year of contract II by negotiating and finishing a budget and contract NCRE III. Under this third contract twelve IRA researchers were selected to do advanced degree studies. Several consultants were contracted to assist researchers in specific areas.

Highland Maize Breeding continued to develop materials for the mid and high altitude regions of Cameroon. Several promising varieties were advanced to on-farm yield trials and five hybrid selections were chosen for testing. Work continued on selection and purification of existing lines and populations.

Highland Maize Agronomy planted a total of eleven trials concerning soil amendments to improve soil fertility and crop residue management. Over half of the studies concerned intercropping or double cropping with grain legumes, colocasia, hedge rows or soil improvement legumes.

Lowland Maize Breeding carried on work of improving maize populations and developing varieties for the lowlands. The total number of trials increased by 20% over that of 1989. A total of 768 genotypes were tested for the hybrid program. Nine varieties underwent seed multiplication for distribution to farmers.

Lowland Maize Agronomy concentrated on improving soil fertility with minimum use of inputs such as fertilizers and herbicides. Special attention was given to use of improved fallow management systems, green manure production with legume trees, crop associations and rotations and use of supplementary fertilizers.

The **Rice Breeding** unit concentrated on irrigated rice varieties. Previous activities of introduction, collection and evaluation of germplasm continued. More emphasis was placed on selecting agronomically improved varieties with resistance or tolerance to stresses such as low temperature, blast, sheath rot and glume discoloration.

Rice Agronomy gave emphasis to fertilizer management and cultural practices for improved varieties developed by the breeding program. Several experiments concerned crops associated with rice or planted after rice in rotation.

The **Cereals Agronomy** Unit at Garoua conducted research both on-station and on farmer's fields for Maize and Sorghum. Tests were done using green maize as a short term garden crop for the hunger period. Tillage tests, brewery by-product tests, seed treatment and Striga Control were the major lines of research followed. Seed multiplication was done for varieties of Maize, soybean, pigeon peas and crotalaria.

Sorghum and Millet Breeding concentrated on development of open pollinated Sorghum and Millet varieties as well as hybrid Sorghum varieties. Many international trials were evaluated in the search for new genetic material. Materials developed in Cameroon was tested against other varieties. A total of 110 Sorghum hybrids were developed. Seed of 20 local and developed varieties were multiplied for use by other researchers and seed producers.

Sorghum and Millet Agronomy research was conducted both on-station and on farmer's fields. Research centered around soil and water conservation, efficient use of fertilizers, control of Striga, animal drawn field equipment and development of a local soil testing laboratory.

The Bambui Testing and Liaison Unit had their most ambitious year in 1990. The return of two researchers from studies in the USA gave them additional staff to increase their research program. Over 60 farm households were surveyed with regards to maize storage practices. Market prices were continuously monitored in 11 village markets. Over 300 minikits were distributed for testing 9 improved maize varieties. Seed of KASAI maize was directly distributed to farmers.

The Ekona TLU identified seven constraints for action or further study. These were: (1) low soil fertility due to shortened fallow (2) insect and weed problems (3) labor bottlenecks (4) low-yielding and disease prone local varieties (5) crop marketing (6) diffusion of IRA technologies and (7) maize storage. Specific activities included collection of data for economic models, market price recording, fertilizer risk analysis, impact survey, analysis of storage methods, on-farm trials, on-station trials and completion of soil profile descriptions.

The Maroua TLU reorganized their activities to allow a reduction in the number of survey villages and to select 4 permanent research villages. Emphasis was given to three main research operations: diagnosis of farming systems; on farm testing of improved technologies and practices; and dissemination and extension. The agricultural practices survey completed its second year with more information collected on environmental and management practices.

The Nkolbisson TLU had as top priority in 1990 the closure on several research activities. The primary new initiative for 1990 was a series of attempts to establish alley cropping, border hedges and improved fallow sites. It was determined that variety introduction is the most promising avenue to increasing productivity. Fertilizer and other chemical components are not likely to be rapidly adopted. Problems were encountered in the establishment of border hedges.

Cereal Pathology concentrated on Maize pathology. Both Highland and Lowland varieties were screened at Foumbot and Nkolbisson. It appeared that both types of materials could be effectively screened at Foumbot thus reducing costs. In other tests the type of land preparation had significant effects on severity of Rhizoctonia blights.

The Rice Pathology program concentrated on the Mbo Plain. Studies were completed on effects of nitrogen, planting dates and soil preparation on the incidence of pyricularia.

Highland Cereals Entomology continued to work on grain storage methods useable by farmers. Local varieties of maize were still better when evaluated for storage qualities. Sealed storage was better than most other types. Addition of protective insecticides increased the quality of stored grain.

Lowland Cereals Entomology continued studies on the Maize stem borer. Trials tested chemical controls, effects of intercropping peanuts and manioc, soil fertility and selection of resistant varieties.

FORWARD

The purpose of the National Cereals Research and Extension (NCRE) Project is to develop Cameroonian institutional capacity to provide high quality research on cereals and to develop necessary linkages between farmers and researchers to facilitate the transmission of research results.

The NCRE project is co-sponsored by the Government of the Republic of Cameroon and the United States Agency for International Development. Through the NCRE Project, the International Institute of Tropical Agriculture (IITA) was contracted to provide technical assistance to the Institute of Agricultural Research (IRA) since 1981. IITA technical assistants work collaboratively with IRA national counterparts in cereals breeding, agronomy and farming systems research and extension.

This annual report gives an overview of research activities and findings of 1990, the fifth year of the second phase of the project. The report is divided into six substantive chapters, covering project administration, the four commodity research units (Maize, Rice, Cereals Agronomy and Sorghum/Millet) and the Testing and Liaison Units (TLUs).

The Maize Research Unit had four research programs in 1990: Highland Maize Breeding, Highland Maize Agronomy, Lowland Maize Breeding and Lowland Maize Agronomy. The Highland Maize Program is based in Bambui and the Lowland Maize Program at Nkolbisson.

The Rice Research Unit encompasses a Rice Breeding Program and a Rice Agronomy Program both based at Dschang.

The Cereals Agronomy Research Unit consists of a single research program based at Garoua. This unit is responsible for both maize and sorghum research on-station and on-farm.

The Sorghum and Millet Research Unit has a breeding program and an agronomy program at Maroua.

Testing and Liaison Units are the farming systems research and extension component of the project. There are four TLUs based at Bambui (Western Highlands), Ekona (High Rainfall Humid Forest), Maroua (Sudano-Sahelian) and Nkolbisson (Semi-humid forest).

In addition to these programs there are support units within IRA such as plant pathology (Bambui) and cereal entomology (Dschang and Nkolbisson) which work with several cereal crops.

1. ADMINISTRATION

1.1 INTRODUCTION

During the fifth year of NCRE-Phase II, project staff continued to improve the research capacity of IRA. All parts of the IRA cereals program were involved with generating high quality research as well as improving the linkages between farmers and researchers to utilize these research results.

1.2 OUTPUTS AND ACCOMPLISHMENTS

Two IRA researchers successfully completed their degree programs in the USA and returned to duty in Cameroon. One more researcher completed his in-country field work for advanced degree program and one researcher completed all requirements for his PhD degree. Seven other IRA researchers continued their programs of study for advanced degrees in the US. Three IRA researchers departed for graduate training in the USA. Twelve researchers were selected for degree study programs in the USA under contract III.

Short term training in Cameroon included a workshop on MSTAT held in Yaounde and Maroua. Training in the use of word processing software was given by Mr. C. Mouang at several NCRE locations during 1990.

During 1990 NCRE contract III project proposal, budget and contract were drafted and negotiated. An outside consultant, Dr. Guy Baird, was recruited to assist writing the contract III proposal. Subsequent negotiations resulted in a budget for the proposed work plan. A final contract was written and negotiated among staff of IRA, USAID and IITA. Bids were solicited and evaluated for sub-contracting of purchasing and long term training services under NCRE III. USAID completed a commodity inventory and end use check of all project equipment and supplies. Advertising and interviews were started to recruit new staff for contract III.

Over 125 visitors passed through the headquarters office during 1990. Visitors included officials from Cameroon government ministries, foreign embassies, national research programs of other African nations, international research centers, American university staff, local schools and officials of USAID.

The NCRE project financed attendance of 20 staff and counterparts in 13 national and international meetings, symposia and seminars during 1990. Project staff and counterparts participated in numerous other meetings and conferences under the sponsorship of various international funding agencies. All NCRE staff participated in regional planning meetings to determine annual work plans and objectives.

A few remaining items of equipment and supplies were received during 1990 that had been on order. These items were dispatched to each location as required. Among the equipment items received was a year's supply of maize pollinating bags and special mesh bags for drying maize cobs.

Five consultants assisted the project during 1990. Dr. R. Boxall toured all NCRE locations to evaluate the scope for on-farm research of grain storage problems. Dr. N. Hulugalle evaluated soil erosion problems and research methodologies in Garoua. Dr. B. T. Kang evaluated methods of better soil management to control erosion, also in Garoua. Dr. K. Nwanze trained technicians in the Sorghum program to evaluate insect damage in the field. Dr. J. Poku served as an in-project consultant to the Cereals Agronomy program to make an evaluation of weed management problems in the north.

1.2.1 Chief of Party

GOAL: To assist researchers in achievement of project goals.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. Provide overall planning and supervision of technical performance of technical assistance team.	1.1 Staff meetings held 1.2 Field visits undertaken.	1. Annual program planning meetings held in February. Semi-Annual Progress Report, Annual Workplans were published.
2. Facilitate liaison between USAID, IITA, IRA and other organizations cooperating with the project.	2. People aware of project activities and accomplishments, activities coordinated.	2. Meetings were held between IITA, USAID and IRA to define details of NCRE III budget and contract.
3. Provide leadership to technical assistance team in applying research to local problems.	3. Rational work plans.	3. Field visits were undertaken and technical discussion were held.
4. Plan and coordinate long-term and short-term training of national counterparts.	4. Achievement of training goals.	4. Two National Counterparts returned from training. Twelve have been selected to leave for training.
5. Guide and assist administrative officer in providing administrative and logistical support to staff.	5. Staff able to accomplish research objectives.	5. Weekly meetings held with Administrative staff, gave new responsibilities to Administrative Officer.

1.2.2 Deputy Chief of Party

Goal: To assist the Chief of Party and act for him during his Absence.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. Design and install computerized inventory system to facilitate management of project equipment and supplies.	1. Computerized Inventory System.	1. System designed and written. Testing completed. User's manual printed. Data entry completed.
2. Design and install computerized accounting system to manage project finances.	2. Computerized Accounting System	2. System designed and written. Preliminary testing completed. System placed in service at Nkolbisson office.
3. Prepare computer training for staff to permit their efficient use of computers.	3. Training materials and course presentations.	3. Staff able to use word processor for scientific writing.
4. Assist in preparation of semi-annual progress report.	4. Semi-annual progress report.	4. Report finished and copies distributed to interested parties on time.

1.2.3 Administrative Officer

GOAL: To assist researchers in achievement of project goals

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. Facilitate liaison between researchers, IITA and USAID.	1.1 Reports Prepared 1.2 Policy statements issued	1. Monthly financial reports are up to date.
2. Provide administrative support to researchers.	2. Researchers free work toward goal achievement	2. Rental contract and payments are up to date. Staff assisted for annual leave.
3. Provide research, office materials and vehicles to researchers.	3. Materials to researchers	3. All equipment orders received and inventoried.
4. Computerize office operations.	4. Reports produced accurately efficiently and on schedule	4. All staff using computers for reports and data analysis.

1.3 OTHER ACTIVITIES

In addition to the regular processing of financial reports and expense claims a large number of travel arrangements were made for staff and counterparts to attend professional meetings, training programs and to provide staff with home leave arrangements.

2. MAIZE RESEARCH UNIT

2.1 HIGHLAND MAIZE BREEDING

2.1.1 INTRODUCTION

This was a landmark year for Highland Maize Breeding in several respects: 1. Three populations under development since 1984 were tested for the first (ATP and Early White) or second (HAP) year as varieties, and are proving successful. 2. The second year of testing of advanced hybrids confirmed five entries which could now be placed in pilot seed production testing. 3. The first counterpart breeder returned from M.S. training and a second departed for training. 4. Screenhouses for streak virus resistance screening, requested since 1984, arrived in November and plans are underway to set them up.

A major effort was made to put genetic materials developed over the past seven years into the international maize breeding systems as well as into long term storage for safeguarding. Visiting breeders from CIMMYT-Harare, Pioneer Overseas (Harare), Zambia, and IITA observed these materials in the field and were sent major shipments of lines and varieties. Arrangements for long term storage are being made with CIMMYT-Mexico and USDA.

2.1.2. OUTPUTS AND ACCOMPLISHMENTS

GOAL: To increase maize production in Cameroon through the identification and development of suitable maize varieties for highland areas.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. Improve varietal source populations.	1. Source populations improved for agronomic traits.	1.1 Population ATP was cycled through two location half-sib family selection. 1.2 Testcross selection of Population 32 at three sites identified best combining lines for recombination. 1.3 Selections from the High Altitude population were recombined to complete cycle 2 of half-sib family selection.
2. Select new varieties for possible release.	2. Data on new varieties considered for release.	2.1 The National Variety Trial-Midaltitude Late (NVT-HAL) was evaluated at 6 locations. The new ATP population ranked high in yield.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
		2.2. The NVT-MAE (early) identified the new Early White population as the best overall early maturing variety. 2.3 The NVT-HA (high altitude) identified the HCP as the best overall high altitude entry but indicated the need to use the Improved Ndu Local and Pool 9a, Synthetic as donor of better ear and plant traits respectively.
3. Develop inbreds for synthetics, hybrids, and population improvement.	3.1 New inbred lines selected for agronomic traits. 3.2 Improved source synthetics for inbred extraction and variety formation.	3.1 Selection and selfing was made in lines at all stages of inbreeding. Selection among 290 testcross entries was made across 3 locations, with selections advanced to hybrid testing. 3.2 Formation of varietal synthetics from selected inbreds continues. 3.3 Selected inbreds are intermated within heterotic groups to initiate new inbred formation.
4. Select hybrids for release.	4. Data on hybrids considered for release.	4.1 Evaluation of 168 preliminary hybrids plus checks was made, across four locations. 26 entries were selected for the 1991 advanced hybrid trial. 4.2 The 16 entry advanced hybrid trial identified 5 selections which could be tested in pilot seed production by potential hybrid seed producers.
5. Improve and increase seed of new and established varieties.	5.1 Seed for agronomic trials. 5.2 Foundation seed for seed producers. 5.3 Breeder seed for next cycle.	5. Ear to row selection/seed increase, averaging 0.3 ha each, was made for 15 varieties.

2.1.3. OTHER ACTIVITIES

Mr. J. Eta-ndu, having completed his M.S. in plant breeding, returned in January, and Mr. M. Ndioro departed in March, also for M.S. training at the University of Minnesota. Mr. Z. Ngoko returned in December with an M.S. in Plant Pathology from Texas A&M, and Mr. C. Nankam was selected by IRA to depart for a Ph.D. program (four years after completing his M.S) under the project.

Technicians and counterpart scientists continued on-the-job training, with two new technicians being added to the unit, one each in Bambui and Foumbot.

Dr. Everett attended the IITA Maize Program workplan conference and Dr. K. Fischer IITA DDG (Research) visited this unit from IITA. Dr. C. Mungoma, principal maize breeder for Zambia, visited the program for six weeks at harvest. Dr. K. Short, principal midaltitude breeder for CIMMYT-Harare (responsible for East and Southern Africa) and Mr. B. McCarter of Pioneer Overseas, Harare, (responsible for all midaltitude breeding for Africa) visited for one week during harvest. Dr. Short brought data indicating that some lines we had previously supplied had been at the top of their testcross trials in Zimbabwe.

Seed of inbreds, hybrids, and open pollinated varieties was provided to CIMMYT-Harare, Pioneer-Harare, Zambia and IITA. Seed of lines and varieties is being sent for long term storage at the USDA and CIMMYT-Mexico.

Dr. Everett presented a paper ("Maize inbred line development for the midaltitude zone of Cameroon", L. Everett, J. Eta-ndu, M. Ndioro, and I. Tabi) at the American Society of Agronomy meetings in San Antonio.

Equipment on request and delivered in 1990 included two screenhouses for maize streak virus resistance breeding at Foumbot, two heavy disks for primary tillage at Foumbot and Bambui, an equipment trailer, a single ear power sheller and some hand shellers. In this end of phase year, it should be noted that this unit, since 1984, has been responsible for most major equipment purchases at Bambui Station, including three tractors, plows, disk-harrows, heavy disks, and laboratory equipment (incubator, sterile transfer hood, microscopes, etc.).

Facilities development (work space, seed store, seed dryer, etc.) did not progress at Bambui in 1990. Designs for these facilities still have not been coordinated with this unit.

2.1.4. RESEARCH FINDINGS

2.1.4.1. Improve Varietal Source Populations

The Acid Tolerant Population (ATP) was evaluated as half sib families (cycle 4, 338 entries, 2 reps per location) at Bambui Plain (acid site) and Bansoa (fertile site). Thirty nine families were selected to advance the population by recombination in the dry season nursery. Yellow flinty grain, high yield, and good plant type continue to be principal selection criteria.

Fifty four families selected in the 1989 High Altitude Population (HAP) half sib family trial were recombined to complete cycle 2. It is recommended that HAP be improved in ear-to-row isolation selection in future years, since only one generation per year can be obtained in the high altitude zone (1700-2200m). HAP is still maintained as a mixed white and yellow grain type, with the option of using either color in variety formation. In the nursery recombination of selected families, crosses of HAP to Improved Ndu Local and Pool9a Synthetic were made as a first step of incorporating traits from these populations (ear type from Ndu Local and plant type from Pool9a Synthetic).

Population 32 (Eto) line testcrosses onto the B heterotic group single cross tester were evaluated at three locations and selected lines were placed in the 1990B nursery to recombine the population as an improved source of inbred lines. The population still lacks streak virus resistance, but is acceptable for other midaltitude leaf diseases. Population 32 has excellent plant type and white flinty grain.

Population 43SR, having been selected for leaf disease resistance at the S1 and S2 stages in the nursery, was recombined twice. As resistance to midaltitude leaf diseases is not yet sufficient for inbred extraction, selfing to S3 with selection and subsequent recombination should precede inbred extraction, as was the procedure with Population 32.

In addition very small programs in sweet-corn conversion progressed, producing MSR-sh improved one cycle for germination, and MSR-su (BC2), making available two types of midaltitude adapted sweetcorns. MSR-sh is very sweet with the long shelf life typical of the sh gene, but with poor germination. MSR-su has good germination but has more starch (less sweet).

2.1.4.2. Select New Varieties for Possible Release

Advanced open pollinated variety trials were run in the mid and high altitudes. In the midaltitudes, they consisted of a late set, National Variety Trial-Midaltitude Late (NVT-MAL) and an early set, NVT-MAE. The sites were Foumbot (1000m, fertile), Bansoa (1400m, fertile), Bambui Plain (1300m, acid), and Babungo (1100m, fertile) in the Western Highlands, and Mbang Mbirni and MAISCAM (both apparently moderately acid and approximately 1100m altitude) on the Adamawa Plateau. A site at Tibati was flooded out.

In the NVT-MAL (Tables 1 and 2), entries included COCA, Shaba, Ebt(5)MSR87 and three varietal synthetics as late maturing, white grained varieties, Kasai as a short, intermediate white entry, two versions of ATP as a late yellow flint, and ZS206 (from Zimbabwe) as a hybrid check. ZS206 was superior in yield (average 18%) to the top o.p. vari..y at all locations except Foumbot, where a mid-vegetative growth drought and heat period favored an infection of lowland rust (Puccinia polysora), to which ZS206 is not resistant. As in the past, there was no significant difference among the open pollinated varieties across locations, so they must be differentiated based on other traits:

1. ATP and COCA were developed primarily at the acid, P fixing site of Bambui Plain, where they perform well. When grown on more fertile sites, they tend to be unacceptably tall and prone to lodging, and are thus preferable only on the more difficult soils. ATP had the least ear rot and flintiest grain in the trial.

2. Kasai has the shortest plant type and least lodging, and is thus still desirable at 1000-1300m on fertile soils.

3. The varietal synthetics as a group combined good agronomic traits, ear traits, and yield, to give the best total performance across sites.

4. Our field observations indicated that no open pollinated variety was superior across traits to Shaba on the Adamawa Plateau, preventing recommendation of a replacement.

In the early maturing trial (NVT-MAE), entries included Kasai (an intermediate check), BACOA (yellow dent/flint), the new Early White population (EW, a white flint), and our reselected version of the IITA EMSR population. Results (Tables 3 and 4) indicated:

1. BACOA and Kasai do not differ from each other in silking date (again indicating that BACOA is an intermediate, not early) and they are approximately five days later than EW and EMSR.

2. Surprisingly (for a mix of maturity types), there was no significant difference in yield of the four varieties.

3. The best agronomic scores were recorded for the EW population.

4. Considering the earlier flowering date as well as superior plant and ear types of EW, the current backcross program to obtain an early, streak resistant yellow variety, should be restructured to use BACOA as the donor of yellow grain color, and EW, which already has 50% streak resistant parentage, as the recurrent parent. This can be done in the EW isolation.

The IITA EVT-MSR (MSR variety trial) was run at Foumbot, Babungo, Mbang-Mbirni, Maiscam (Tables 5 and 6). Entries were experimental varieties from the first three cycles (1983, 85, and 87) of full sib family selection in MSR. Across 87 MSR was not available at one site, however. A hybrid check, 8537-18, outyielded the open pollinated varieties by approximately 2 T/ha. All open pollinated entries but one fell within one LSD of each other, i.e. no significant yield differences among them. Lowland rust was scored at Foumbot. Other traits did not differ substantially.

In the NVT-HA (high altitude), only three sites were available, so two trials were run per site. The same varieties were also compared in the TLU on-farm trials, with similar results to those presented here (see TLU report). As usual, the high altitude sites are more variable due to difficult soil conditions (acid, P fixing soils at Santa and Upper Farm), as well as a seedling root and stem rot at Santa which reduced stands. Entries included the High Altitude Population (HAP), Improved Ndu Local, COCA, and Pool9a Synthetic. Results across sites (Tables 7 and 8) indicated that HAP and Improved Ndu Local yielded significantly better than the other two entries. The best plant type, including lodging scores, was that of Pool 9a Syn, while the best ear scores were from Ndu Local and Pool 9a Syn. Ndu Local is least desirable for plant height. It is therefore recommended that the process of incorporating the best families of Ndu Local and Pool9a Syn into HAP for improvement of ear and plant type be continued, and that the high altitude program concentrate its efforts on ear to row selection/seed increase of HAP at Mbiyeh TDC, which is the site most representative of the high altitude maize growing zone.

2.1.4.3. Develop Inbreds for Synthetics, Hybrids, and Population Improvement

Selfing in crosses involving the reciprocal source synthetics and East African introductions continued, with segregating lines from S1 to S6 being advanced in the nursery. A new cycle of the reciprocal synthetics is being formed in the 1990B nursery.

Recycling of the best lines through the reciprocal synthetics A and B in a reciprocal recurrent selection system, using single cross testers at the S3 stage, provided the principal source of lines being advanced into 1991 preliminary hybrid trials. Testcross trials, totaling 290 entries with checks, were planted at 3 locations, 2 reps per location in 2-row plots. The S3's were advanced to S4's, and those lines selected in the testcrosses were planted in the 1990B nursery for formation of the preliminary hybrids.

Varietal Synthetic 4, first recombined in 1989B, was placed in ear to row isolation/recombination in 1990A. A third recombination is being done in the 1990B nursery. In the formation of future varietal synthetics it would be advisable to select the component inbreds for uniformity in plant type contribution, perhaps by a growout of a diallel among lines, to avoid the heterogeneity in the current synthetics. Grain color mixes can be maintained (as in Syn 4) in early recombinations and testing, with color sorting prior to varietal release. Given the performance of the varietal synthetics across traits, we can conclude that for the late maturing mid-altitude types (the thrust of the inbred development program), it is not necessary to maintain a parallel population improvement program for open pollinated variety development.

A small program of conversion of U.S. popcorn lines to midaltitude adaptation was advanced by selfing in the equivalent of the first backcross generation. Progress has been very slow, requiring two reversals of the backcross program to obtain better recombinants.

2.1.4.4. Select Hybrids for Release

The Advanced Hybrid Trial was run at the same six locations as the NVT-MA. Entries included 15 single crosses promoted from the 1989 preliminary hybrid and IITA hybrid trials, as well as the Zimbabwe ZS206 check. The trial was in 4 reps with 4-row plots. Results (Tables 9 and 10) indicated significant yield differences at all sites and across sites, with the check ranking third. The check yield was reduced at Foumbot by lowland rust (P. polysora); most NCRE lines carry some resistance to lowland diseases due to line selection at a transition altitude (1000m at Foumbot). ZS206 performed relatively better on the Adamawa Plateau, where the climate is more similar to Harare, Zimbabwe than the high rainfall Western Highlands. Based on agronomic and ear traits, five hybrids can be recommended for potential pilot seed production testing by seed companies: 88069 x 87036, 88094 x M131, 8534-7, 87366 x 88030, and 87014 x M131. The first is a yellow x white cross, and 8534-7 (an IITA hybrid) is a yellow flint; the others are white flint and flint/dent types. Husk cover and ear rot resistance of the NCRE hybrids is better than that of the check, and plant type and standability are good. At MAISCAM, where an apparent nutrient deficiency caused excessive stalk lodging, only 88069 x 87036 and ZS206 were standing well, however.

Four sets of preliminary hybrids were tested, 44 entries per set in 3 reps, 2-row plots at 4 locations (Foumbot, Bambui Plain, Babungo, and Mbang Mbirni). Checks were ZS206 and Fbt(5)MSR87, which ranged in yield from 10.1-10.8 and 7.1-7.4 T/ha respectively in the four sets across sites. The frequency of acceptable hybrids was higher than in the past (26 were selected for advancement), reflecting the improvement in parental lines developed in the program since 1984. Selection was based on agronomic type, husk cover, ear rot resistance, grain type (preference to flintier texture), and yield. These selections are flintier than the Zimbabwe hybrids, which increases resistance to storage pests and the yield of grits for the brewery industry. In the tables of top yielding entries plus checks across sites (Tables 11-14), hybrids selected for advanced trials are (by order of entry in the tables):

Set 1; 2,5,6,7,8,9,11,12
Set 2; 3,4,5,7,8,9,10,11,12
Set 3; 3,5,8,9,11
Set 4; 6,7,9,11.

Remnant seed of these hybrids and others was forwarded for observation in Zimbabwe and in Jos, Nigeria in 1991.

In addition, a trial of Pioneer hybrids from Zimbabwe was run at Foumbot, Babungo, and Mbang Mbirni, 3 reps per location, 2-row plots. Results (Tables 15-16) showed substantial variety x location interaction, reflecting partly the lowland rust infection at Foumbot on some entries. Husk cover, ear rot, and deep dent grain type are problems with most entries. Data has been forwarded to Pioneer-Zimbabwe to facilitate selection of hybrids for initial sale in Cameroon. Pioneer will be testing NCRE-IRA lines in combination with their own, which should improve their hybrids for the above traits. As no other seed company is currently installed in Cameroon, close cooperation of this unit with Pioneer will be essential to the eventual use of NCRE-IRA lines in hybrids produced and marketed in Cameroon.

2.1.4.5. Improve and Increase Seed of New and Established Varieties

Ear to row isolation/seed increases were made in 15 varieties, with 0.25 to 0.5 ha per variety. They include:
Bab(3)MSR89, Fbt(5)MSR87, Kasai, Early White, and Synthetic 4 at Foumbot; COCA, COCA-Lg2, BACOA, and ATP at Bambui Plain; Synthetic 3 at Babungo, Shaba at Mbang Mbirni, HAP and Improved Ndu Local at Santa; Ekona White and Ekona Yellow at Befang.

Kasai x MSR BC3 and COCA x Syn BC1 were screened and selfed at IITA, and the S1's were forwarded to Bambui while being screened and scored at IITA. Recombination of selected S1's will be made in 1991, giving the final version of streak resistant Kasai and COCA-SR BC1. After a second recombination, both varieties should be compared with the original varieties.

Foundation seed of the released varieties has been provided to MIDENO, UCCAO, and Projet Semencier. Seed of released and experimental varieties was provided to the TLU, Agronomy Unit, MIDENO, IRA-Dschang, and others for testing.

Table 1 1990 NATIONAL VARIETY TRIAL, MID - ALTITUDE LATE
TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
ZS 206	76	255	124	1.7	1.8
ATP-EV89	77	249	136	2.3	2.3
ATP 89	78	247	134	2.0	1.8
Synthetic 3	77	238	122	2.0	2.1
COCA	78	253	138	2.5	2.9
Synthetic 1	78	239	123	2.3	2.1
Synthetic 2	79	233	122	2.0	1.9
SHABA	78	244	123	1.9	1.7
KASAI	77	219	106	2.1	1.4
FBT MSR 87	79	244	121	2.7	1.9
Number of Locations	6	6	6	3	5
LSD (0.05)	1.1*	9.6	9.5*	0.6	0.4*
SE	0.41	4.30	4.12	0.20	0.17
CV%	2	6	12	32	30

CONTINUED

VARIETY	HUSK COVER (1-5)	PLANT ASPECT (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	YIELD T/HA
ZS 206	2.5	1.4	1.2	2.6	8.9
ATP-EV89	2.1	2.2	1.9	1.9	7.7
ATP89	1.8	2.3	2.0	1.9	7.6
Synthetic 3	1.9	2.0	1.8	2.2	7.6
COCA	1.8	3.0	2.2	2.6	7.5
Synthetic 1	1.8	1.8	2.0	2.0	7.4
Synthetic 2	1.8	2.1	2.0	2.0	7.3
SHABA	1.4	2.1	2.1	2.5	7.2
KASAI	1.6	1.3	2.5	2.4	7.1
FBT MSR 87	1.6	2.1	1.8	2.5	7.0
Number of Locations	5	5	6	6	6
LSD (0.05)	0.4	0.6*	0.4*	0.5*	0.8*
SE	0.14	0.19	0.11	0.15	0.24
CV%	33	25	23	22	10

* Variety x Location interaction used as error.

TABLE 2 1990 NATIONAL VARIETY TRIAL, MID - ALTITUDE LATE YIELD (T/HA) BY LOCATIONS

VARIETY	FOUMBOT	BANSOA	NTONIA	BABUNGO	MBANG MBIRNI	MAISCAM	AVERAGE
ZS 206	7.5	11.3	7.3	9.9	8.7	8.7	8.9
ATP-EV89	7.5	9.3	6.8	8.7	8.1	6.1	7.7
ATP 89	8.0	8.7	6.4	8.2	7.9	6.5	7.6
Synthetic 3	8.5	8.8	6.6	8.5	6.7	6.4	7.6
COCA	6.3	9.1	6.5	7.5	8.3	7.4	7.5
Synthetic 1	7.7	8.5	5.4	8.9	7.8	6.1	7.4
Synthetic 2	8.1	9.0	5.7	7.1	7.7	6.2	7.3
SHABA	7.6	8.5	5.6	7.7	7.8	6.0	7.2
KASAI	7.8	8.1	6.1	7.2	7.1	6.4	7.1
FBT5 HSR 87	7.2	8.4	5.9	7.5	6.9	5.8	7.0
LSD (0.05)	0.9	0.9	0.9	1.7	NS	1.3	0.8
SE	0.29	0.29	0.27	0.52	0.44	0.40	0.24
CV%	8	6	9	13	11	12	10

Table 3 1990 NATIONAL VARIETY TRIAL MID - ALTITUDE EARLY TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
Kasai	75	220	111	1.9	1.6
Bacoa	74	240	127	2.5	2.3
EW	71	209	102	1.6	1.6
EWSR	71	221	109	2.1	2.0
Number of Locations	6	6	6	6	6
LSD (0.05)	1.5	12.1	9.5	0.6*	0.5*
SE	0.33	2.7	3.31	0.20	0.16
CV%	2	6	14	27	26

CONTINUED

VARIETY	HUSK COVER (1-5)	PLANT ASPECT (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	YIELD T/HA
Kasai	1.5	1.8	1.9	1.8	7.2
Bacoa	2.4	2.9	2.1	2.3	7.2
EW	2.0	1.7	1.9	2.3	7.0
EHSR	1.9	2.4	2.7	2.4	6.8
Number of Locations	5	5	6	6	6
LSD (0.05)	0.3	0.5*	0.3	0.4*	NS
SE	0.11	0.11	0.11	0.15	0.13
CV%	27	22	24	22	9

* Location X Variety interaction used as error.

Table 4 1990 NATIONAL VARIETY TRIAL MID - ALTITUDE EARLY YIELD (T/HA) BY LOCATIONS

VARIETY	LOCATIONS						
	FOUMBOT	BANSOA	NFONTA	BABUNGO	NDANG NDIRNI	MAISCAM	AVERAGE
Kasai	8.6	7.5	6.3	7.9	6.6	6.3	7.2
Bacoa	7.4	8.0	6.0	8.5	6.4	6.6	7.2
EW	8.8	8.2	5.9	7.7	5.4	6.2	7.0
EHSR	8.0	8.0	5.7	7.5	5.6	5.9	6.8
LSD (0.05)	0.9	NS	NS	NS	NS	NS	NS
SE	0.28	0.30	0.16	0.32	0.42	0.28	0.13
CV%	7	8	5	8	14	9	9

Table 5

1990 EVT-MSR-WHITE TRIAL
TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)	RUST P.P (1-5)
ACR. 83 TZMSRW	78	248	137	1.8	2.6	4.5
BAB(3) 83 TZMSRW	76	244	128	1.7	2.7	4.7
GWE(1) 83 TZMSRW	78	249	140	1.7	2.5	3.5
JOS(2) 85 TZMSRW	75	239	124	1.5	2.1	3.7
FOU(1) 85 TZMSRW	76	248	128	1.7	2.2	4.2
HARARE 86 TZMSRW	77	248	132	2.0	2.7	4.0
JOS 87 TZMSRW	75	252	141	1.9	2.4	4.0
FBT 5 MSR 87	76	247	130	1.6	2.7	3.5
8537 - 18	75	254	136	1.6	2.7	3.0
COCA	77	262	141	1.9	3.0	5.0
FBT 3 MSR 85	76	255	135	1.6	2.7	4.2
Number of Locations	4	4	4	4	4	1
LSD (0.05)	1.3*	10.1*	9.5	NS	0.5*	0.7
SE	0.83	5.18	3.41	0.15	0.25	0.25
CV%	2	6	10	35	28	12

CONTINUED

VARIETY	HUSK COVER (1-5)	PLANT ASPECT (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	YIELD T/HA
ACR. 83 TZMSRW	1.8	2.7	2.7	2.5	7.0
BAB(3) 83 TZMSRW	1.8	2.7	2.5	2.4	6.9
GWE(1) 83 TZMSRW	1.6	2.0	2.3	2.9	7.0
JOS(2) 85 TZMSRW	1.8	2.0	2.7	2.7	6.6
FOU(1) 85 TZMSRW	1.7	2.2	2.6	2.5	7.0
HARARE 86 TZMSRW	1.8	2.7	2.3	2.7	7.4
JOS 87 TZMSRW	2.1	2.3	1.9	2.4	7.3
FBT 5 MSR 87	1.7	2.2	2.2	2.5	7.3
8537 - 18	2.7	2.2	1.2	1.9	9.2
COCA	2.1	2.9	2.3	2.8	7.2
FBT 3 MSR 85	1.6	2.6	2.2	2.6	7.5
Number of Locations	3	3	4	4	4
LSD (0.05)	0.5*	0.5	0.3*	0.4	0.6
SE	0.21	0.17	0.14	0.13	0.20
CV%	30	25	20	21	11

* Location x Variety interaction used as error.

Table 6 1990 EVT - MSR - WHITE
YIELD (T/HA) BY LOCATIONS

	LOCATIONS				
VARITY	FOUMBOT	BABUNGO	NDANG-MBIRNI	MAISCAM	AVERAGE
ACR. 83 TZMSRW	7.5	7.1	7.4	5.8	7.0
BAB(3) 83 TZMSRW	6.8	7.6	7.8	5.3	6.9
GW(1) 83 TZMSRW	7.0	7.1	7.8	6.0	7.0
JOS(2) 85 TZMSRW	6.9	6.9	7.5	5.0	6.6
FOU(1) 85 TZMSRW	7.3	7.4	7.3	5.8	7.0
BARARE 86 TZMSRW	7.3	7.6	9.1	5.7	7.4
JOS 87 TZMSRW	7.6	7.5	8.0	6.3	7.3
FBT 5 MSR 87	7.1	8.3	8.0	5.9	7.3
ACR 87 TZMSR		7.6	7.9	6.1	
8537 - 18	9.5	9.8	10.3	7.1	9.2
COCA	6.1	8.1	8.6	6.1	7.2
FBT 3 MSR 85	7.9	8.0	8.5	5.6	7.5
LSD (0.05)	0.9	0.8	1.5	NS	0.6
SE	0.30	0.28	0.54	0.45	0.20
CV%	8	7	13	15	11

Table 7 1990 NATIONAL VARIETY TRIAL, HIGH - ALTITUDE
TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
NAP	100	247	138	1.6	2.3
Ndu Local	102	264	154	2.1	2.0
COCA	99	235	124	1.8	2.5
POOL 9A SYN	101	241	130	1.6	1.9
Number of Locations	6	6	6	6	6
LSD (0.05)	1.5	10.1*	9.5*	NS	0.4
SE	0.51	2.40	2.16	0.20	0.14
CV%	2	5	8	56	33

CONTINUED

VARIETY	HUSK COVER (1-5)	PLANT ASPECT (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	YIELD T/HA
HAP	2.3	2.0	1.7	2.6	5.5
Ndu Local	1.7	2.6	1.6	2.0	5.5
COCA	1.5	1.7	2.0	3.0	4.8
POOL 9A SYN	1.8	1.7	1.9	2.0	4.6
Number of Locations	6	6	6	6	6
LSD (0.05)	0.4	0.6*	NS	0.5*	0.5
SE	0.14	0.12	0.13	0.12	0.16
CV%	38	29	35	25	15

* Location x Variety interaction used as error.

Table 8

1990 NATIONAL VARIETY TRIAL, HIGH-ALTITUDE
YIELD (T/HA) BY LOCATIONS

VARIETY	LOCATIONS						
	SANTA1	SANTA2	MBIYEH1	MBIYEH2	UPPER FARM1	UPPER FARM2	AVERAGE
HAP	4.8	5.6	5.8	7.1	4.8	5.1	5.5
Ndu Local	5.0	4.6	6.1	7.0	4.8	5.3	5.5
COCA	4.2	5.7	4.4	5.5	3.9	4.9	4.8
POOl 9A SYN	3.9	4.1	5.2	6.2	3.5	4.5	4.6
LSD (0.05)	0.7	NS	NS	NS	NS	NS	0.5
SE	0.22	0.51	0.51	0.44	0.34	0.22	0.16
CV%	10	20	19	14	15	9	15

Table 9 1990 ADVANCED HYBRID TRIAL
TRAITS ACROSS LOCATIONS.

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
88069 X 87036	78	271	133	1.3	1.3
88069 X H131	78	257	122	1.6	1.9
ZS206	76	248	126	1.5	1.7
88094 X H131	77	253	124	1.6	1.9
8556 - 6	77	257	133	2.0	2.4
8534 - 7	75	242	116	1.7	1.5
88010 X H131	77	243	117	1.8	2.1
88036 X H131	79	256	132	1.6	2.0
88210 X C70	78	245	128	1.9	1.4
87366 X 88030	79	252	122	2.0	1.4
87014 X H131	80	244	124	1.3	2.0
88010 X C70	78	250	122	1.6	2.0
87047 X H131	79	237	123	1.5	2.5
88103 X C70	79	258	134	1.4	2.4
8535 - 23	78	239	133	1.8	1.7
8536 - 23	77	233	121	1.3	2.4
Number of Locations	6	6	6	6	6
LSD (0.05)	1.3*	8.9	7.7	NS	0.7*
SE	0.29	3.19	2.75	0.11	0.12
CV %	2	6	11	35	31

Table 9 CONTINUED

VARIETY	HUSK COVER (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	PLANT ASPECT (1-5)	YIELD T/HA
88069 X 87036	2.2	1.9	2.0	1.8	11.1
88069 X M131	2.6	2.1	2.5	1.6	10.8
ZS206	2.8	1.4	2.6	1.6	9.9
88094 X M131	1.6	1.6	1.9	1.9	9.8
8556 - 6	2.1	2.0	2.3	2.5	9.4
8534 - 7	1.7	1.9	2.0	1.3	9.1
88010 X M131	1.1	1.9	2.0	1.7	9.1
88036 X M131	1.2	2.2	2.0	2.0	9.1
83210 X C70	1.4	1.7	1.9	2.0	9.0
87366 X 88030	1.2	2.2	1.4	1.9	8.9
87014 X M131	1.6	1.8	1.9	1.6	8.8
88010 X C70	1.2	2.0	1.8	1.6	8.8
87047 X M131	1.7	2.0	2.4	1.8	8.7
88103 X C70	1.3	1.3	2.0	1.3	8.6
8535 - 23	1.3	2.3	1.4	2.0	8.4
8536 - 23	1.6	2.5	2.6	1.7	8.0
Number of Locations	5	6	6	5	6
LSD (0.05)	0.4*	0.5*	0.5*	0.5*	0.9*
SE	0.11	0.16	0.10	0.12	0.17
CV %	29	22	23	30	9

* Location x Variety interaction used as error.

__Table 10__

1990 ADVANCED HYBRID TRIAL
YIELD (T/HA) BY LOCATION

	LOCATIONS						
VARIETY	FOUHBBOT	BANSOA	MFONTA	BABUNGO	MBANG-MBIRNI	MAISCAM	AVERAGE
88069 X 87036	11.1	13.0	8.4	11.9	13.0	9.4	11.1
88069 X M131	10.4	13.5	8.5	12.5	10.9	8.8	10.8
ZS 206	7.7	12.0	8.1	10.3	11.5	9.9	9.9
88094 X M131	9.5	12.9	7.9	9.6	11.1	8.0	9.8
8556-6	9.2	11.5	8.2	9.2	10.3	7.8	9.4
8534-7	9.9	10.5	8.1	9.5	9.2	7.8	9.1
88010 X M131	9.4	9.9	7.2	9.8	10.3	7.8	9.1
88036 X M131	9.4	11.8	7.4	9.8	8.5	7.4	9.1
88210 X C70	8.5	11.5	6.9	10.2	9.6	7.7	9.0
87366 X 88030	9.6	10.9	7.0	9.5	9.2	6.9	3.9
87014 X M131	8.6	11.6	6.8	9.9	10.1	6.3	8.8
88010 X C70	8.6	10.1	6.3	8.4	10.8	8.4	8.8
87047 X M131	9.1	10.2	6.8	8.7	9.8	7.8	8.7
88103 X C70	8.8	10.4	6.2	9.8	9.5	6.6	8.6
8535-23	8.2	9.5	7.2	8.0	10.3	7.1	8.4
8536-23	6.0	7.5	7.3	9.7	10.7	6.9	8.0
LSD (0.05)	0.7	1.0	0.9	0.9	1.9	1.4	0.9
SE	0.23	0.35	0.32	0.33	0.67	0.50	0.17
CV%	5	6	9	7	13	13	9

Table 11 1990 HYBRID SET 1 TOP YIELDING ENTRIES
TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
88069 X 89246	75	263	129	1.8	1.7
88069 X 88091	73	254	129	1.3	1.3
88069 X 89299	78	256	129	1.5	1.7
ZS 206	73	248	121	1.8	1.4
87366 X 89311	73	241	122	1.8	1.8
87366 X C70	75	239	118	2.2	1.8
88069 X 89207	74	239	116	1.5	1.5
87366 X 89199	73	251	128	1.8	1.4
89223 X 88099	73	258	136	1.4	1.3
87014 X 89293	73	234	121	1.4	1.3
87366 X 89243	76	243	127	2.3	1.8
87366 X 89296	75	238	134	2.2	1.5
Fbt 5 HSR 87	76	244	125	1.6	2.0
Number of Locations	4	4	4	4	4
LSD (0.05)	1.8*	14.5*	11.1*	0.7*	NS
SE	0.55	4.50	3.48	0.15	0.17
CV%	3	7	10	31	37

CONTINUED

VARIETY	HUSK COVER (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	PLANT ASPECT (1-5)	YIELD T/HA
88069 X 89246	2.8	1.8	2.8	2.1	11.3
88069 X 88091	2.7	1.8	1.7	1.8	10.9
88069 X 89299	1.8	2.9	2.6	1.9	10.7
ZS 206	2.6	1.3	2.8	1.9	10.4
87366 X 89311	1.6	1.6	1.8	1.8	9.8
87366 X C70	1.2	1.7	2.7	2.0	9.8
88069 X 89207	2.1	1.8	2.1	1.7	9.7
87366 X 89199	1.3	1.3	1.6	1.7	9.7
89223 X 88099	1.8	1.3	1.9	2.5	9.5
87014 X 89293	2.6	1.7	2.5	1.7	9.5
87366 X 89243	1.1	1.8	1.7	1.9	9.5
87366 X 89296	2.6	1.8	2.4	2.0	9.3
Fbt 5 HSR 87	1.5	2.3	3.3	2.4	7.1
Number of Locations	4	4	4	4	4
LSD (0.05)	0.6*	0.5*	0.6*	0.5*	1.1*
SE	0.16	0.15	0.14	0.15	0.24
CV%	31	25	21	29	9

* Location x Variety interaction used as error.

Table 12 1990 HYBRID SET 2 TOP YIELDING ENTRIES TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
ZS 206	73	262	138	1.8	1.6
88098 X 89299	73	257	139	2.1	1.5
89274 X 89302	72	241	134	1.5	1.3
89274 X 89293	72	252	134	1.4	1.2
89277 X 89302	72	237	132	1.3	1.4
88099 X 89182	72	251	130	1.5	1.4
89277 X 89293	74	243	129	1.6	1.3
89223 X 89258	72	248	127	1.8	1.2
Z28 X 89293	76	248	136	1.7	1.2
88099 X M131	73	[illegible]	135	1.4	1.7
Z28 X 89242	75	253	134	1.8	1.6
89223 X 89260	76	236	125	1.3	1.2
Fbt 5 HSR 87	76	248	129	1.8	2.2
Number of locations	4	4	4	4	4
LSD (0.05)	1.5	9.2	10.3*	0.6*	0.8*
SE	0.53	3.34	3.25	0.14	0.18
CV%	3	5	9	30	35

CONTINUED

VARIETY	HUSK COVER (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	PLANT ASPECT (1-5)	YIELD T/HA
ZS 206	2.4	1.4	2.8	1.8	10.8
88098 X 89299	1.1	2.2	2.7	2.1	10.7
89274 X 89302	1.3	2.4	1.8	1.8	10.3
89274 X 89293	1.4	1.8	1.9	1.8	10.2
89277 X 89302	1.9	2.5	2.4	1.7	9.9
88099 X 89182	1.7	2.1	2.0	2.0	9.8
89277 X 89293	1.7	1.3	2.1	2.3	9.7
89223 X 89258	1.5	1.8	1.6	1.8	9.6
Z28 X 89293	1.5	1.3	2.1	2.2	9.5
88099 X M131	1.5	2.1	2.0	2.2	9.4
Z28 X 89242	1.0	1.8	2.4	2.4	9.3
89223 X 89260	1.0	2.1	1.6	1.4	9.2
Fbt 5 HSR 87	1.7	2.6	3.2	2.5	7.4
Number of locations	4	4	4	4	4
LSD (0.05)	0.6*	0.5*	0.6*	0.6*	0.9*
SE	0.15	0.13	0.15	0.16	0.23
CV%	33	21	21	27	9

* Location x Variety interaction used as error.

Table 13 1990 HYBRID SET 3 TOP YIELDING ENTRIES
TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
ZS 206	73	259	133	1.9	2.0
89291 X M131	75	260	136	2.4	3.1
89258 X 89182	70	245	124	1.8	1.7
89258 X 89203	71	248	132	1.6	2.7
89258 X C70	74	244	127	1.5	1.7
89248 X 89243	78	253	131	2.3	2.3
89243 X 89299	76	247	143	2.5	1.8
89246 X C70	77	253	128	1.9	1.7
88099 X 89260	70	253	133	1.4	1.6
89291 X 88099	74	257	135	1.6	2.4
89258 X 89248	75	254	134	1.6	1.8
Fbt 5 MSR 87	76	244	123	1.9	1.9
Number of locations	4	4	4	4	4
LSD (0.05)	1.9*	11.1*	9.0	0.6*	0.9
SE	0.50	3.40	3.30	0.17	0.20
CV %	2	5	9	31	35

CONTINUED

VARIETY	HUSK COVER (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	PLANT ASPECT (1-5)	YIELD T/HA
ZS 206	2.4	1.5	3.0	2.0	10.2
89291 X M131	2.3	1.8	2.8	2.3	10.1
89258 X 89182	1.6	1.8	2.0	1.8	10.1
89258 X 89203	1.6	1.9	2.9	2.4	10.0
89258 X C70	2.0	1.9	2.4	1.9	9.9
89248 X 89243	1.0	1.8	2.3	2.2	9.8
89243 X 89299	1.0	2.7	2.3	1.9	9.8
89246 X C70	1.3	1.4	1.9	1.8	9.6
88099 X 89260	2.3	1.8	1.7	2.0	9.6
89291 X 88099	3.3	1.5	2.9	2.5	9.6
89258 X 89248	2.1	2.3	2.5	2.2	9.2
Fbt 5 MSR 87	1.6	2.3	3.2	2.5	7.3
Number of locations	4	4	4	4	4
LSD (0.05)	0.5*	0.5*	0.6*	0.5*	1.0*
SE	0.12	0.15	0.15	0.16	0.23
CV %	29	25	19	27	9

* Location x variety interaction used as error.

Table 14 1990 HYBRID SET 4 TOP YIELDING ENTRIES TRAITS ACROSS LOCATIONS.

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
89293 X 89299	77	248	133	2.2	1.8
ZS 206	73	254	132	2.0	1.5
89558 X 89292	74	252	126	1.8	1.7
88098 X 89292	74	247	132	1.6	1.8
89291 X 89302	74	233	118	1.6	2.0
89293 X 89302	75	231	120	2.0	1.3
89293 X 89310	77	255	137	1.4	1.3
89302 X 89292	75	230	120	1.9	2.1
89310 X C70	77	254	135	1.8	1.5
89310 X 89258	76	241	121	1.7	1.5
89302 X 88099	75	224	117	1.3	1.4
Fbt 5 MSR 87	76	242	125	1.7	1.6
Number of Locations	4	4	4	4	4
LSD (0.05)	1.9*	13.6*	11.5*	0.6*	0.8*
SE	0.57	4.08	3.38	0.17	0.17
CV%	3	6	9	33	32

CONTINUED

VARIETY	HUSK COVER (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	PLANT ASPECT (1-5)	YIELD T/HA
89293 X 89299	2.1	1.3	2.3	2.6	10.4
ZS 206	2.6	1.5	2.9	1.9	10.1
89558 X 89292	2.8	1.4	2.4	2.0	10.0
88098 X 89292	2.3	1.2	2.4	1.9	9.8
89291 X 89302	2.6	1.4	2.3	1.7	9.5
89293 X 89302	2.5	1.3	1.8	1.9	9.4
89293 X 89310	1.9	1.7	2.3	2.7	9.4
89302 X 89292	2.8	1.6	2.9	1.9	9.2
89310 X C70	1.2	1.8	2.1	1.9	9.0
89310 X 89258	2.0	2.1	2.1	1.9	8.7
89302 X 88099	2.1	1.8	1.8	1.5	8.6
Fbt 5 MSR 87	1.3	2.5	3.2	2.3	7.2
Number of Locations	4	4	4	4	4
LSD (0.05)	0.6*	0.5*	0.6*	0.6*	0.7*
SE	0.18	0.14	0.15	0.16	0.26
CV%	31	26	20	27	10

* Variety x location interaction used as error.

TABLE 15 1990 PIONEER HYBRIDS TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT (CM)	EAR HEIGHT (CM)	ROOT LODGE (1-5)	STALK LODGE (1-5)
Y9G65	69	230	112	1.4	1.4
8919964	69	234	112	2.3	2.1
8919565	72	236	108	1.7	1.8
Y9E67	67	224	101	1.6	1.6
8919556	69	238	108	2.1	2.1
88144242	74	226	112	3.0	2.2
Y9E72	69	211	101	2.3	1.6
Y9E73	68	226	106	2.2	2.0
Y9E74	70	236	107	2.2	2.1
8919589	70	232	105	1.6	1.3
8919598	71	212	104	2.0	2.0
8919638	72	228	108	1.4	1.6
8919577	73	237	117	1.8	1.8
8919552	70	224	113	1.7	1.6
8815765	71	236	109	1.8	1.6
8919616	70	222	105	2.7	2.0
ZS206	74	251	125	2.6	2.0
R215	71	233	111	1.6	3.0
SC501	72	242	136	2.3	2.1
ZS225	69	238	109	1.8	3.0
Number of Locations	3	3	3	3	3
LSD (0.05)	1.9	1.3	13	1.0	0.7*
SE	0.69	4.60	4.57	0.38	0.25
CV%	3	6	12	31	30

CONTINUED

VARIETY	HUSK COVER (1-5)	PLANT ASPECT (1-5)	EAR ASPECT (1-5)	EAR ROT (1-5)	YIELD T/HA
Y9G65	1.4	1.7	2.8	2.4	9.2
8919964	2.3	2.3	2.7	2.2	8.5
8919565	3.0	2.0	2.3	3.0	8.4
Y9E67	3.7	1.9	1.9	2.7	9.3
8919556	2.1	2.2	2.0	2.0	9.7
88144242	1.7	2.7	1.9	1.9	8.3
Y9E72	2.7	1.2	2.8	2.9	8.7
Y9E73	2.2	2.0	2.9	2.2	8.4
Y9E74	1.9	2.3	2.8	2.3	8.4
8919589	1.4	1.8	2.6	2.0	9.1
8919598	2.1	2.0	2.2	2.6	9.1
8919638	3.0	2.0	2.7	2.8	9.0
8919577	2.6	2.3	1.8	2.2	9.6
8919552	2.1	2.0	2.4	2.6	8.8
8815765	2.7	1.9	1.9	2.1	9.9
8919616	2.2	2.0	2.6	2.6	9.2
ZS206	2.8	2.2	1.4	2.2	9.7
R215	3.4	2.6	3.0	2.8	7.7
SC501	3.3	2.6	2.7	3.2	8.1
ZS225	2.2	2.7	2.4	3.0	8.5
Number of Locations	3	3	3	3	3
LSD (0.05)	0.7*	0.6*	0.6*	0.6*	1.5*
SE	0.26	0.21	0.22	0.20	0.55
CV%	25	24	18	17	10

* Location x Variety interaction used as error.

Table 16 1990 PIONEER HYBRIDS YIELD (T/HA) BY LOCATIONS

VARIETY	LOCATIONS FOUMBOT	BABUNGO	MBANG-MBIRNI	AVERAGE
Y9G65	10.3	8.5	8.7	9.2
8919964	7.5	8.4	9.6	8.5
8919565	8.4	8.3	8.5	8.4
Y9E67	9.7	9.6	8.6	9.3
8919556	10.3	8.8	10.1	9.7
88144242	6.6	9.0	9.3	8.3
Y9E72	9.2	7.5	9.4	8.7
Y9E73	8.5	8.3	8.4	8.4
Y9E74	8.2	8.0	9.2	8.4
8919589	10.1	9.1	8.2	9.1
8919598	10.2	8.0	8.9	9.1
8919638	8.5	9.0	9.7	9.0
8919577	8.2	9.5	11.2	9.6
8919552	8.3	8.7	9.4	8.8
8815765	9.6	10.8	9.4	9.9
8919616	9.3	8.7	9.4	9.2
ZS206	7.8	9.2	12.0	9.7
R215	7.4	7.5	8.4	7.7
SC501	8.4	8.3	7.4	8.0
ZS225	7.2	8.9	9.5	8.5
LSD (0.05)	1.0	1.3	1.9	1.5*
SE	0.37	0.46	0.69	0.55
CV%	7	9	13	10

* Location x Variety interaction used as error.

2.2 HIGHLAND MAIZE AGRONOMY

2.2.1 INTRODUCTION

The Highland Maize Agronomy Unit had a fairly normal cropping season except for rather late planting and severe lodging later in the season. The rains were late and planting had to be delayed for at least 2 weeks.

When the rains finally came they were continuous such that germination was good for even the trials that were planted in the dry soil.

A total of eleven (11) trials were planted in 37 trial plots on research station trial sites (22), Trial and Demonstration Centers (14) and the University Center farm (1). They were mainly in two main themes; soil fertility amendment through improved fallow, organic matter incorporation liming, and residue management and crop responses to fertilizers; plant population, and land preparation methods. Over half the studies involved either intercropping or double cropping with grain legumes and colocasia or with hedge rows or soil improvement legumes. Most of the planting was done on ridges as farmers do. The grain legumes used were groundnuts, phaseolus beans and soybeans.

Due to the strong winds that occurred in the middle of the season (June 11, 1990 at Bambui Plain and slightly later at Babungo and other sites, there was a lot of devastating lodging that greatly affected grain yield and the quality of the result obtained.

The yields of legumes continued to be poor due to lack of adapted varieties. The harvesting period was fairly dry thus allowing for good harvest with very few rotten grains in the trials that did lodge badly.

Although the unit has a technician and a national counterpart the team is supported by only one competent recorder at one of the sites. It would greatly benefit from one more technician and two field recorders, one at each of the other sites. There is also a need for a researcher who will replace the present national counterpart when he goes for further training.

2.2.2 OUTPUTS AND ACCOMPLISHMENTS.

GOAL: To Develop agronomic practices that will result in a sustainable highly productive maize-based cropping systems in the Western Highlands of Cameroon.

Sub-Goal	Outputs	Accomplishment
1. Determine response of maize varieties to plant population and fertilizer.	1.Year 3 of 3 years. Response of new and old varieties to plnt population and fertilizer for recommendation to various production levels. 1.2 Information on intercropping.	1. Yield response to plant population and fertilizer of recently released varieties similar to Kasai 1 and 85-MSR similar to that of older variety COCA.

Sub-Goal	Outputs	Accomplishment
		1.2 Soybean yields not affected by maize variety. Increase in maize population had negative effect on soybeans.
2. Find the most efficient land preparation method for maize based cropping systems.	2.1 Characterize crop response to ridge, flat and no-till at various fertilizer levels for differing soil fertility environment.	2.1 Best yields obtained when crop planted on ridges and poorest when under no-till. Response to fertilizer similar at all three land preparation methods. 2.2 Ridge and flat had similar labour requirements which were about 35% higher than no-till.
3. Determine long-term effect of residue management on productivity.	3.1 Characterize long-term effect of residue management practices on productivity. 3.2 Determine the effect of fertilizer application on the productivity.	3.1 Maize yield from plots where residue was previously burnt underground was 32% lower than where it was buried. Burning residue underground had higher yield than bury residue. The effect was greater in plots where residue was previously buried. 3.2 Effect of previous residue management was reduced by fertilizer application.
4. Determine the effect of soil fertility amendment on the land productivity	4.1 Identify lime sources and rates that would be economical. 4.2 Compare liming with plant organic material as soil amendment practices.	4.1 Lime application increased yield up to 5.0 Tons/Ha. Higher levels had no additional effect. Dolomitic lime had best results and calcitic lime had least effect on yield of maize and groundnuts. Soil pH was increased by application of lime but not in proportion to levels. 4.2 Lime application had greater effect on maize yield than the application of composte or plant residue.
5. Determine the residual effect of phosphorus on maize production.	5. Data on how long a single phosphorus application can be effective. Identification of the most appropriate source of phosphorus.	5. Maize showed response to phosphorus applied in 1987 which was dependent on rates previously used. SSP had greatest effect compared to Rock Phosphate and PAPR.

Sub-Goal	Outputs	Accomplishment
6. Identify cultural practices involving improved fallow and agroforestry that would increase land productivity.	6.1 Identification of Species residual effect which would increase land productivity. 6.2 Quantification of the effect of species on crop yield. 6.3 Quantity effect of fertilizer application on the agroforestry species.	6.1 Fallow of Crotalaria and tephrosia was better than natural grass fallow. The effect was greatest on poor soils. There was no carry-over effect after the first year of cropping. 6.2 Calliandra and cassia had better attributes than leucaena. The effect of fertilizer application on species early growth was only slight.
7. Institutional Development.	7. Two technicians trained in agronomy skills.	7. On-job training of two senior technicians was conducted in the areas of soil amendment and improved fallow skill. This involved laying out trials collection and analysis of preliminary data.
8. Professional Improvement.	8.1 Attending of ASA meetings in San Antonio-Texas. 8.2 Attending the West African Fertilizer Management and Evaluation Network Meetings - Lome, Togo.	8. Presented two papers at the ASA Meetings on "varietal response to delayed planting" and "Effect of improved fallow on maize yield".

2.2.3 OTHER ACTIVITIES.

The other activities included the training of students from the Technicians school at Dschang and participation in meetings.

Two trainees from the technician school at Dschang carried out their practical training in the unit. The areas of interest were effect of soil amendment and the other was in the area of maize fertilizer response.

Dr. Kikafunda participated in the West African Fertilizer Management and Evaluation Network (WAFMEN) Annual Meetings held in March at Lome Togo. He also presented two papers at the American Society of Agronomy Annual Meetings held at San Antonio, Texas, October 21-26. The two papers prepared with the national counterpart were on **maize varietal response to delayed planting** and **maize response to improved fallow.**

The team also gave a strong contribution in the Western Highland regional food crop and agroforestry planning meetings.

2.2.4. RESEARCH FINDINGS

Poor adaptability of grain legumes continued to give poor results when intercropped with maize. In most cases therefore, it was not possible to discern the treatment effects due to the high coefficient of variability.

2.2.4.1. Response to fertilizer and plant population of maize varieties and intercropped soybeans.

Farmers normally plant at populations and fertilizer rates different from those used by breeders. Varietal differences can lead to differences in response to these factors. To determine whether there would be any differences two relatively new varieties, MSR and Kasai I were compared with the older variety COCA.

The three maize varieties were planted at two plant populations the one used by most farmers (26 666 plants/ha and the one commonly used by breeders (53333 plants/Ha). This was done by varying the number of plants per hill; either one plant or two plants per hill in two rows on top of a 1.5m ridge. The plots with maize were divided into three fertility groups low, medium and high rates of fertilizer (0-0-0, 50-60-30 and 100-120-60 kg NPK/ha).

Soybeans were planted on the outer side of the maize rows in the central ridge of the three ridge plot. In addition two soybean plots were planted per replicate one with no fertilizer and another with medium fertilizer level. The trial was planted at four locations (Bambui Plain, Babungo, Wum and Bansoa) and there were four replications at each of the sites.

The results obtained are summarized in Tables 1 and 2. There were no significant differences in yield among the varieties used although COCA yielded slightly higher than the other two varieties (Table 1). The yield of soybeans was also not affected by the different maize varieties. Fertilizer application increased the yield of maize at all locations especially when it was applied at the medium level. Fertilizer had a tendency to reduce the yield of the intercropped soybeans although the decrease was not significant at most of the locations.

Reducing the plant population of maize, resulted in significant reduction in maize yield at Bambui Plain and Babungo and significant increase in yield of soybeans at all locations. It had no effect on the number of ears per plant. Maize grain size was however, greatly increased by 14% when the population was decreased and the crop stood better against lodging.

Among varieties, Kasai I was the shortest (179 cm) and COCA was the tallest (208cm) and MSR was intermediate. Addition of fertilizer increased plant height at both plant populations (Table 2).

When soybeans were planted as a sole crop, fertilizer application significantly decreased yield at Bambui Plain and Wum, had no effect at Bansoa and increased soybean yield at Babungo. The overall effect was a 6% reduction in grain yield. This indicates that reduction in yield when it was intercropped with maize was related to both the shading effect of the more vigorous maize and the direct effect of the fertilizer or soybeans.

In conclusion, the varieties tested are not significantly different. They also have a similar effect on the soybeans when the two are intercropped. Choice among the varieties would depend on other characters such as storability, resistance to disease and insects. This confirms the results previously obtained in the same study. It is recommended that the study be discontinued until more varieties are available for agronomic studies.

2.2.4.2. Maize Yield and Labour requirements as affected by the land preparation methods.

Farmers in the area ridge the land during land preparation. This was perceived to be time consuming without having additional yield benefits. To determine the relative merits of land preparation methods on labour requirement and yield, a trial was started in 1988 at Bambui Plain and Babungo and has been carried out through to 1990. The effect of three land preparation methods; ridge, flat and no-till on maize yield were compared at three fertilizer levels 0-0-0, 50-60-30, and 100-120-60 kg NPK per hectare. Each treatment was replicated four times at each location.

The yield results obtained indicate that at both locations, planting on the ridge resulted in the highest yield (Table 3a.) At Bambui Plain it outyield planting on the flat by 10.8% and planting on the No-till by 72% (2.78 vs 2.53 and 1.62 Tons/Ha). At Babungo, the corresponding figures were 18.4% and 56%. At both locations adding fertilizer increased grain yield especially when the increase was from 0-0-0 to 50-60-50 kg NPK/Ha. indicating greater efficiency at lower fertilizer levels.

There were no significant fertilizer x land preparation method interactions thus indicating similar responses to fertilizer for all preparation methods. Combined analysis showed significant fertilizer x location interaction which was due to greater response to fertilizer at Babungo compared with Bambui plain. There was a highly significant correlation between the number of ears per plot and grain yield especially at Bambui Plain which was related to the poor establishment and growth under no-till conditions.

As regards labour requirement, planting on the flat required the highest labour and was significantly greater than that required by other methods (Table 3b) at Bambui Plain. No-till required the least labour. Whereas tilling and ridging required similar labour, the crop planted on the flat required more labour at weeding than when the crop was planted on the ridges (113.1 man-days vs 80.2 man-days).

At Babungo planting on ridges and planting on the flat required similar amounts of labour due to the inter-operation adjustments similar to those of Bambui Plain.

It can therefore be concluded that planting on ridges is superior to other methods. Any recommendations should also take into consideration the effect of the various methods on erosion control, weed control. Soil properties such as compaction, leaching and nutrient recycling as they relate to plant residue and organic matter should also be considered.

2.2.4.3. The effect of Residue Management on the yield ofmaize,beans and colocasia.

This is a report on a continuation of a long term study started in 1985 at Bambui Plain. It involved the determination of the effect of residue management fertilizer on the yield of the various cropping patterns. The results of the previous years 1985 - 1988 are reported in the NCRE annual reports of those years. They indicated that burning residue underground resulted in initial yields of as high as 500% of those obtained from plots where residue was only buried. There was yield reduction in plots where residue was burnt under ground with subsequent cropping such that the yields obtained in the fourth year were only 62% of those obtained in plots where residue were buried.

To determine the effect of the previous management and assess the implication on subsequent management, new treatments were superimposed on the old management as indicated in **Figure 1**. Each treatment was replicated four times.

Figure 1: RESIDUE MANAGEMENT TRIAL - TREATMENTS 1990

GROUP A.

Previous Residue Management	Fertilizer Levels (kg NPK/Ha)	New Residue Management and Cropping Pattern
1) Bury Residue 2) Burn Residue underground	1) 0-0-0 2) 50-60-30 3) 100-120-60	1) M+B - Bury Residue 2) M+B - Burn residue underground 3) M+B+C -Burn Residue 4) M+B+C -Burn Residue underground.

GROUP B.

Previously Burn Residue at Soil Surface.	Fertilizer	New Residue Management
	1) 0-0-0 2) 50-60-30 3) 100-120-60	1) Bury Residue 2) Burn Residue underground 3) Remove residue 4) Residue burnt at soil surface.

Plant Population:
1) Maize: 53333 plant/ha in the maize/Beans Intercrop 41000 plant/ha in the maize/Beans/Colocasia intercrop.
2) Beans: 177 000 Plant/Ha.
3) Colocasia: 20000 plants.

M = Maize, B = Beans, C = Colocasia.

The results obtained were quite interesting. Considering the plots that previously had either residue buried or burnt underground, there was a significant reduction in yield in the plots where residue was previously burnt underground as compared to where residue was previously buried (Table 4). This was associated with greater number of ears and higher 1000 grain weight. The number of plants at harvest was not affected. Previous residue management did not have a significant effect on the yield of beans.

Fertilizer application increased maize yield. This was mainly through increased number of ears per plant and the size of the ear since the 1000 grain weight was not increased tremendously. Fertilizer application also increased the yield of beans. There was no difference in the yield of maize whether it was planted with either beans or beans and colocasia. Burning residue at the beginning of the 1990 season increased yield by 71% compared to when residue was only buried. The increase in yield was observed in both the plots where residue was previously buried and in those where it was burnt underground. The difference in yield was most pronounced in plots that were not fertilized (Figure 2). Both the overall yields and the response to current burning were less obvious in plots where residue was previously burnt underground. This is in confirmation of the previous results that burning residue underground increase yield considerably in the first year. The low yields obtained in plots that were burned previously at all levels of cropping patterns and new management regimes demonstrates the permanent damage the practice does to the soil.

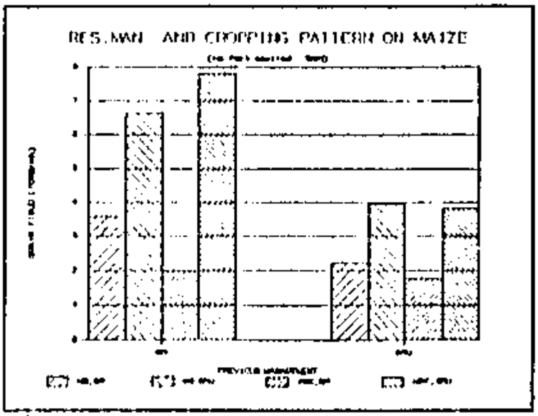


Figure 2

When four residue management practices were compared at three fertilizer levels, burning residue underground had the highest yield and no difference among other residue management treatments was observed (Figure 3). As in previous studies, the greatest effect of burning residue underground was greater when no fertilizer was applied. The various residue management treatments had no significant effect on the yield of beans although burning it underground had slightly higher yields..

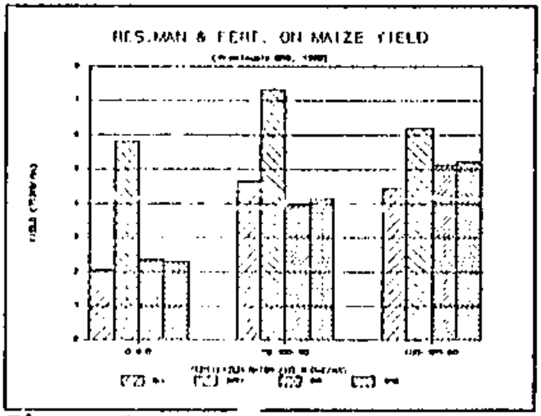


Figure 3

The study demonstrates that there is increased yield due to burning residue underground. Leaving land that was previously burnt for a year's fallow and then burning residue underground results in a positive yield response in maize yield that is inferior to that obtained from plots that had not been burned before. This shows that productivity cannot be maintained at a high level with this system especially when no fertilizer is applied. Burying residue maintains a fairly high yield.

2.2.4.4 The effect of liming on the yield of maize and legumes

In the soils that are highly acidic, lime might be required. Though it might not be economical at farmer level given the present high cost of lime information about practical sources and rates should be obtained in case it could be proved economical. It can also be useful in improving soils at research station and trial sites for trials that require less acid soils. The study was started at the Upper Farm in 1987 and in 1989 at Bambui Plain.

At the Upper Farm Lime was applied at the rates of 0, 3.0, 6.0 and 9.0 tons/ha. To determine the significance of the secondary elements and micronutrients each level had three plots which were assigned NPK, NPK + Calcium, Magnesium and Sulphur and the third plot had micronutrient in the form of Zinc, Boron, and copper during 1987, 1988 and 1990. The plot was fallowed during 1989.

At Bambui Plain the trial involved application of four sources at the rates of 2.0, 5.0, 10.0 and 15.0 Tons of lime per Ha which were supposed to change the pH from 4.7, to 5.0, 5.5, 6.0 and 6.5 respectively. The sources tested were calcitic Lime, Agri 56, Slaked lime and Dolomitic lime. The lime was applied only in 1989 and all the plots received uniform fertilizer. Maize was followed by late beans in 1989 and it was intercropped with groundnuts in 1990. Only data the crops grown in 1990 are reported. Each treatment was replicated five times.

Strong winds at the time of tasselling had a severe setback on crop performance resulting in low yields and high variability. At the Upper Farm there was a high incidence of stem rot that resulted in lodging towards the end of season.

At the Upper Farm application of 3.0 Ton/Ha of lime increased the yield of maize as compared to when lime was not applied (Table 5). Application of NPK at the rate 120-100-100 increased yield as compared to no fertilizer added (3.24 tons vs 2.05 tons). Addition of secondary elements and micronutrient had no significant effect on maize yields. The yields were quite low at all the levels of lime thus indicating that factors- other than lime were influencing yield. The severe lodging, ear and stem rot, foliar diseases and low soil and air temperatures could have been responsible. The solution would be to breed for resistance to the most important of these factors.

The results obtained from the trial conducted at Bambui Plain are indicated in Table 6. Dolomitic lime had the highest yield of maize (3.62 tons/Ha) while application of calcitic lime resulted in the lowest yield (2.95 Tons/Ha). Agric 56 had yields similar to those of slaked lime and dolomitic lime thus showing that it could replace the two sources which are presently very expensive (over 5000Fr/50kg bag). The influence of lime increased up to 10 tons beyond which there were no increases in yield.

Neither source nor rate of lime had a significant effect on the yield of groundnuts **(Table 6b)**. Their yields were very poor. The lack of response could be due to the poor adaptability of the variety to the environment. Also maize lodging at pegging time could have reduced light penetration to the groundnuts. The effect of the lime sources on nodulation was also inconsistent although dolomitic lime and Agri 56 showed higher number than others early in the season. There were no differences on pod filling. Lime affected soil pH even when applied at very low levels (Table 6c). The effect of liming on pH ranged between 4.8 and 5.7. Agri 56 resulted in the highest pH both at the lowest rate and overall.

The results are not conclusive due to the poor yields. The trial will be repeated in the same plot to assess the residual effect of the treatments. It is hoped that the yields of the late season beans will show some treatment differences. The trial will be continued for two more years to get the full extent of the treatment effects.

2.2.4.5. Residual Effect of Soil Amendment and on Maize Yield

A trial was started in 1989 where the effect of compost and plant residue at 5 tons/ha were compared with that of 5 tons/ha of dolomitic lime. Assuming that organic material would reduce the harmful effects of high acidity it was hoped that organic material would replace the need for liming. The effect of the amendment treatments were assessed at low, medium and high levels of fertilizer (0-0-0, 50-60-50 and 100-120-100 kg/ha). The amendment treatments were applied only at the beginning of the 1989 season. Maize in 1989 was followed by late season beans which was followed by maize in 1990. Fertilizer was applied to maize in both seasons.

Lime application increased the soil pH from about 4.1 to 5.2. None of the other amendment treatments increased soil pH significantly. Both soil amendment practices and fertilizer affected the yield of maize (Table 7). There was no significant effect of adding either manure or organic residue the previous year on the yield of maize but the addition of 5 tons of lime increased maize yield significantly when compared to no added amendment (6.46 Tons/Ha vs 4.31 Tons/ Ha). Application of fertiozer resulted in a significant increase in maize yield at all levels. There was no fertilizer x amendment interaction thus indicating that the response was similar for all the amendment practices. Among the components of yield only grain size was affected by the amendment practice whereby application of 5.0 tons lime resulted in larger grain size as compared to the rest of the treatments (402 gm vs 346, 341 and 360 gms for liming, no amendment, 5 Tons of manure and 5 tons of organic material respectively).

The lack of response to addition of manure and organic residue could be associated with the high organic matter of the soil at the site (% organic Carbon = 9.87). This explains why addition of manure or organic material did not have significant effect on the yield of maize.

The study should be continued with further addition of organic material and assessing the effect on nutrient availability and comparative costs when compared with lime application. Plant material to be added should decompose easily to release nutrients without having to add to the organic matter which is already high.

2.2.4.6 Effect of Residual Phosphorus on Maize Yields.

This is a continuation of a trial started in 1986. In 1986 Rock phosphate, 50% partially acidulated Rock P and Single Super phosphate (SSP) were applied at rates of 25, 50, 75, 100 and 150 kg P_2O_5/Ha. These rates were doubled in 1987 in the same plots. In addition to these levels Triple Super phosphate (TSP), Diammonium phosphate(DAP) and Bicalcium phosphate were applied at the rate of 100kg in 1986 and 150kg P_2O_5/Ha in 1987. Cropping was carried out in all the years until 1990. In all cases only nitrogen at the rate of 80kg N/Ha and potassium at the rate of 40kg K_2O were added. The treatments were replicated five times. The results obtained in earlier years can be obtained from the NCRE Annual report 1986 - 1989.

The yield of maize contimued to show a fair amount of response to added phosphorus even after the fourth year of continuous cropping (Table 8). In all cases it was the plots that previously received SSP that outyielded the check where only N and K have been applied over the years. Rock Phosphate and partially acidulated rock phosphate had caused very little response over the years and had no significant effect on maize yield during the 1990 growing season.

When all the sources were compared at 150kg P_2O_5, Bicalcium phosphate (3.18 Tons) and SSP (3.17 Tons) had the highest yields followed by TSP (2.71 Tons) and DAP (2.70 Tons) and the lowest yields were given by Rock Phosphate (1.88 Tons) and PAPR (2.07 Tons). The ranking in 1990 was similar to that of the past years thus showing the superiority of SSP and Bicalcium Phosphate over other sources. This could relate to the high calcium content of these sources. Soil analyses have shown that the soils are low in Calcium and Magnesium which might explain why the application of dolomitic lime had good results compared with the other soil amendment treatments in 2.2.4.5 above.

The results show that phosphorus application can lead to sustained productivity in the acid soils especially when a relatively high dose of phosphorus is initially applied. The choice of phosphorus source will influence the residual effect. The sources with calcium did better than those with little or no calcium.

The study should be extended to include the application of small frequent rates as compared to large doses that are less frequent.

2.2.4.7 The effect of improved fallow on maize yield.

Crop yields have been observed to decline with continuous cropping. One of the ways to reduce this decline is to use improved fallow species either planted sole or in mixture with the crops.

Work in this area was started in 1986 when annual and biennial legumes were screened for use in improved fallow. The present trial was started in 1988 when Tephrosia and Crotalaria were planted either as sole species or intercropped or relay cropped with maize and the residual effect observed in subsequent years. A similar trial was started in 1989. Both trials were planted at Bambui Plain and Babungo and each treatment was replicated four times. Minimal fertilizer (20-40-0 NPK) was applied in the years of cropping. The results obtained are shown in Table 9.

Using legume species outyielded leaving the land under grass fallow although for the period of study it was still advantageous to crop continuously. The effect of the fallow was positive in trial 1, but not so encouraging in the second trial (**Table 9b**) mainly due to lodging in the second year when the effect of the fallow was supposed to be expressed. Tephrosia gave better yield at Bambui Plain while Crotalaria was the better species at Babungo. When combined over years, it is advantageous to intercrop the legumes with the crop. At the level of soil fertility at the station, it was still better to grow maize continuously than to fallow the land. The situation may be different at farmers' fields where land is more degraded.

Presently thirteen species or types are being tested for adaptability at 4 locations (Befang, Bambui Plain, Babungo and Upper Farm). Among them, **Tephrosia vogelii, Crotalaria Caricea, and C. anagyroides, C.lachnophora, Desmodium intortum D. distortum** and Pegion peas show the greatest promise. Weed control, soil fertility improvement aggressiveness, adaptability to planting date, erosion control, other uses such as fodder fuel wood will be among the criteria used to select the species to be used in further studies.

2.2.4.8. Alley Cropping:

Alley Cropping studies were started in 1987 but no conclusions have ever been drawn due to poor establishment and adaptability. In 1990, alley cropping studies involved determining effects of fertilizer application on the establishment and growth of some selected species at Bambui Plain.

Three species, **Leucaena leucocephala, Calliandra callothyrsus** and **Cassia spectabilis** were planted in alleys with or without fertilizer. The fertilizer levels were 0-0-0 or 50-100-50 kg NPK plus 2.0 Tons of dolomitic line. Measurements were taken on plant height, number of leaves and the number of branches after transplanting and at the end of rainy season, July 9 and November 31 respectively. Information was recorded on 10 plants in each row. Each treatment was replicated three times.

At the beginning of the season there were no significant differences among species in the number of leaves but calliandra was Iıter than leucaena and cassia (**Table 9**). About five months later **Calliandra calothyrus** was about two times as tall as the others (180.2 cm vs 99.8cm and 98.0cm). Application of fertilizer also increased plant height. Cassia had the highest number of leaves compared to the other species and leucaena had the least number. Fertilizer application had no significant effect on the number of leaves of the main shoot. Fertilizer application slightly decreased the number of branches for leucaena and cassia but resulted in a slight increase in the number of branches in the case of calliandra.

It is too early to judge which species is best. The study will continue with measurement of plant height and the number of branches before and after pruning. The biomass yield will also be determined and tissue analysis done to determine which species is most promising.

Table 1: Effect of fertilizer, population on the yield of maize varieties and intercropped soybeans at four mid-altitude location.

TREATMENTS	BAMBUI PLAIN		BABUNGO		WUM		BANSOA		MEAN	
	Maize	Soybeans	Maize	Soybeans	Maize	Soybeans	Maize	Soybean	Maize	Soybeans
VARIETIES										
NSR-3	3.85	702	5.27	970	3.65	592	3.58	1219	4.03	871
Kasai 1	3.74	766	5.43	951	3.65	663	3.92	1370	4.19	936
COCA	4.13	709	5.47	946	3.94	576	4.17	1343	4.43	894
MEAN	3.90	725	9.35	956	3.75	610	3.88	1311	4.23	870
Sign.	NS	NS	NS	NS	NS	NS	NS	NS		
FERTILIZER										
0-0-0	3.32	849	4.46	935	3.09	620	2.78	1223	3.41	907
50-60-30	4.01	722	5.66	957	3.77	647	3.79	1303	4.31	907
100-120-60	4.38	609	6.05	972	4.38	564	5.07	1405	4.97	887
SIGNIFICANCE	**	**	**	NS	*	NS	**	NS		
POPULATION										
26,666	3.65	856	5.11	1116	3.82	714	3.80	1455	4.10	1035
53,333	4.15	595	5.67	795	3.67	507	3.96	1166	4.35	766
SIGNIFICANCE	**	**	*	**	NS	**	NS	*		
LSD (Varieties)	.47	153	.62	114	.59	105	.72	279		
LSD (Fert.)	0.47	153	.66	114	.59	105	.72	279		
LSD (Popn.)	0.19	125	.51	93.0	.24	86	.58	228		
CV%	20.8	36.5	20.1	20.6	27.3	29.9	32.1	36.9		

SOLE SOYBEAN YIELD (kg/ha)

	BAMBUI PLAIN	BABUNGO	WUM	BANSOA	MEAN
- Fertilizer	2426	1231	2093	1978	1932
+ Fertilizer	2178	1529	1568	1951	1807
SIGNIFICANCE	**	*	**	NS	

Table 2: Maize Yields and Yield Components in Relation to locations, varieties, Fertilizer and Population -1990

LOCATIONS	GRAIN YIELD	1000 GRAIN WT (gms)	EARS/HA	PLANTS at Harvest	PLANT Height Cm
Wum	3.75	360	31.8	35.61	145
Babungo	5.39	364	40.58	39.73	257
Bambui Plain	3.40	325	37.36	38.29	180
Bansoa	3.88	306	34.5	38.63	198
Mean	4.23	339	36.06	38.61	
Significance	*	*	*	*	
VARIETIES					
HSR	4.08	331	36.57	37.95	198
Kasai	4.18	322	36.72	38.23	179
COCA	4.43	362	35.89	38.02	208
Significance	NS	*	NS	NS	
FERTILIZER & POPULATION COMBINATION					
P_1 F_1	3.47	347	26.32	27.29	191
P_1 F_2	4.07	368	27.74	27.43	197
P_1 F_3	4.75	369	28.91	28.23	205
P_2 F_1	3.36	304	40.92	47.96	181
P_2 F_2	4.51	321	44.35	47.44	195
P_2 F_3	5.23	322	48.12	50.04	202
LSD (Locat.)	0.35	11.1	2.1	2.1	6.5
LSD Varieties	30	9.7	1.8	1.8	5.6
LSD Fert & Pop.	43	13.7	2.56	2.56	7.9
CV%	25.1	9.9	17.5	16.5	10.0

P_1 = 26 666 plants /Ha. P_2 = 53 333 plant/Ha.
F_1 = 0-0-0 NPK F_2= 50-60-30. F_3 = 100-120-60 kg NPK.

Table 3a: The Effect of Land Preparation on Maize Grain Yield

	Bambui Plain	Babungo	Average over Location
Land Prep. method			
Ridge	2.78	4.95	3.86
Flat	2.51	4.18	3.34
No-Till	1.62	3.16	2.39
Mean	2.30	4.10	3.20
Significance	**	*	
Fertilizer Level.			
0-0-0	1.52	2.72	2.12
50-60-20	2.59	4.32	3.46
100-120-40	2.80	5.24	4.02
Significance	**	**	**
LSD (Land Prep.)	0.54	0.92	0.52
LSD (0.05) (Fertilizers)	0.54	0.92	0.52
LSD (0.05) Land prep. x Fert.	0.93	1.59	0.74
CV%	27.7	26.6	27.6

Table 3b: Labour Requirements (mandays/Ha) for three Land Preparation Methods.

	BAMFUI PLAIN				
	RIDGE	FLAT	NO-TILL	(LSD .05)	CV
1) Clearing	16.6	17.3	16.2	4.35	31.6
2) Ridging and Tilling	35.7	33.0	-	7.60	38.9
3) Planting	9.7	10.9	10.1	1.62	19.17
4) Weeding	80.2	113.1	78.0	28.6	30.4
5) Moulding and Fert. appli.	14.8	15.8	15.9	2.86	22.4
6) Harvesting	23.6	18.9	17.9	3.8	22.8
7) Total	180.6	209.0	138.2	28.0	19.2

	BABUNGO				
1) Clearing	8.5	7.3	5.8	1.16	19.6
2) Ridging and Tilling	27.7	20.3	-	3.2	24.3
3) Planting	8.4	9.6	14.1	2.59	29.5
4) Weeding	30.8	37.9	37.0	11.3	38.8
5) Moulding and Fert. applic.	21.6	28.6	22.4	5.27	26.4
6) Harvesting	22.5	15.9	14.4	3.03	20.8
7) Total	119.5	119.6	93.7	14.1	15.5

Table 4: The Effect of residue management, fertilizer and crop combination on the yield of maize and beans.

TREATMENTS	Maize				
	Plant Count	Ear Count	1000Gr. Wt .	Yield Tons/ha	Yield of Beans
PREVIOUS RESIDUE MANAGEMENT					
Bury Residue	46.25	46.21	300	5.65	328
Burn Residue Underground	45.64	41.28	279	4.28	361
Significance	NS	*	*	*	NS
Fertilizer (kg NPK/Ha)					
0-0-0	46.60	41.42	282	3.96	295
50-60-30	44.98	42.85	289	5.04	350
100-120-60	46.25	45.47	297	5.89	390
Significance	NS	*	NS	*	*
Cropping Pattern x New Residue Management.					
M+B, BR	52.51	42.91	261	3.78	337
M+B, BRU	49.38	49.81	300	6.27	410
M+B+C BR	40.89	37.52	291	3.48	267
M+B+C BRU	40.99	42.71	306	6.32	365
Significance	**	**		**	**
Mean	45.94	43.25	289	4.96	344
Mean					
LSD (Previous Management)	1.86	1.94	20	1.52	45
Fertilizer cropping	2.38	3.57	13	1.0	63
Cropping patter x New Management.	2.33	3.76	18	1.14	70
CV% (Sub plot)	8.8	15.1	10.8	23.1	35.2

Key: M= Maize B= Beans, C = Colocasia, BR= Bury Residue,
BRU = Burn Residue Underground.

Table 5: The Effect of Lime and Fertilizer on the Yield of Maize (Tons/Ha) Upper Farm 1990.

LIME RATES	FERTILIZER COMBINATIONS			
	NPK	NPK+Ca+Mg+S+Micronutrients.	NPK+Ca+Mg	Mean
0.0 Tons	3.24	3.66	3.30	3.40
3.0 Tons	3.76	4.67	3.74	4.06
6.0 Tons	4.30	4.46	4.41	4.39
9.0 Tons	4.23	4.62	4.64	4.50
Mean	3.88	4.35	4.02	4.09

Yield of Check 2.05 LSD (LIME)= 62 LSD (Fertilizer) = .53
LSD (Lime x Fertilizer)= 1.07 CV% 20.6%

Note Fertilizer : NPK = 120-100-100 NPK kg/Ha. Ca, Mg, S at rates of 60, 60, 80 respectively. Micronutrient: 6kg copper 5 kg Zinc and 1kg Born.

Table 6: The effect of lime sources and rates on maize and groundnut yield and on soil pH. Bambui Plain 1990.

	RATES (Tons/HA)				
SOURCES	2.0	5.0	10.0	15.0	MEAN
Slaked Lime	3.02	3.08	4.37	3.86	3.58
Agri 56	2.48	3.35	3.56	3.93	3.33
Calcitic Lime	2.15	3.39	2.95	3.30	2.95
Dolomitic	3.36	3.16	4.10	3.84	3.62
Mean	2.75	3.25	3.74	3.74	3.37

Absolute check = 1.85 Check (No Lime) = 2.49
LSD (Sources) = 0.40 LSD (Rates) = 0.40
LSD (Sources x Rates) = 0.79 CV% = 14.2

(b) GROUNDNUT YIELD

Slaked Lime	227	183	117	162	172
Agri 56	197	259	208	227	223
Calcitic Lime	154	172	269	331	232
Dolomitic Lime	190	247	176	167	195
Mean	192	215	193	221	205

Absolute check = 144 Check (No Lime = 146
LSD (Sources) = 60, LSD Rates = 60
LSD (Source and Rates = 121 CV% 35.3%.

(c) Soil pH

Slaked Lime	4.8	5.1	5.3	5.5	5.2
Agri 56	5.3	5.1	5.7	5.6	5.5
Calcitic Lime	4.8	5.1	5.8	5.7	5.3
Dolomitic Lime	5.0	5.6	5.3	5.7	5.4
Mean	5.0	5.2	5.5	5.7	5.4

Absolute Check = 4.5 Check No Lime = 4.4
LSD (0.05) Source and rates = 0.2
LSD (0.05) Interaction = 0.4
CV = 4.5%

Table 7: The Effect of amendment and fertilizer on pH, and yield components of maize.

Amendment Fertilizer	SoilpH (1:1 H_2O) (x 1000)	Plants Harvest (x 1000)	Ears Harvest (gms)	1000Grain Weight	Grain Yield
No amendment					
0-0-0	4.1	61.30	53.78	348	3.46
50-60-50	3.9	64.00	55.70	335	4.00
100-120-100	4.3	61.04	58.37	356	5.46
MEAN	4.1	62.22	55.95	346	4.31
5 TONS MANURE					
0-0-0	4.4	62.52	51.56	341	3.54
50-60-50	4.4	61.63	59.70	357	4.83
100-120-100	4.3	62.22	53.18	325	5.00
MEAN	4.4	62.12	54.81	341	4.46
5 Tons Organic Material					
0-0-0	4.4	61.33	56.89	344	3.76
50-60-50	4.4	59.21	56.18	352	4.09
100-120-50	4.5	63.11	56.82	386	5.59
MEAN	4.43	61.23	56.63	361	4.48
5 Tons Dolomitic Lime					
0-0-0	5.1	62.08	59.70	379	5.25
50-6-50	5.2	62.37	58.52	413	6.60
100-120-100	5.2	60.15	58.52	414	7.53
MEAN	5.2	61.53	58.91	402	6.46
GENERAL MEAN	4.5	61.78	56.58	363	4.93
LSD Amendment		3.49	3.58	34	1.2
LSD Fertilizer		3.02	3.10	29	1.1
LSD Amendment x Fert.		6.05	2.99	58	2.06
CV%		5.00	6.47	9.5	24.7

Table 8: Maize Yield (Tons/Ha) response to residual phosphorus 1990.

Sources of Phosphorus	Previous Phosphorus Rates Rates (kg P_2O_5/Ha) 50	100	150	200	300	Mean
1) 50% PAPR	1.23	1.78	2.07	2.40	2.99	2.09
2) SSP	2.19	3.16	3.17	3.56	4.82	3.38
3) Rock P	1.50	1.91	1.88	2.27	2.46	2.01
MEAN	1.64	2.28	2.37	2.74	3.42	

Yield of Check: No fertilizer = 1.81

Only N & K = 1.21

LSD (Source) = 0.32 LSD (Rates) = 1.21

LSD (Sources x rates) = 0.71

Table 9A: Maize Yield (Tons/Ha) Response to Improved Fallow. Trial 1 (Started 1988)

Fallow Regime	Bambui Plain			Babungo		
	1988	1989	1990	1988	1989	1990
1) Maize (M)	4.61	2.80	2.01	6.82	2.90	4.95
2) Grass (G)	-	3.08	1.52	-	4.43	5.06
3) Tephrosia (T)	-	6.57	2.84	-	5.59	5.79
4) Crotalaria (c)	-	5.27	2.92	-	7.42	6.94
5) M+T, Time 1(t_1)	3.62	5.15	2.48	6.80	3.73	5.18
6) M+C, T_1	2.41	4.28	2.17	5.88	5.06	5.99
7) M+T, T_2	5.35	3.90	1.88	6.29	3.18	4.82
8) M+C, T_2	4.35	3.60	2.14	6.95	4.70	5.62
9) M+T, T_3	5.03	3.71	2.14	6.66	3.35	5.01
10) M+C, T_3	6.19	4.45	2.61	6.72	3.28	5.06
MEAN	4.55	4.28	2.27	6.59	4.35	5.44
LSD (0.05)	2.19	1.73	1.30	1.24	1.27	.89
CV%	32	27.9	40.4	13	20	11.6

Table 9B: Maize Yield (Tons/Ha) response to Improved Fallow, Trial II (Started in 1989).

Fallow Regime	Bambui Plain		Babungo	
	1989	1990	1989	1990
1) Maize (M)	4.37	3.71	4.41	4.50
2) Grass (G)	-	3.59	-	4.67
3) Tephrosia (T)	-	4.40	-	5.01
4) Crotalaria (C)	-	3.48	-	4.70
5) M+T, Time 1 (T_1)	3.09	4.68	2.46	4.36
6) M+C, T_1	3.52	4.22	2.31	4.22
7) M+T, T_2	4.14	3.95	4.76	4.47
8) M+C, T_2	3.90	3.90	4.61	4.60
9) M+T, T_3	3.55	4.00	4.74	4.59
10) M+C, T_3	2.91	4.03	4.85	4.53
11) M+ Sesbania, T_3	4.48	3.89	4.60	4.96
12) M+ Soybean T_1	2.97	4.44	4.34	4.37
MEAN	3.66	4.02	4.12	4.58
LSD (0.05)	.95	1.18	.85	.68
CV%	18.3	20.2	14.1	10.4

T_1 Time 1 = Planting the legume at the same time with maize
T_2 Time 2 = Plant legume at Knee high stage of maize.
T_3 Time 3 = Plant legume at 2 weeks after silking of maize.

Table 10: The Effect of Fertilizer on the growth of three Alley Cropping Species.

Species	July 9, 1990 Height (Cm)	July 9, 1990 No. of Leaves (Main Shoot)	November 30, 1990 Height (Cm)	November 30, 1990 No. of Leaves (Main Shoot)	No. of Branches
No - Fertilizer					
Leucaena leucocephala	31.9	15.03	96.8	26.7	9.9
Calliandra calothyrsus	29.8	13.4	160.9	35.0	5.5
Cassoa spectabilis	29.3	13.5	92.4	47.2	6.7
Species + Fertilizer					
Leucaena leucocephala	36.3	11.56	102.8	28.9	8.8
Calliandra Callothyrsus	50.6	12.8	199.6	39.0	7.8
Cassia Spectabilis	27.3	14.3	103.7	48.8	4.5
Fertilizer Effect					
Without fertilizer	30.3	14.0	116.7	36.3	
With Fertilizer	38.1	12.9	135.4	38.9	
LSD (0.05) species	6.1	5.3	28.4	5.5	
LSD (0.05) Fertilizer	4.9	4.3	23.2	4.52	
LSD (0.05) Species x Fert.	8.5	7.5	40.2	7.8	
CV%	13.8	30.7	17.5	11.5	

2.3 LOWLAND MAIZE BREEDING

2.3.1 INTRODUCTION

In 1990, the lowland maize breeding unit carried a total of 227 trials. 183 of these trials consisted in evaluating 2414 genotypes. Eighteen of these trials involved the maintenance or the improvement of 1590 genotypes. The 1990 trial names and number tested are presented in table 1. 60% of the 183 trials had their C.V below 20%. In addition, 30% of the 183 trials had their C.V between 20% and 30%. Only 10% of all trials had their C.V higher than 30%. Forty four trials out of the 227 trials were introductions from international centers and from private companies.

Sixteen locations (8 in forest and 8 in savanna) were used in 1990. The 1990 location names and land area used are presented in table 2. This table showed that about 39 ha of land were used in 1990 to carry all breeding activities.

Compared to 1989 the total number of trials increased by 20%. However, activities during the second season were reduced by 45%. Population improvement in 1990 used 4 schemes (half-sib, mass selection, S_1 recombination, testcrosses). 12 populations were improved for agronomic characteristics such as husk cover, plant and ear height and maturity cycle.

Hybrid evaluation was done on 768 genotypes. In addition 2633 testcrosses were evaluated in 1990. In Nkolbisson breeding nurseries, 1590 genotypes were either maintained or advanced to the next generation of inbreeding.

Finally seed multiplication was intensified in 1990. Nine varieties were multiplied on about 10 ha of land.

2.3.2 OUTPUTS ACCOMPLISHMENTS

Goal: To identify or develop acceptable materials that enhance the productivity and income of resource poor farmers in the lowland forest and savanna of Cameroon.

SUB-GOAL	METHODS	ACCOMPLISHMENTS
1. Evaluation and selection of introduced and newly developed maize varieties or hybrids.	1.1 New varieties for release. 1.2 New traits donor sources. 1.3 Data for program evaluation and/or for publication.	1.1 Confirmation of the good potential of CHS 8501, Ndock 8701, CHS 8710, CHS 8701, Pool 16 DR, CMS 8806 and TZUT. 1.2 TZEFY and CSP x I. Payitiri identify through SAFGRAD testing as good extra-early varieties.

SUB-GOAL	METHODS	ACCOMPLISHMENTS
2. Population improvement of already released varieties through S_3, half-sib and testcrosses improvement scheme.	2.1 Improved plant and ear aspect, disease resistance, drought tolerance, acid tolerance and grain yield.	2.1 Formation of two early synthetic varieties from S_3 recombination of 22 lines from CMS 8503 DMR ESR-W (Syn E_1, Syn E_2).
	2.2 Creation of new experimental varieties from S_3 recombination or varieties crosses.	2.2 Formation of drought tolerant pool by recombination of MAKA, CSP, Pool 160 JFS, KU 144SR Blanc-2 precose Tuxpeno drought.
		2.3 Half-sib improvement of CMS 8501, CMS 8704, Pool 16 DR, CMS 8806, Suwan I (W), Ndock 8701, CMS 8710, Yaoundé 8701.
3. Line development through inbreeding and testcrosses.	3.1 To select new trait donors sources of resistance (striga, drought, acid tolerance, borers).	3.1 About 170 lines evaluated for their tolerance to striga.
	3.2 To select good combiners for hybrids and synthetic varieties.	3.2 - 130 lines evaluated for tolerance to borers.
	3.3 To select lines heterotic to major release varieties.	3.3 - 90 lines evaluated for their drought tolerance.
		3.4 - 369 TZB SR S_4 lines evaluated on testcrosses with 1368, 5012, 9071, TZUT.
		3.5 - 280 Suwan I SR S_3 lines evaluated on testcrosses with 4001, 9848, 9450.
4. Hybrid development for target farmers and areas.	4.1 To select hybrid or topcrosses which are at least 20% better than the released open pollinated varieties.	4.1 About 60 three way crosses were evaluated.
		4.2 - 708 single crosses were evaluated
		4.3 - 755 lines were test crossed to at least 3 testers (1368, 5012, 9071) for a total of 22633 genotype tested.

SUB-GOAL	METHODS	ACCOMPLISHMENTS
5. Breeder seed maintenance and seed multiplication of major varieties and inbred lines.	5.1 Enough seed to supply IRA agronomist and TLU's.	5.1 - 4 tones of CMS 8704 produced
	5.2 Maintenance of breeders seed.	5.2 - 2 tons of CMS 8806 produced.
	5.3 Supply for seed company, some government agencies in charge of seed multiplication.	5.3 - 10 others varieties maintained through half-sib.

2.3.3 OTHER ACTIVITIES

A. National and international cooperation was maintained with the following organizations: IITA, SAFGRAD, CORAF, Pionneer, Agri-Lagdo, Madagascar Mideno, Projet Semencier.

B. <u>International Travel and seminars</u>

- SAN-ANTONIO, (ASA) where a paper was presented on "Heterosis and combining ability of local lowland maize accessions"

- Douala (CORAF)

- Cotonou (SAFGRAD) where a paper was presented in "Recent advances in breeding for drought and striga tolerance for the Sahel zone of Cameroon".
- Dr. THE Charles visited the Benin national program and a maize farm in Gabon (SIAEB)
- Dr. THE Charles also visited CIRAD/Montpellier to set up a basis for the creation of the "Base Centre" for maize research in the humid zone to be headquarter in Yaoundé.

C. <u>The program was visited by:</u>

- SAFGRAD monitoring tours (11 African researchers from 11 different countries).
- His Excellency the Ambassador of the U.S.A The "Project Garoua" review team
- Dr. Konate and Traore from Bukina-Faso
- Mr. Jacques Dintinger CIRAD maize breeder

2.3.4 RESEARCH FINDINGS

2.3.5.1 National Variety Trial (N.V.T)

2.3.5.1.1 N.V.T. Late in Forest Zone

This trial was conducted in 8 Forest Locations during the first cropping season and in 3 Forest Locations during the second cropping season. The mean yields across 7 locations during the first season are presented in table 3. Mean yield ranged between 3.3t/ha in Batchenga to 7.0t/ha in Ntui. Coefficient of variation ranged between 13.2% obtained in Foumbot to 41.2% in Batchenga. Unexpectedly CMS 8507 (6.3t/ha) ranked first among the 15 entries. It was followed by CMS 8505 and Ndock 8701 (6.2t/ha). The soft endosperm version of CMS 8507 (TZB SR SE) yielded 5.3 t/ha which corresponded to 1.0t/ha yield difference. No significant difference was observed between the popular CMS 8704 (6.1/ha) and the highest yielding variety CMS 8507.

2.3.5.1.2 N.V.T Late in Savanna Zone

Except for the check TZPB k 81 and for Bertoua 8701, the N.V.T. late in Savanna had the same entries as in Forest zone. In this zone, the trial was tested in 7 locations. The mean across the seven locations are presented in table 4. Grain yield mean ranged from 1.6t/ha at Mouda to 6.8t/ha in Sanguere. Coefficient of variation ranged from 10.2% in Sanguere to the 31.1% at Mouda. The single cross hybrid 8321-18 (5.5t/ha) outyielded the other entries. The yield difference was not statistically significant among the top five entries. CMS 8501 (5.2t/ha) which is the released and most cultivated variety was the best open-pollinated variety for the zone. However its yield advantage was not statistically different from the soft endosperm variety TZB SR SE (5.0t/ha).

Performance across the two zones showed that hybrid 8321-18 was the best with 5.9t/ha. The three best open-pollinated across the two zones were CMS 8505 (5.6t/ha), Ndock 8701 (5.6t/ha) and CMS 8501 (5.5t/ha).

2.3.5.1.3 N.V.T Early in Forest Zone

This trial was composed of 15 entries. Six of those entries were of intermediate maturing cycle, and 2 of them were extra early varieties (TZEF y and CSP x L Rayitiri). The trial was tested in 8 Forest locations during the first cropping season and in 2 Forest location during the second growing season. Mean performance over the best 5 Forest locations are presented in table 5. The best yielding variety was Across 88 Tzut (5.1t/ha). However this variety was also of intermediate maturing cycle (105 days). The best early white variety was TZE composite 3x4 (4.7t/ha). The best yellow early variety was CMS 8806 (4.4t/ha). Among the five top varieties, 3 of them were of intermediate cycle. The two Extra-early varieties (less than 82 days) was ranked among the last. These were CSP x L Rayitiri (2.6t/ha) and TZEF-y (2.2t/ha). In general, yield ranged from (3.1t/ha) in Foumbot to 4.3t/ha in Ntui and in YOKE. Coefficient of variation ranged from 15.8% in YOKE to 19.6% in Bertoua.

2.3.5.1.4 N.V.T. Early in Savanna Zone

The N.V.T. early in Savanna consisted of the same entries as in Forest zone except for BSR SYNI which did not germinate. This trial was carried out in seven locations. The means across the seven locations are presented in table 6. Grain yield means ranged from 1.7t/ha in Mouda to 6.4t/ha in Sanguere. Coefficient of variation ranged from 8.4% in Sanguere to the unacceptable 42.2% obtained in Mouda. Like in Forest zone, Across 88 Tzut ranked first 5.8t/ha. This was followed by TZE Comp 3 x 4 (5.6t/ha) and by CMS 8503 (5.3t/ha). Like in Forest area, the best early white variety was TZE composite 3 x 4 and the best early yellow entry was CMS 8806 (5.1t/ha). The two extra early varieties ranked among the last. There were Csp x L Rayitiri F2 (3.9t/ha) and TZEF-y (3.6t/ha). Pool 16 DR (4.4t/ha) was disappointing in 1990. This was partly due to its low plant stand.

2.3.5.1.5 Conclusion to the N.V.T.

Due to poor rainfall distribution in Savanna, the N.V.T early yielded the same as the N.V.T late (4.7t/ha). In Maroua, the early set outyielded the late set by 1.6t/ha (4.5t/ha) versus (2.9t/ha) while in Soucoundou the performance of the two set was similar (3.7t/ha). In general, the Forest late set was 0.8t/ha better than the Savanna late set. However, for the early set, the Savanna set outyielded the Forest set by 0.9t/ha.

2.3.5.2 Experimental Variety Trial (E.V.T.)

The E.V.T in 1990 was made of introduced trials from IITA, SAFGRAD, CIRAD and pionneer.

2.3.5.2.1 E.V.T LSR White

This trial originated from IITA and comprised 13 entries tested at four locations. The mean grain yields for the four locations are presented in table 7. Grain yield means ranged from 6.8t/ha in Ndock to 4.2t/ha in Touboro. Coefficients of variation were good and ranged from 10.7% in Ndock to 17.3% in Ntui.

The best variety across the four sites was a three-way cross hybrid check 8321-18 x 27-1 (6.1t/ha). This variety yielded the same as the open pollinated E.V. 8722 SR (6.1t/ha). CMS 8710 (6.0t/ha) and Ndock 8701 (5.9t/ha) ranked as the second and third best open pollinated respectively. The ranking of the three top open pollinated varieties was similar to 1989 rankings over 11 African countries.

2.3.5.2.2 R.U.V.T Extra-Early

This trial originated from SAFGRAD and was comprised of 13 extra early varieties (less than 82 days). This trial was planted at 3 locations using high plant density (70000 plots/ha) Urea application was done 25 days after planting. The extra-early varieties yielded 4.9t/ha across the 3 locations which corresponded to a 0.2t/ha yield increase over the early and late N.V.T sets. The mean grain yields of the extra-early varieties across the 3 locations are presented in table 8. Mean grain yield ranged from 4.4t/ha in Maroua to 5.5t/ha in Soucoundou. The coefficient of variation ranged from 7.9% in Soucoundou to 18.4% in

Maroua. The silking date was 44 days after planting as compared to 56 for the N.V.T. early. The best entry was an early check variety Pool 16 DR (5.8t/ha). This was followed by an early entry TZESR-W x GUA 314 BC_1 F_3 (5.6t/ha). The best extra-early entry was CSP x L Rayitiri F_3 (5.5t/ha). The poorest entry was TZEE-y (3.8t/ha). This last entry was also the earliest (40 days for silking).

2.3.5.2.3 R.U.V.T Early

This trial was conducted in three Savanna locations. The entries consisted of 14 varieties. Six of those were drought tolerant. The mean grain yield for the three locations are presented in table 9. Grain yield ranged from 5.0t/ha obtained in Maroua to 7.1t/ha obtained in Sanguere. Plant density at harvest ranged from 57000 plant/ha in Maroua to 65000 plant/ha in Sanguere and in Soucoundou. Coefficients of variation ranged from 8.0% at Sanguere to 19.1% in Maroua. The 3 best entries across the three environments were Farakoba 88 Pool 16 DR (6.9t/ha). Across 86 Pool 16 DR (6.7t/ha), and TZE composite 3 x 4 F_1 (6.5t/ha). The poorest entry was an extra-early variety TZEF-y which yielded 5.5t/ha and was about 5 days earlier than the other entry.

2.3.5.2.4 Probe Trial

This trial was made of 8 entries and was tested at 4 locations in 1990. The trial was designed to characterize our testing locations based on the variety reaction to an environment. The trial consisted of 4 Forest and 4 Savanna adapted varieties. The trial had 6 replications. The findings and plant characteristics are showed in table 10. In the usual Savanna locations (Maroua and Sanguere), the Savanna adapted varieties outyielded the Forest adapted varieties. Ntui behaved like Forest and Savanna location. Actually it is a transitional zone. Ndock tended to behave like Forest area. This last finding was in agreement with 1989 Findings suggesting that Touboro located at 80 km from Ndock tended to behave like a Forest location. In overall means, the best variety was Across 86 Tzut (6.2t/ha) followed by Population 25 SR (6.0t/ha). FR1141 x FR303 (4.3t/ha), which was a temperate hybrid yielded the least.

2.3.5.2.5 Early germplasm (Table 11)

This trial was made of 16 entries. The objective was to identify new germplasm that could be useful to the program. The trial was tested at two locations: Ntui and Sanguere. Suwan R-SR BC_3 was the best variety at Ntui with 5.8t/ha, while Baguada 88 BU ESR W outyielded the others entries at Sanguere (5.7t/ha). The following selected entries will be retested in 1991. Across 88 TZE comp 7 (5.3t/ha), EV 8731/SR BC_6 (5.2t/ha). TZE Composite 5 cycle 2 (5.1t/ha), Suwan 2 SR BC_2, and Pool 15 SR QPM (5.1t/ha). The last entry was Bagando 88 Pool 16 SR (4.5t/ha).

2.3.5.2.6 Late Germplasm

This trial was composed of 21 entries and was tested at 3 locations in 1990. The objective was to compare some new gemplasm with known varieties. The results presented in table 12 showed superiority of Tzut-SR-w C_3 (6.6t/ha) over the other entries. This was followed by hybrid 8321-18 (6.3t/ha) and 8644-31 (6.2t/ha). Four others entries which showed yield superiority to TZPB SR and to Suwan ISR (CMS 8704) will be retested next year. These were TZ SR w-1-C_4 (6.2t/ha), E.V. 22 DMR-SR (6.0t/ha) la Posta C_1 (5.9t/ha) and TZ; comp 3 (5.8t/ha). In addition 2 others varieties were retained for their tolerance to borers TZBR-SE5-2 (5.5t/ha) and TZBR-Eld-2 (5.3t/ha).

2.3.5.2.7 New late Varieties

The trial (table 13) consisted of 10 new cycles of late varieties tested at 2 locations. Days to silk (DTS) ranged from 59 to 66 days. Grain yield ranged from 40t/ha for PoP 61 SR BC_4 to 6.4t/ha for the check 8321-18. The best open pollinated was TZL comp 3 (6.0t/ha), followed by Across 88 Tzut SR-w (5.9t/ha). These two varieties were retained for further testing.

2.3.5.2.8 International white and yellow grained hybrid

Three sets of white and 4 sets of yellow grained hybrids originated from IITA were planted in 1990. In the white set (table 14), grain yield ranged from 4.9t/ha at Mayo Golke to 7.1t/ha in Sanguere. Coefficients of variation ranged from 10.9% in Sanguere to 17.9% at Mayo Golke. Yields ranged from 6.4t/ha for 8516-12 to 5.4t/ha for the open pollinated CMS 8501. Three hybrids were better than our usual reference check 8321-18 (5.9t/ha) and 8428-19 (5.9t/ha).

For the yellow set, grain yield ranged from 4.9t/ha at Mayo Golke to 6.0 in Sanguere. Coefficients of variation ranged from 12.7% obtained at Ntui to 18.1% at Sanguere. 8522-2 (6.3t/ha) outyielded the open pollinated check CMS 8704 (5.3t/ha) by 1.0t/ha. Only the three way cross 8644-32 (6.1t/ha) was better than the reference check 8329-15 (5.7t/ha). The results are presented in table 15.

2.3.5.2.9 CIRAD African French Hybrid

Four sets of these hybrids were evaluated in 1990. The trial consisted of 20 hybrids, 2 rows/plot and 4 replications. Grain yield per location ranged from 5.1t/ha at Yaounde to 7.4t/ha in Ntui. Coefficients of variation ranged from 10.1% at Sanguere to 22.9% at Yaounde. The 3 best entries yielded over 7.0t/ha across the 4 environments (table 16). These were: Tx 1015 (7.3t/ha); P.3210 (7.3t/ha) and IR 30 (7.1t/ha). The poorest entry was IRAT 298 (4.9t/ha).

2.3.5.2.10 Pioneer Hybrids

Three sets of Pioneer hybrids were tested in 1990 at 3 locations. The trial consisted of 22 entries including one local check. Grain yields across the 3 environment are presented in table 17. The performance of the hybrids ranged from 4.6t/ha (155322) to 8.1t/ha (9001 ly). The coefficient of variation was unacceptable at Yaounde. This was attributed to the poor plant stand at harvest due to flooding 2 weeks after flowering. Twelve hybrids had their average performance superior to 7.0t/ha. The four first hybrids were retained to be included in a Hybrid National Variety trial.

2.3.5.3 Hybrids

2.3.5.3.1 Experiment I, II and III

These trials constituted the most advanced hybrid trials available in the program. All of them have been tested at least for 3 years. The objective was to identify high yielding hybrids to be recommended for on-farm and agronomic trials.

Experiment I (table 18) was made of 14 entries. Eleven of those varieties were crosses between the single cross 8321-18 and a NCRE line. Grain yield ranged from 7.9t/ha for 8321-18 x 52 to 5.6t/ha for 8321-18 x 61. The best open pollinated check was CMS 8501 (6.9t/ha). Five hybrid yielded 10% or more than CMS 8501. The best three way cross had 1.0t/ha superiority over the open pollinated check. IITA single cross check 8516-12 (6.8t/ha) yielded the same as the O.P check.

Experiment II results are presented in table 19. The trial was composed of 13 entries tested at 2 locations. Yields ranged from 6.3t/ha for 8428 x 1 to 4.9t/ha for 8428-19 x 46. The best O.P check was Ndock 8701 (6.1t/ha). None of the crosses outyielded the O.P. by more than 5%.

Experiment III was composed of 15 entries tested at 5 locations (table 20). Mean grain yields ranged from 5.6t/ha at Touboro to 7.0t/ha obtained at Ntui. Coefficients of variation ranged from 9.2% at Touboro to 16.7% at Maroua. Twelve Hybrids outyielded the IITA check 8705-6 (5.8t/ha). 5 entries had 14% or more yield superiority over the best open pollinated Ndock 8701 (5.6t/ha). The best three way hybrid was 8321-18 x 13 with 6.5t/ha across the 5 environments. This represented a 16% increase over Ndock 8701.

2.3.5.3.2 NCRE Single Crosses Group I, Group II, Group III

These trials were the most advanced single crosses of the program. Group I involved crosses of NCRE lines with 1368 which is an IITA line derived from population 21. This group had 36 Crosses tested in 3 sets of 12 varieties. Each had 4 Replications, 4 Rows/plot. The results are shown in table 21. Only four crosses out of 36 showed more than a 15% yield increase over the best open pollinated. These were: 1368 x (1-3) (7.1t/ha); 1368 x (37) (7.1t/ha); 1368 x (71-73) (6.9t/ha) and 1368 x 67-70 (6.3t/ha).

Group II involved crosses of NCRE lines with 9071 which is an IITA line derived from the temperate line N28. This group had 30 crosses tested in 2 sets. The results are shown in table 22 . Average yields obtained in this group were in general higher than those obtained in group I. However only 2 crosses had more than 15% yield increase over the best open pollinated CMS 8501. These were: 9071 x 2 (7.7t/ha) and 9071 x 52 (8.7t/ha at Ntui).

Group III was made of 3 sets of 15 entries each. This consisted of NCRE lines crossed to IITA line 5012 derived from the CIMMYT subtropical population 34. The performances of those crosses are presented in table. Five lines out of 43 had their yield potential 15% or more of the best open pollinated. These hybrids are: 5012 x 10-13 (8.4t/ha); 5012 x 64-66 (8.3t/ha) 5012 x 72-73 (7.8t/ha); 5012 x 39-41 (7.5t/ha) and 5012 x 58-59 (7.4t/ha).

2.3.5.3.3 NCRE Single Yellow Crosses

These were composed of NCRE yellow lines crossed to 3 IITA inbred lines (4001, 9450, 9848). This consisted of 94 entries tested in 3 sets and the results are shown in table 24. The IITA 3 ways cross 8644-31 and the O.P. CMS 8704 were used as checks. 4 lines exhibited a 15% or more yield increase over the best open pollinated CMS 8704. These were 9848 x 30 (7.6t/ha); 32 x 4001 (6.4t/ha) 9848 x 38 (6.5t/ha); 9848 x 39 (6.3t/ha) and 41 x 9848 (6.0t/ha).

2.3.5.3.4 Tester Single Crosses

This trial consisted of single crosses among NCRE lines classified under different, heterotic groups. The summary of their performance is shown in table 25. Group I inbred lines were those lines that were selected based on their performance when crossed to the Tuxpeño derived lines 1368. Group 2 was made of lines heterotic to the temperate derived lines 9071 and group 3 consisted of NCRE lines heterotic to the subtropical derived line 5012. The 38 crosses between group I lines and group III lines yielded 12 crosses (32%) superior or equal to the single cross hybrid 8428-19 (1368 x 5012). However only 5 of those lines had 15% yield superiority over the best open pollinated CMS 8501 (6.7t/ha). The 38 crosses involving group I lines and group 2 lines gave 9 (24%) lines superior or equal to the check single cross 8321-18. 2 of those lines were 17% higher than the best open pollinated check CMS 8501 (6.4t/ha).

The 40 Crosses between group 2 and group 3 yielded 14 hybrids (35%) equal or better than the best single cross check 8321-18. But only 3 of those crosses had a 15% or more yield superiority over the best open pollinated Ndock 8701 (6.6t/ha).

2.3.5.3.5. MIR Single Crosses

This trial consisted of 72 lines from various sources around the world. The yellow lines (50 in total) were crossed to 4001 and 9450 which are two IITA lines. The white lines (22 in Total) were crossed to 1368 and 5012. The selected lines are presented in table 26. These crosses were tested at two locations in 2 sets. About 30% of the lines were retained based on their performance comparative to the white or yellow open pollinated variety. 1368 and 4001 had the highest percentage of lines retained, 45% and 33% respectively.

2.3.5.4 Population Improvement
2.3.5.4.1 Heterotic Pools

Three heterotic pools were formed in 1989. Crosses among lines from different pools yielded a higher percentage of hybrids significantly different from their counterpart single crosses (see tester single crosses table 22) than did those lines crossed to their corresponding tester (table 20). In 1990, the 3 heterotic pools were remade based on the F1 among lines from different groups.

2.3.5.4.2 TZB SR Testcrosses

Nine sets of TZB SR Testcrosses were evaluated in 1990 at two locations. Entries consisted of 100 S_4 lines from TZB SR populations crossed to four testers namely 1368, 9071, 5012, Tzut. The objective were to identify lines with good general combining ability that would be recombined to make a new version of TZB SR variety. In addition, selected lines will be grouped in heterotic pool.

The performance of the testcrosses was different from Forest to Savanna zone. 1368 was efficient in identifying lines in both Forest and Savanna (12.5 versus 13.4). 5012 as tester reacted better with lines in Savanna but had a very poor performance in Forest zone. Tzut and 9071 which had some temperate germplasm were identified as good testers for Savanna zone. It was concluded that the genetic background of each heterotic pool will differ not only with the tester used but also with the testing site.

2.3.5.4.3 Suwan I SR Testcrosses

Seven sets of 41 entries of Suwan 1 SR testcrosses were evaluated at 3 locations: Yaounde, Ntui and Sanguere. The entries consisted of about 100 S_1 lines derived from the Suwan 1 SR BC_3 population crossed to three testers namely: 4001, 9450 and 9848. More lines were retained with 4001 and 9848 as testers than with the temperate derived line 9450. Lines retained with at least 2 testers will be recombined to form a new variety from Suwan I SR.

2.3.5.4.4 I.P.T.T. (TZL composite 3 x 4)

Eight sets of 49 Full sibs from TZL composite 3 crossed to TZL composite 4 were tested at 2 locations: Ntui and Mouda. The trial in Mouda failed because of early drought at flowering stage. Different numbers of lines were retained per set based on the deviation of their mean performance from the set mean. Parents of the selected Full-sib will be recombined to improve the 2 heterotics composite population.

2.3.5.4.5. I.P.T.T TZB SR SE

One hundred lines from the soft endosperm version of TZB SR SE were evaluated in a 10 x 10 lattice with 3 Replications. The mean of the trial was 5.0t/ha and the coefficient of variation 24.4%. 30 lines will be retained and recombined to improved the variety.

2.3.5.4.6 Local x improved crosses

Eight local varieties were crossed to 8 improved varieties in 1989 in a design II fashion. The local materials were made of one early variety (Bafia local) and seven late accessions (Bougzoudou, Bezcola Miki; Local Saa, Local Yaounde; Local Mfoumou and Local Betourou). The improved varieties were 2 early (Pool 16 SR and TZESR), 3 intermediate (CMS 8503, Tzut and E.V. 8435 SR), and 3 late (Ndock 8701, CMS 8501, E,V, 8443 SR). The 64 crosses and their 16 parents were evaluated in 1991 at five locations (Maroua, Sanguere, Yaounde I, Yaounde II and Ntui).

Yaounde local combined very well with all improved varieties. Mid-parent heterosis was positive for all cross combinations. However high parent heterosis was positive for only crosses involving the early and the intermediate improved varieties. The best cross was CMS 8503 x Yaounde selection (6.3t/ha). It was concluded that high yielding soft endosperm versions of the improved varieties are obtainable. (table).

Table 1: 1990 Trials names and number tested.

I. Introductions

Trial name	origine	entries number	Reps	Number Tested Forest	Savanna	Total
1. EVT LSR-W	IITA	13	4	1	3	4
2. Probe Trial	IITA	8	4	1	3	4
3. Late germplasm	IITA	21	6	1	3	4
4. Early germplasm	IITA	16	5	1	1	2
5. New late Varieties	IITA	10	6	1	1	2
6. TZB SR-SE IPTT	IITA	100	3	1	-	1
7. TZL comp 3 x 4 IpTT	IITA	392	4	1	1	2
8. Streak Resistent inbred	IITA	15	4	1	1	2
9. Striga observational trial	IITA	8	4	-	1	1
10. international white hybrid	IITA	10	4	1	3	4
11. international yellow hybrid	IITA	8	4	1	3	4
12. R.U.V.T Extra early	SAFGRAD	13	4	-	3	3
13. R.U.V.T early	SAFGRAD	14	4	-	3	3
14. Pool 16 DR IpTT	SAFGRAD	169	3	-	1	1
15. Hybride Afrique	CIRAD	20	4	2	2	4
16. Pionneer Hybride	U.S.A.	22	3	2	1	3
Total		824		14	30	44

II. NCRE/IRA EVALUATION

name	Set	entries	Reps	Number Forest	Tested Savanna	Trial Total
1. N.V.T. (E/I)	-	15	4	11	7	18
2. N.V.T (Late)	-	15	4	11	7	18
3. Three way Hybrids	-					
Experiment I	-	14	4	1	1	2
Experiment II	-	13	4	2	2	4
Experiment III	-	15	4	3	4	7
Others	-	20	4	2	1	3
4. NCRE Single Crosses						
group I	2	30	4	3	2	5
group II	2	30	4	2	2	4
group III	3	42	4	3	3	6
5. NCRE Single yellow crosses	3	94	3	4	3	7
6. Tester Single crosses	3	120	3	3	3	6
7. HIR Single crosses	2	82	3	2	2	4
8. TZB Testerosses	9	369	3	9	9	18
9. Suwan I SR Testerosses	7	287	3	7	7	14
10. Early germplasm Testcrosses	3	99	3	3	6	9
11. Early partial Diallel	-	40	3	-	2	2
12. Striga Screening trial	4	164	3	-	4	4
13. Drought Screening trial	-	90	4	-	2	2
14. Busseola, Screening trial	-	130	3	1	-	1
16. Local x Improved Diallel	-	81	2	3	2	5
Total		1720		70	69	139

III. POPULATION IMPROVEMENT

Populations	Activities	Locations	Total
1. CMS 8704	Half-sib	Nkolbisson, Sanguére	2
2. CMS 8501	Half-sib	Nkolbisson	1
3. Ndock 8701	Half-sib	Nkolbisson, Sanguére	2
4. CMS 8806	Half-sib	Nkolbisson, Sanguére	2
5. CMS 8710	Half-sib	Nkolbisson SOUCOUNDOU	2
6. Yaounde 8701	Half-sib	Nkolbisson	1
7. Suwan I white	Half-sib	Nkolbisson	1
8. Pool 16 DR	Half-sib	Sanguére	1
9. Early Syn I (E^1)	S^3 Recombination	Nkolbisson	1
10. Early Syn II (E^2)	S^3 Recombination	Nkolbisson	1
11. TZEF-Y	Mass Selection	Sanguére	1
12. Major Varieties	Testcrosses 1368, 9071, 5012	Nkolbisson	1
Total			16

IV INBRED/TESTCROSSES

Populations	Entries	Activities	Location
1. Experiment I	11	Seed increase + three-way	Nkolbisson
2. Experiment II	10	Seed increase + three-way	"
3. Experiment III	12	Seed increase + three-way	"
4. NCRE group$_1$		Seed increase + single crosses	"
5. NCRE group$_2$		Seed increase + single crosses	"
6. NCRE group$_3$	102	Seed increase + single crosses	"
7. La posta lines	20		
8. Highland lines	11		
9. Drought resistant lines	90	Advance to SH	"
10. Suwan 1SR S4	300	Advance to 3S5	"
11. TZB SR S1	310	Testcrosses,1368,9071,5012,Tzut	"
12. Early lines S3	250	Advance to S4 + Testcrosses	"
13. Single yellow population	49	Single crosses 4001,9848,9450	"
14. Crosses S3 lines	323	Advance to S4 + Testcrosses	"
15. Tester single crosses line	45	Single crosses among hetorotic groups	
16. CIRAD	20	S1 formation	"
17. Pionneer	22	S1 formation	"
18. TZUT new lines	15	Seed increase	"
	190		

V SEED INCREASE

Population	Total land area	Locations
1. CMS 8501	2 ha	Minkomeyos, Sanguére
2. CMS 8704	5 ha	Ntui, Ndock
3. CMS 8806	3 ha	Ntui, Sanguére
4. Ndock 8701	1 ha	Sanguére, Ntui
5. Pool 16 DR	1/4 ha	Sanguére
6. BSR 81	-	Bertoua
7. BSR Syn II	-	Bertoua
8. Acid tolerant	-	Nkolbisson
9. Madagascar varieties	-	Nkolbisson

Table 2: 1990 Locations and Land area used

Locations	Total Land area used (ha)	Number of 1st season	Trials 2nd season	Total
FOREST				
1. Nkolbisson	8	13	17	30
2. Ntui	8.5	62	6	68
3. Mamo	0.8	3	2	5
4. Foumbot	1	5	-	5
5. Ekona	0.8	3	2	5
6. Ebolowa	0.7	3	1	4
7. Bertoua	0.7	4	-	4
8. Batchenga	0.7	3	-	3
Total	20.2	97	27	124
SAVANNA				
1. Sanguere	8.3	53	-	53
2. Guiring	2.0	13	-	13
3. Mouda	1.5	10	-	10
4. Soucoundou	1.5	9	-	9
5. Mayo Galke	1.3	6	-	6
6. Ndock	1.0	5	-	4
7. fouboro	2.0	5	-	5
8. IRZ Sanguere	2.0	1	-	1
Total	19.0	103		103

Table 3: Mean of the 1990 N.V.T. (Late) in forest Zone

Entries	Ntui	Foumbot	Yaounde	Yoke	Mamo	Bertoua	Batchenga*	Mean
1. CMS 8507	7.7	6.4	6.3	5.1	5.0	7.0	4.4	6.3
2. CMS 8505	7.2	7.1	8.2	4.7	4.1	5.6	3.0	6.2
3. Ndock 8701	7.2	7.1	7.0	6.2	3.9	5.6	3.3	6.2
4. 8321-18	7.3	6.9	7.1	6.3	3.8	5.5	4.1	6.2
5. Suwan x gene Pool (y)	7.8	5.7	4.8	7.1	4.9	3.6	4.7	6.2
6. CMS 8704	7.8	7.4	6.5	5.7	4.3	4.8	3.2	6.1
7. CMS 8710	7.4	6.6	7.5	5.6	4.0	5.3	2.8	6.1
8. CMS 8501	7.7	6.9	7.7	5.1	3.4	4.2	6.5	5.8
9. Yaounde 8701	7.1	5.8	6.0	6.2	4.2	5.7	1.9	5.8
10. Suwan I SR(W)	6.8	6.9	7.2	5.2	4.4	3.7	3.2	5.7
11. Local check	8.4	7.2	6.1	4.4	4.7	2.3	1.0	5.5
12. E.V 8422 SR	6.1	6.7	5.2	5.3	3.4	5.8	3.0	5.4
13. Bertoua 8701	5.9	5.3	6.0	6.2	2.9	6.2	3.1	5.4
14. TZB SR SE	7.2	5.8	4.9	6.1	4.1	3.7	4.3	5.3
15. Ntui TZFB SR	3.5	3.1	7.2	4.2	3.3	3.6	1.6	4.2
Mean	7.0	6.3	6.5	4.6	4.0		3.3	5.5
C.V (%)	16.8	13.2	17.1	25.0	22.8	25.1	41.2	-
L.S.D.(0.05)	0.6	0.9	1.1	1.0	0.7	0.5	0.9	-

* Did not enter the overall means

Table 4: 1991 N.V.T. (Early) Forest Zone

Entries	Ntui	Foumbot	Mamo	Yoko	Bertoua	Means DTS	Means Yield
1. TZut (across 87)	6.2	4.4	4.9	5.4	4.7	60	5.1
2. TZE Comp 3 x 4	4.5	4.2	4.4	5.5	4.9	56	4.7
3. CMS 8503	6.1	5.1	3.7	4.7	3.7	60	4.7
4. E.V. 8435 SR	5.0	3.5	4.4	4.9	4.1	60	4.4
5. CMS 8806	4.7	3.8	4.3	5.1	3.9	56	4.4
6. BSR-Syn I	4.6	3.0	4.4	5.3	4.0	62	4.3
7. pool 16 SR	4.9	3.7	4.0	4.0	4.3	54	4.2
8. DMR-ESR-W	4.0	3.6	4.2	5.5	3.2	54	4.1
9. BSR-81	4.3	3.5	4.4	4.7	3.1	61	4.0
10. BSR-Syn II	4.3	3.4	4.1	4.4	3.5	60	4.0
11. TZESR-SR	4.2	3.0	3.2	4.3	3.5	57	3.6
12. TZESR-W x GUA314 F_1	3.6	1.4	3.5	4.1	3.4	48	3.2
13. Maka	3.6	1.9	1.9	3.5	1.9	57	2.6
14. CSP x L Rayitiri	2.3	1.3	3.8	3.4	2.0	47	2.6
15. TZEF-Y	2.7	1.0	-	2.2	2.3	47	2.2
Means	4.3	3.1	3.9	4.3	3.5	-	3.9
C.V.(%)	19.2	19.9	23.0	15.8	19.6	-	
L.S.D. (0.05)	0.6	0.5	0.7	0.5	0.5	-	

Table 5: Means of 1990 N.V.T (Late) in Savanna Zones

Entries	Sanguere	Soucoundou	Mouda*	Maroua	Touboro	Ndock	Mayo Galke	Mean
1. 8321-18	7.4	5.2	2.7	3.5	5.4	6.4	5.3	5.5
2. CMS 8501	7.0	3.9	1.8	2.8	4.9	7.1	5.4	5.2
3. CMS 8505	7.3	4.4	1.9	2.9	4.5	6.4	4.3	5.0
4. TZB SR SE	6.9	3.5	1.7	3.8	6.0	5.6	4.0	5.0
5. Ndock 8701	7.5	3.2	1.6	3.1	4.9	6.0	4.4	4.9
6. CMS 8704	5.5	4.0	1.1	2.8	5.1	6.7	4.8	4.8
7. CMS 8710	7.1	3.0	1.4	3.0	4.9	6.0	4.2	4.7
8. Suwan I (W)	6.6	4.3	1.7	2.4	4.4	6.2	4.2	4.7
9. Suwan x gene Pool(Y)	7.1	3.6	2.2	3.2	4.7	5.0	4.3	4.7
10. TZPB (check)	6.5	3.3	1.5	3.4	4.8	5.9	3.8	4.6
11. E.V 8422 SR	7.1	4.3	1.8	3.0	5.1	5.0	3.8	4.6
12. CMS 8503	6.6	4.0	1.8	2.4	4.5	5.7	4.0	4.5
13. CMS 8507	6.7	3.2	1.4	3.0	4.8	5.5	3.3	4.4
14. Ntui TZPB	7.1	3.5	1.3	2.7	4.5	4.9	3.1	4.3
Mean	6.8	3.7	1.6	2.9	4.8	5.7	4.1	4.7
C.V (%)	10.2	23.0	31.1	16.7	20.2	12.5	15.7	-
L.S.D. (0.5)	0.5	0.6	0.4	0.4	0.7	0.5	0.6	-

* Did not enter the overall mean

Table 6: Means of N.V.T (Early to intermediate) in Savanna Zone

Varieties	Ndock	Mouda	M.Galke	Touboro	Sanguere	Maroua	Soucoundou	Means DTS	Means PAH	Means Yield
1. TZUT Across 88	7.0	1.5	5.5	5.9	8.7	4.5	5.9	59	44	5.8
2. TZE Comp 3 x 4	6.0	2.4	5.3	5.4	6.7	5.2	5.2	54	45	5.6
3. CMS 8503	5.6	1.9	4.4	5.5	7.8	4.6	3.9	59	39	5.3
4. CMS 8806	5.9	1.6	4.8	4.9	6.0	4.5	4.4	57	43	5.1
5. DMR-ESR-W	5.9	1.7	4.7	4.5	6.5	4.6	4.0	56	44	5.0
6. BSR SYN II	6.3	1.3	4.2	4.8	6.3	4.3	4.0	59	38	5.0
7. TZESR-SE	5.2	2.3	4.5	4.3	5.7	3.8	3.8	56	43	4.9
8. E.V. 8435 SR	5.0	1.4	4.2	5.0	6.9	4.4	2.9	58	44	4.7
9. BSR 81	5.7	1.1	4.4	4.4	5.6	4.0	3.3	60	39	4.6
10.TZESR x GUA 314 BC_5	4.6	2.6	4.1	4.0	5.7	3.8	4.3	53	42	4.4
11.Pool 16 DR	4.7	1.9	3.4	4.4	6.5	4.5	3.0	56	35	4.4
12.MAKA	4.3	1.8	3.7	3.7	6.2	4.6	3.6	57	43	4.4
13.CSP x L.Royitiri F_3	3.9	2.3	2.9	3.5	5.0	4.5	3.5	49	38	3.9
14.TZEF-Y	2.8	2.0	2.2	3.6	5.3	4.1	3.5	50	37	3.6
15.BSR-SYN I	-	-	-	-	-	-	-	-	-	-
Means	5.2	1.7	4.1	4.5	6.4	4.5	3.7	56	41	4.7
C.V.(%)	11.4	42.2	15.0	18.3	8.4	21.1	23.0	-	-	
L.S.D (0.05)	0.4	0.5	0.4	0.6	0.4	0.7	0.6	-	-	-

Table 7: Means of 1990 E.V.T LSR white

Entries	Ntui	Touboro	Ndock	Sanguere	MEANS DTS	PAH	Yield
1. Check[2] (8321-18 x 27-1)	6.3	4.5	5.6	8.0		37	6.1
2. E.V 8722 SR BC6	4.8	4.3	8.0	7.3		41	6.1
3. 8321-18	5.5	4.9	7.4	6.4		40	6.1
4. CMS 8710	5.6	4.4	7.3	6.6		41	6.0
5. Ndock 8701	5.0	4.4	7.3	6.9		39	5.9
6. Mokwa 87 TZPB SR	3.9	3.8	8.2	7.3		38	5.8
7. E.V 8843 DMR SR	5.4	3.9	7.2	6.5		39	5.8
8. TZD SR SE	4.8	4.6	6.7	6.1		42	5.6
9. Okomasa	4.8	3.9	6.6	6.8		38	5.5
10. Check (CMS 8501)	5.4	4.0	6.1	6.4		37	5.5
11. TZB SR SE	4.3	3.7	6.9	6.4		40	5.3
12. Gandajika 8022	4.7	4.1	6.0	5.4		38	5.1
13. Across 85 TZSR-W1	4.4	4.2	5.7	5.8		38	5.1
Mean	5.0	4.2	6.8	6.6		39	5.7
C.V (%)	17.3	14.2	10.7	11.9		-	-
L.S.D (0.05)	1.1	0.9	0.7	0.6		-	-

Table 8: 1990 Means of the R.U.V.T (Extra-early)

Entries	Maroua PAH	Maroua Yield	Sanguere PAH	Sanguere Yield	Soucoundou PAH	Soucoundou Yield	DTS	Mean PAH	Mean Yield
1. Check (Pool 16DR)	42	4.5	45	7.0	49	5.9	49	45	5.8
2. TZESR-W x GUA 314 BC_1 F_3	43	4.5	56	5.9	52	6.4	48	50	5.6
3. CSPxL-RAYITIRI F_3	48	4.9	53	6.0	52	5.6	44	51	5.5
4. Across 813 x JFS x L.R. F_5	45	4.9	53	5.3	51	5.8	44	50	5.3
5. TZEF-Y	44	4.5	52	5.1	52	6.1	45	49	5.2
6. CSP early	40	4.1	54	5.6	51	5.8	44	48	5.2
7. TZEE-yellow Pool	47	4.9	52	4.4	50	5.8	42	50	5.0
8. Pool 27 x GUA 314 BC_1 F_3	48	4.7	56	4.8	54	5.5	42	53	5.0
9. TZEE W-1	52	4.7	51	4.7	52	4.9	42	52	4.6
10. Pop 30 x GUA 314 BC_1 F_3	49	4.5	49	4.3	52	5.3	43	50	4.7
11. TZEE white pool	46	4.2	53	4.2	57	5.3	43	52	4.6
12. TZEE-W-2	49	4.1	49	3.9	50	5.0	42	49	4.3
13. TZEE-Y	36	3.3	48	3.2	51	4.8	40	45	3.8
Means	45	4.4	52	4.9	52	5.5	44	50	4.9
C.V (%)	11	18.4	7	12.6	9	7.9	-	-	-
L.S.D (0.05)	-	0.9	-	1.2	-	0.8	-	-	-

Table 9: Mean of 1990 R.U.V.T (early)

Entries	Sanguere PAH	Sanguere Yield	Soucoundou PAH	Soucoundou Yield	Maroua PAH	Maroua Yield	DTS	Means PAH	Means Yield
1. FARAKOBA 88 Pool DR (H.D)	55	7.9	51	6.4	47	6.5	50	52	6.9
2. Across 86 Pool 16 DR	54	7.7	57	7.1	42	5.2	49	51	6.7
3. TZE Comp 3 x 4 F3	52	7.2	58	7.2	46	5.3	50	51	6.4
4. SAFITA-2 (RE)	53	7.1	54	6.9	46	5.3	50	51	6.4
5. Across 87 Pool 16-SR	54	7.5	51	6.4	49	5.2	49	51	6.4
6. Kamboin SE 88 Pool 16 DR	55	7.4	54	6.8	48	4.8	51	52	6.3
7. DR Comp Early	52	6.9	51	6.6	49	5.2	48	51	6.2
8. Across 88 Pool 16 DR	53	7.2	52	6.5	46	4.8	49	50	6.2
9. EV 8730 SR BC_4	51	7.1	52	6.5	48	4.9	52	50	6.2
10. E.V. 8731 SR BC_4	52	7.5	53	6.8	45	4.1	51	50	6.1
11. DMR-ESR-W	53	7.3	56	6.6	47	4.2	52	52	6.0
12. DMR-ESR-Y	53	6.8	32	6.0	46	4.6	52	50	5.7
13. TZESRW-SE	53	6.7	49	5.8	48	4.8	51	50	5.8
14. Check (TZEF-y)	51	5.3	50	5.9	46	5.4	45	49	5.5
Means	53	7.1	53	6.5	47	5.0	50	51	6.2
C.V. (%)	5	8.0	8	10.4	8	19.1	-	-	-
L.S.D.	2	0.4	6	0.5	-	0.7	-	-	-

Table 10: 1991 PROBE TRIAL

Varieties		Maroua	Sanquere	Ndock	Ntui	MEANS DTS	MEANS PAH	MEANS Yield
1. Suwan ISR	(F)	2.8	6.0	7.5	6.9	63	40	5.8
2. E.V. 8443 SR	(F)	2.5	5.7	7.3	6.4	63	38	5.5
3. DMR LSR-W	(F)	2.8	6.3	6.8	6.9	63	37	5.7
4. Ac 86 TZUT-SR-W	(S)	3.9	6.7	6.7	7.4	60	39	6.2
5. E.V. 8443 SR	(S)	3.1	6.3	6.8	6.8	60	38	5.8
6. Pop 25 SR	(F)	3.5	6.3	7.5	6.6	61	40	6.0
7. 8321-18	(S)	3.6	6.8	6.7	6.6	63	39	5.9
8. FR1141 x FR 303*	(S)	4.3	4.0	2.6	6.2	58	34	4.3
Mean		3.3	6.0	6.5	6.7	61	38	5.6
C.V (%)		21.4	11.9	10.1	14.7	-	-	-
L.S.D (0.05)		0.7	0.7	0.6	1.0	-	-	-
Mean Forest		2.9	6.1	7.3	6.7			
Mean Savanna		3.5	6.6	6.7	6.9			
Classification		Savanna	Savanna	Forest	Forest or Savanna			

* did not enter mean Savanna Calculation

F = Forest adapted S = Savanna adapted

Table 11: 1991 Early Germplasm

Varieties	Ntui	Sanguere	Means DTS	Means PAH	Means Yield
1. BAG 88 BU-ESR-W	5.2	5.7	54	42	5.5
2. AC 88 TZE Comp 7	5.3	5.3	54	35	5.3
3. EV 8731 SR BC_6	5.4	5.0	53	39	5.2
4. TZE Comp5 C_2	4.9	5.3	53	38	5.1
5. Pool 15 SR QPM	5.2	4.9	55	36	5.1
6. Pool 18 SR QPM	5.0	5.0	54	32	5.0
7. Suwan 2-SR BC_2	5.8	4.1	54	32	5.0
8. Pop 31 DMR SR BC_2	4.9	5.0	52	38	4.9
9. EV 8749 SR-W	5.3	4.5	55	34	4.9
10. TZE Comp 3 x 4 C_0	4.8	4.9	53	41	4.9
11. E.V 8730 SR BC_6	4.6	5.2	54	43	4.9
12. Ik.88 BU ESR-W	5.0	4.8	52	37	4.9
13. TZE Comp 6 C_0	4.9	4.6	53	38	4.8
14. AC 88 Pool 16 SR	4.6	4.8	51	35	4.7
15. AC 87 DMR-ESR-W	4.6	4.3	51	40	4.5
16. BAG 88 Pool 16 SR	4.5	4.0	50	39	4.3
Means	5.0	4.8	53	37	4.9
C.V.(%)	11.3	17.8	-	-	-
L.S.D (0.05)	0.4	0.6	-	-	-

Table 12: 1991 LATE GERMPLASM

Hybrids	Ntui	Sanguere	Touboro	Means DTS	PAH	Yield
1. TZUT SR-W C_4	7.1	6.9	5.7	60	41	6.6
2. 8321-18	6.8	6.8	5.3	60	41	6.3
3. 8644-31	6.6	6.9	5.2	62	40	6.2
4. TZSR-W-1 C_4	6.8	6.5	5.2	63	39	6.2
5. E.V. 22 DMR SR	6.6	6.4	4.9	60	40	6.0
6. La Posta C_3	6.2	6.5	5.0	62	41	5.9
7. TZL Comp 3	5.6	6.5	5.2	63	38	5.8
8. DMR-LSR-W	5.7	5.8	4.9	62	38	5.8
9. TZPB SR	5.8	6.0	4.8	64	38	5.5
10. SUWAN I SR	5.9	5.7	4.9	62	38	5.5
11. TZBR-SES-2	5.6	5.7	5.1	62	39	5.5
12. E.V. 8749SR	5.8	5.6	5.2	59	40	5.5
13. POP 28 DMR SR	5.6	6.0	4.7	63	37	5.4
14. TZB SR	5.2	6.6	4.3	63	39	5.3
15. TZBR-ELD-2	4.7	6.3	4.8	63	37	5.3
16. E.V. 8725 SR	5.1	6.0	4.9	63	38	5.3
17. E.V. 8721 SR	5.1	5.9	5.0	63	39	5.3
18. Pool Tardio	5.1	5.7	4.0	65	37	4.9
19. Pool 24	4.3	6.2	4.1	62	37	4.9
20. Pool 23	5.1	4.9	4.0	62	31	4.7
21. TZi-SR-W	3.6	5.4	3.9	61	33	4.3
Means	5.7	6.1	4.8	62	38	5.5
C.V.(%)	17.9	14.4	13.9	-	-	-
L.S.D (0.05)	0.6	0.5	0.4	-	-	-

Table 13: New Late Varieties

Varieties	Sanguere	Ntui	Means DTS	PAH	Yield
1. 8321-18	6.1	6.7	62	40	6.4
2. 8644-31	5.6	6.3	61	40	6.0
3. TZL comp 3	5.6	6.2	62	38	5.9
4. Across 88 TzutSR-w	5.1	6.4	61	41	5.8
5. FUN 88 TZSR-w	5.6	5.6	61	39	5.6
6. For 88 TZSR-w	5.2	5.5	66	41	5.4
7. E.V. 8747 SR BC_6	5.3	5.2	60	42	5.3
8. Ik 88 TZSR -y-1	5.0	5.4	61	38	5.2
9. Across 88 TZE comp 7	4.5	5.2	61	38	4.9
10.Pop 61 SR-BC_4	4.0	3.9	59	40	4.0
Mean	5.2	5.6	61	40	5.4
C.V (%)	19.1	13.9	-	-	-
L.S.D	0.8	0.7	-	-	-

Table 14 : 1990 International White Hybrid

Varieties	Sanguere	Mayo Galke	Touboro	Mean DTS	PAH	Yield
1. 8516-12	7.3	5.8	6.1	60	39	6.4
2. 8505-5	7.5	5.7	5.5	60	41	6.1
3. 8705-6	6.9	5.4	5.7	61	39	6.0
4. 8428-19	7.8	4.0	5.9	58	38	5.9
5. 8321-18 (RE)	6.3	5.5	5.9	60	39	5.9
6. $Check_2$ (8321-18 x Exp 27)	7.7	3.8*	6.3	61	39	5.9
7. 8321-21	6.3	5.5	5.9	60	39	5.9
8. 8705-4	7.1	4.5	5.6	61	40	5.7
9. Ikenne TZ SR-W	6.4	5.1	5.2	62	41	5.6
10. $Check_1$ (CHS 8501)	7.3	4.2	4.6	60	36	5.4
Mean	7.1	4.9	5.6	60	39	5.9
C.V (%)	10.9	17.9	12.1	-	-	-
L.S.D (0.05)				-	-	-

* CHS 8501

Table 15: 1990 International Yellow Hybrid

Varieties	Ntui	Sanguere	Mayo Galke	Touboro	Mean DTS	Mean PAH	Mean Yield
1. 8522-2	7.0	6.4	5.9	5.7	62	41	6.3
2. 8644-32	5.8	7.3	5.6	5.8	61	41	6.1
3. 8329-15 (RE)	6.1	5.4	5.8	5.4	61	40	5.7
4. 8644-27	5.2	5.8	5.3	6.1	62	41	5.6
5. 8644-31	5.6	6.3	5.5	4.9	62	39	5.6
6. $Check_1$ (CMS 8704)	5.2	6.0	4.4	5.6	63	37	5.3
7. $Check_2$ (CMS 8501)	4.6	5.7	3.2	6.0	63	34	4.9
8. Across TZSR-Y	4.5	5.4	3.7	4.9	63	36	4.6
Means	5.5	6.0	4.9	5.5	62	38	5.5
C.V (%)	12.7	18.1	13.1	16.7	-	-	-
L.S.D.(0.05)	0.7	1.1	0.6	0.9	-	-	-

Table 16: CIRAD AFRICAN FRENCH HYBRID

Entries	Ntui	Yaounde	Sanguere	Ndock	Means DTS	Means PAH	Means Yield
1. Tx 1015	8.6	6.7	6.5	7.4	63	38	7.3
2. P. 3210	8.8	7.0	7.4	6.0	63	40	7.3
3. IR 30	8.1	6.2	7.4	6.8	64	40	7.1
4. Tx 1029	8.1	5.9	6.6	6.5	62	39	5.8
5. Tx 1030	7.8	5.4	6.4	7.1	62	39	6.7
6. 8644-31	7.1	5.6	7.0	6.9	62	38	6.7
7. Local check	7.3	6.2	6.5	6.4	62	39	6.6
8. DINA 170	8.6	4.3	7.2	6.2	62	39	6.6
9. IR 31	6.8	4.5	6.2	7.7	64	37	6.3
10. Tx 1031	7.6	5.2	7.0	5.4	62	38	6.3
11. 8321-18	7.3	4.8	6.6	6.0	63	38	6.2
12. FBH 87358	6.9	4.3	6.2	7.3	63	36	6.2
13. Tx 1013	7.3	6.3	5.5	6.5	63	39	6.1
14. SW 1030	7.9	4.5	6.8	5.2	60	37	6.1
15. IRAT 81	8.9	3.4	6.4	5.6	65	35	6.1
16. IR 33	6.9	4.5	5.4	6.2	63	38	5.8
17. FBH 87217	6.0	3.7	6.4	6.9	61	37	5.8
18. IRAT 340	6.3	5.6	5.1	5.3	62	38	5.7
19. SW 1012	6.5	5.4	5.6	4.5	63	37	5.5
20. IRAT 298	6.2	3.1	5.8	4.3	61	36	4.9
Means	7.4	5.1	6.4	6.2	63	37	6.3
C.V.(%)	12.1	22.9	10.1	16.2	-	-	-
L.S.D (0.05)	0.6	0.7	0.4	0.6	-	-	-

Table 17: 1991 PIONEER HYBRIDS

Hybrids	Mtui	Yaounde	Sanguere	Means DTS	Means PAR	Means Yield
1. 9001 IY	9.2	4.0	7.0	60	38	8.1
2. 86319	8.9	4.6	6.6	59	41	7.8
3. 124549	8.3	4.3	6.9	59	44	7.6
4. 124535	8.3	5.7	6.6	61	41	7.5
5. 155294	8.7	5.1	6.3	61	43	7.5
6. 9005 IY	8.4	4.7	6.3	60	40	7.4
7. 124529	8.0	4.8	6.5	59	42	7.3
8. 9004 IY	7.9	5.6	6.4	57	44	7.2
9. 121591	8.2	5.7	6.1	60	40	7.2
10. 124602	8.6	5.0	5.8	58	39	7.2
11. 3271	8.4	4.3	5.9	57	42	7.2
12. 155312	7.7	5.1	6.2	60	42	7.0
13. 124600	7.9	4.3	5.6	60	42	6.8
14. 124596	7.6	4.3	5.9	57	41	6.8
15. local check	7.5	3.8	5.9	59	44	6.7
16. 3086	7.3	4.8	5.7	61	41	6.5
17. 124598	7.0	4.3	5.9	60	33	6.5
18. 3078	6.2	4.5	5.7	57	41	6.5
19. 9003 IY	6.4	4.8	4.8	61	40	6.1
20. 155317	6.4	4.9	4.0	57	33	5.6
21. 507	7.5	5.6	3.4	60	26	5.5
22. 155322	4.9	4.3	-	60	22	4.6
Means	7.7	4.7	5.9	59	39	6.8
C.V.(%)	15.9	39.3	9.5	-	-	-
L.S.D (0.05)	0.8	1.1	0.3	-	-	-

Table 18: 1991 Three way Crosses - Experiment I

Entries	Ntui	Sanguere	Means DTS	PAH	Yield	% Best O.P
1. 8321-18 x 52	8.2	7.6	[illegible]	44	7.9	114
2. 8321-18 x 24	8.6	6.9	59	42	7.8	113
3. 8321-18 x 23	8.4	7.2	59	43	7.8	113
4. 8321-18 x 20	8.4	6.8	58	42	7.6	110
5. 8321-18 x 51	8.0	7.1	58	42	7.6	110
6. 8321-18 x 42	8.0	6.8	57	40	7.5	109
7. 8321-18 x 40	8.3	6.0	58	39	7.2	104
8. 8321-18 x 1	7.0	7.1	56	44	7.1	103
9. 8321-18 x 57	7.8	6.3	57	38	7.1	103
10. CMS 8501	7.0	6.8	60	41	6.9	100
11. 8516-12	7.0	6.6	58	40	6.8	99
12. Ndock 8701	6.3	6.5	60	38	6.4	93
13. 8321-18 x 80	6.2	6.4	60	37	6.3	92
14. 8321-18 x 81	6.5	5.1	58	32	5.8	84
Means	7.6	6.6				
C.V (%)	10.2	11.0				
L.S.D (0.05)	0.5	0.6				

Table 19: 1991 Three way Crosses - Experiment II

Entries	Ntui	Sanguere	Means DTS	PAH	Yield	% Best O.P
1. 8428-19 x 1	6.7	5.9	58	42	6.3	103
2. 8428-19 x 26	7.3	5.2	59	40	6.3	103
3. 8705-6	6.5	5.9	59	41	6.2	102
4. 8428-19 x 2	6.2	6.1	59	43	6.2	102
5. 8428-19 x 25	6.5	5.7	59	41	6.1	100
6. 8428-19 x 41	7.0	5.1	59	40	6.1	100
7. Ndock 8701	6.2	6.0	60	40	6.1	100
8. 8428-19 x 10	5.9	6.1	58	41	6.0	99
9. CMS 8501	6.4	5.4	60	38	5.9	97
10. 8516-12	5.8	5.7	60	36	5.8	95
11. 8428-19 x 43	6.0	4.7	60	37	5.4	89
12. 8428-19 x 5	5.5	5.1	59	41	5.	88
13. 8428-19 x 46	4.9	4.9	60	37	4.9	80
Means	6.2	5.5				
C.V. (%)	14.9	16.6	-	-	-	
L.S.D	0.7	1.1				

Table 20: 1991 Three way Crosses - Experiment III

Entries	Mayo Galke	Ntui	Maroua	Sanguere	Touboro	Mean	% Best O.P.
1. 8321-18 x 13	6.0	7.8	6.5	6.4	5.6	6.5	116
2. 8321-18 x 18	6.6	7.5	5.5	6.6	5.6	6.4	114
3. 8321-18 x 22	6.5	7.3	6.9	5.8	5.4	6.4	114
4. 8321-18 x 27	6.4	8.3	4.7	7.0	5.8	6.4	114
5. 8428-19 x 10	6.5	7.1	5.8	6.6	6.5	6.4	114
6. 8321-19 x 5	7.0	6.5	5.7	6.4	5.7	6.3	113
7. 8321-18 x 52	6.0	7.3	5.9	6.3	5.8	6.3	113
8. 8321-18 x 3	6.3	7.1	5.4	6.0	6.4	6.2	111
9. 8321-18 x 7	5.9	6.5	5.1	6.9	6.5	6.2	111
10. 8321-18 x 10	6.1	6.9	5.6	6.2	6.1	6.2	111
11. 8321-18 x 14	6.6	7.2	6.1	5.7	6.0	6.3	113
12. 8321-18 x 42	5.7	6.8	8.0	4.8	5.0	6.2	111
13. 8705-6	5.9	5.8	5.8	6.2	5.2	5.8	104
14. Ndock 8701	4.9	6.5	5.9	5.9	5.0	5.6	100
15. CMS 8501	5.5	6.6	5.3	5.8	5.0	5.6	100
Means	6.0	7.0	5.7	6.2	5.6	6.1	
C.V. (%)	11.0	10.3	16.7	14.9	9.2	-	
L.S.D.(0.05)							

Table 21: 1990 Selected MCRB Single crosses Group I

Set	Entries	Ntui	Sanguere	Means	% Best O.P
Set-1	(1-3)x 1368	7.2	6.9	7.1	118
	(11-15) x 1368	7.1	6.2	6.7	111
	(37-41) x 1368	7.4	6.8	7.1	118
	(52-55) x 1368	6.4	6.1	6.3	104
	CMS 8710	6.0	5.9	6.0	100
Set-2	1368 x (71-73)	6.9	6.9	6.9	121
	1368 x (67-70)	7.1	6.4	6.8	119
	1368 x (78-80)	6.0	6.3	6.2	109
	1368 x (90-93)	6.2	6.3	6.3	111
	Ndock 8701	5.8	5.6	5.7	100
Set-3	1368 x 130	7.2	7.3	7.3	109
	1368 x (116-120)	7.0	6.5	6.8	101
	CMS 8501	6.9	6.4	6.7	100

Table 22: 1991 Selected NCRE Single Crosses
Group II

Set	Entries	Ntui	Sanguere	Means	% Best O.P
Set-1	9071 x (2-1)	9.0	6.3	7.7	115
	9071 x (17-19)	7.5	6.9	7.2	107
	9071 x (13-16)	6.9	6.8	6.9	103
	9071 x (3-4)	6.9	6.5	6.7	100
	CMS 8501	6.9	6.4	6.7	100
Set-2	9071 x 52	8.7	-	8.7	126
	9071 x (45-48)	7.2	6.1	7.2	104
	9071 x (39-41)	7.3	6.9	7.1	103
	9071 x (61-62)	7.4	6.8	7.1	103
	9071 x (29-31)	7.4	6.6	7.0	101
	9071 x (53-55)	7.6	6.5	7.0	101
	CMS 8501	6.9	6.9	6.9	100

Table 23: 1991 Selected NCRE Single Crosses Group III

Set	Entries	Ntui	Sanguere	Means	% Best O.P
Set-1	5012 x (10-13)	8.7	8.1	8.4	118
	5012 x (1-3)	8.5	7.2	7.9	111
	5012 x (14-16)	7.5	8.1	7.9	111
	5012 x (27-29)	7.9	7.1	7.5	106
	Ndock 8701	7.2	7.0	7.1	100
	8516-12	7.3	6.5	6.9	97
Set-2	5012 x (64-66)	10.9	5.6	8.3	130
	5012 x (72-73)	8.4	7.2	7.8	122
	5012 x (39-41)	7.8	7.2	7.5	117
	5012 x (58-59)	7.3	7.5	7.4	116
	CMS 8501	6.0	6.8	6.4	100
Set-3	5012 x (83-87)	7.4	5.5	6.4	107
	5012 x (99-102)	6.8	5.7	6.3	105
	5012 x (88-92)	7.2	5.0	6.2	103
	CMS 8501	6.0	6.0	6.0	100

Table 24 : Means of selected single yellow crosses

Set	Crosses	Ntui	Sanguere	Means			% Best
				DTS	PAH	Yield	O. P.
Set-1 (30)	3 x 9848	6.8	8.9	61	40	7.9	108
	8 x 9450	7.8	7.8	62	39	7.8	107
	8644-31	7.7	7.1	61	42	7.4	101
	CMS 8704	7.7	6.8	62	42	7.3	-
Set-2 (31)	17 x 9450	6.6	6.6	59	40	6.6	108
	27 x 4001	8.2	5.0	59	40	6.6	108
	30 x 9848	6.4	8.7	61	40	7.6	125
	8644-31	8.6	5.7	60	39	7.2	118
	CMS 8704	6.5	5.6	61	41	6.1	-
Set-3 (33)	32 x 4001	7.3	5.5	61	38	6.4	123
	38 x 9848	7.2	5.2	61	40	6.5	125
	39 x 9848	6.9	5.8	60	39	6.3	121
	41 x 9848	6.2	5.8	60	40	6.0	115
	8644-31	4.2	5.7	62	40	4.9	94
	CMS 8704	4.7	5.6	62	40	5.2	-

Table 25: Tester Single Crosses

Groups/check	Number of Crosses equal or superior To Hybrid	Means (t/ha)	Number of lines Selected (15%)	Mean (t/ha)	Best Hybrids
Group1 x Corp 3	12 (32%)	7.5	5	7.9	group 1 91 x group 3 27 (8.4t/ha)
8429-19	-	7.1	-	-	group 1 23 x group 3 119 (8.2t/ha)
CMS 8501	-	-	-	6.7	
Group 1 x group 2	9 (24%)	7.0	2	7.5	group 1 x 1 x group 2 59 (7.5t/ha)
8321-18	-	6.7	-	-	group 1 61 x group 2 50 (7.5t/ha)
CMS 8501	-	-	-	6.4	
Group 2 x group3	14 (35%)	7.6	3	8.1	group 3 61 x group 2 50 (8.5t/ha)
8321-18	-	7.0	-	-	
8428-19	-	6.9	-	-	
Ndock 8701	-	-	-	6.6	

Table 26: KIR Single Crosses

Parent in Common	Total Number of crosses	Number Selected	%	Means	Percent of Best O. P.	Best Crosses
5012	11	2	18	6.4	139	5012 x 3 (6.4t/ha) 5012 x 11 (6.4t/ha)
1368	11	5	45	6.3	137	1368 x 3 (7.3t/ha)
4001	33	11	33	5.8	121	4001 x 9 (6.8t/ha)
9450	17	4	24	5.3	110	945 x 6 (6.1t/ha)
8644-31	-	-	-	4.8	-	-
8321-18	-	-	-	6.2	-	-
CMS 8501	-	-	-	4.6	-	-
CMS 8704	-	-	-	4.8	-	-

Table 27: Early Diallel among 8 varieties

	9848	Tuxpeno DR	Maka	Temp x Tropical	f FS	Blanc-2 Prec.	CSP	NCRE	ARRAY Means
9848	2.7	4.5	4.3	3.9	3.2	4.5	3.9	4.6	4.1
Tuxpeno DR		3.1	4.3	4.3	3.4	4.3	4.3	3.0	4.0
Maka			4.2	5.0	4.0	4.5	3.9	3.9	4.3
Temp x Tropical				5.3	4.4	4.3	4.4	4.4	4.4
f FS					3.7	3.9	3.0	3.3	3.5
Blanc-2 prec.						4.4	3.6	4.1	4.2
CSP							3.2	4.3	3.9
NCRE 37								2.8	3.9

Table 28: Number and percentage of selected lines per each Tester from CMS 8503 x DMR-ESR-W lines

Set	Location	9071	5012	1368	E_1
E_1	Ktui	6 (8)	6 (8)	11 (14)	9 (12)
	Soucoundou	12 (16)	9 (12)	10 (13)	10 (13)
E_2	Ktui	10 (13)	4 (5)	10 (13)	8 (11)
	Soucoundou	13 (17)	12 (16)	12 (16)	12 (16)
Mean	Savanna	13 (17)	10 (13)	11 (14)	11 (14)
	Forest	6 (11)	5 (7)	11 (14)	9 (12)

Table 29: Mean Striga rating and number of lines selected for Striga tolerance among the five sets of inbred lines.

Set	Number tested	Line Selected	Mean Striga rating (1-7.5)	Checks	Poorest line	Mean yield (t/ha)
1. Experiment I, II, III	33	Exp_1 23-1 Exp_1 52-1 Exp_2 5-1 Exp_3 3-1	3.0	9030 (3.0) 4001 (3.0)	Exp_2 14 (7.0)	0.6
2. NCRE group 1	35	line 31 line 37 line 56 line 62	3.0	9030 (3.5) 4001 (3.0)	line 104 (6.0)	0.9
3. NCRE group 2	23	line 33 line 46	3.5	9030 (4.5) 4001 (4.0)	line 17 (6.0)	0.3
4. NCRE group 3	39	line 24 line 80 line 87	2.9	9030 (3.5) 4001 (3.5)	line 77 (6.5)	0.3
5. IITA lines	15	1368 9499	3.0	4001 (3.5)	4058 (5.5)	1.1

Table 30: Striga Observation on Maize

Entries	DTS	PAH	Yield	Striga I 1-9	Striga II 1-5	Mean Striga 1-7
1. 8322-13 STR	57	36	4.8	3.0	1.6	2.0
2. 8322-13 (RE-Str)	58	32	4.4	2.5	1.9	2.0
3. Syn (1-4) SR STR	57	42	5.1	3.0	1.8	2.5
4. Exp_3 8321-18 x 27	58	39	5.2	3.8	1.6	2.5
5. TZPB-SR STR	60	46	5.4	4.0	1.6	2.5
6. TZB SR STR	60	30	4.4	3.5	1.9	3.0
7. Ndock 8701	59	39	5.3	4.8	2.1	3.4
8. 8338-1 (RE suc)	58	28	3.7	6.8	3.0	4.9
Mean	58	37	4.8	4.0	1.9	3.1
C.V (%)	1	17	2.6	3.1	2.7	-
L.S.D (0.05)	2	4	1.2	-	-	-

2.4. LOWLAND MAIZE SYSTEMS AGRONOMY

2.4.1. INTRODUCTION

Farmers in the forest zone of Cameroon grow maize at very low densities (5,000 to 8,000 plants/ha) in association with other crops such as groundnut, cassava, taro, vegetables and banana. Short fallow periods (3 to 7 years) alternate with cropping phases of 2 to 3 years, and these fallows are not efficient in restoring soil fertility. Problem weeds such as Chromolaena odorata, Imperata cylindrica, Trema orientalis, etc limit area brought under manual cultivation using simple tools. Only cash crops such as green maize, tomato and other vegetables are cultivated as sole crops, using, if available at affordable prices, some quantity of fertilizers.

In broad terms, (1) declining soil fertility and soil erosion, (2) weed infestation, (3) erratic rainfall distribution, (4) high cost, undependable supply and scarcity of inputs, and (5) poor infrastructure and marketing are the major constraints to intensification of food crop production in the forest zone.

The main goal of the program is to increase and sustain the productivity of cropping systems involving maize. Improvement and maintenance of soil fertility as well as control of weeds and soil erosion are essential to achieve the above goal. Owing to the limited availability of cash and labor in rural farms, greater attention is given to the development of efficient low cost technologies including agroforestry systems as shown below:

- Improved fallow management systems,
- In-situ green manure production with legume trees,
- Crop associations and rotations, and
- Methods for the efficient and balanced use of supplementary fertilizers in the above systems.

A close collaboration with the Testing and Liaison Units (TLUs) as well as the maize breeder and the IRA/ICRAF agroforestry team is maintained to plan and periodically review the research agenda. This avoids duplication of work and keeps the design of technologies appropriate to the farmers' needs.

2.4.2. OUTPUTS AND ACCOMPLISHMENTS

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. Determine appropriate green manure & residue management techniques for maize systems.	Identify low-input and sustainable technologies for soil fertility management under intensive cultivation.	The cassia/food crop association trials have been established at the three sites. Biomass production was similar in all the three tree/crop arrangements. First year results will be available in 1991. This trial should continue for a minimum of 2-3 years more. Sesbania sesban and Mimosa invisa var. inermis appear to be promising in improving soil fertility and controlling weeds in maize crop. This trial should continue for two more years to confirm results.
2. Determine NxP or NxK response of high yielding maize varieties.	Fertilizer response surface for improved maize varieties in the forest zone.	Intensification of cropping in the forest zone requires the application of N from the beginning, and P and K fertilizers after two to three seasons of cropping. These trials will continue at the same site for 2 more years to characterize the evolution of crop response and soil fertility with time.
3. Assess maize + groundnut/ soybean rotations and associations.	Evaluation of alternate maize + grain legume systems.	Soybean was identified as a highly productive alternate grain legume to groundnut in the subhumid forest zone. At Yoko, maize + cocoyam intercrop was not found profitable.
4. Assess cassava + maize + groundnut association patterns.	Evaluation of alternate cassava based associations.	Row intercropping and boundary planting systems of cassava and maize/groundnut appear to be highly productive. On-farm testing of similar systems will monitor farmers' reactions to them.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
5. Assess yield stability of improved maize varieties under different dates of planting.	Identification of stable maize varieties across a range of planting times.	Identified the late (110-120 days) maize varieties CMS 8704, Ndock 8701 and CMS 8501 as high yielding and stable in the first season. Similar varieties for second season need to be identified.
6. Characterize soils at trial sites.	Well characterized sites for interpretation of trial results.	Four profiles in S.W. Province have been studied and samples analyzed. Soil data have been used to better interpret the trial results.
7. Provide technical back-up and coordination for IRA soil fertility research.	Better research coordination on soils management in different zones.	Visited soil management and agroforestry trials and held discussions with researchers in Ekona and Bamenda. Prepared the trip report to indicate the research priorities for soil erosion control/management in the western highlands and the need for soils lab in Bambui.

2.4.3. OTHER ACTIVITIES

In-service training: On-the-job training of the counterpart staff Mr. Nguimgo Kemptsa Aubin Blaise and technicians in maize agronomy and soil fertility management research continued as part of the program. Mr. Nguimgo went to IITA to participate in the group training course on Sustainable Food production Systems from June 8 to July 6, 1990. He also participated in the Fourth AABNF conference September 22-27, 1990, and presented a poster paper on improved fallow.

Professional meetings: On invitation, I participated in the ICRAF conference on methods for on-farm agroforestry research held at Nairobi, Kenya, in February 1990 and presented two papers. I attended the Annual Meeting of the American Society of Agronomy at San Antonio, Texas during October 22-27, 1990 and presented a paper on improved fallow management for sustainable production in Africa.

Participation in the NCRE-II Contract III project design: I assisted in the NCRE-II Contract III project design and prepared the proposal for Resource Management Research in NCRE-II Contract III.

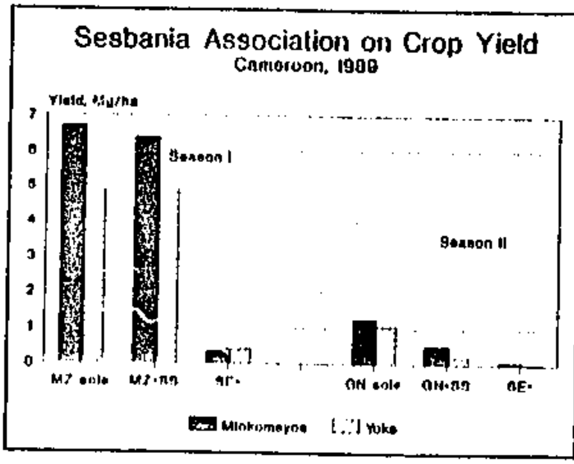
Assistance to Peace Corps Volunteers: I assisted technically and supplied seeds/planting materials to German and US volunteers working in Gabon and Central African Republic. I also reviewed the Agroforestry Proposal for 1990s prepared by Peace Corps, Cameroon.

2.4.4. RESEARCH FINDINGS

2.4.4.1. Improved Fallow Management for Soil Fertility Maintenance and Weed Control

The aim of this study is to test planted fallow with Sesbania sesban as an alternative means to restore and maintain soil fertility. Weed suppression and erosion control could be added advantages of this method.

Preliminary results indicate that the slow-growing Sesbania did not decrease the yield of associated maize in the first season, but severely reduced the yield of groundnut in the second season due to competition and/or shading (Figure 1). Thus, it is better to intercrop slow-growing legumes such as Sesbania with food crops in the first season and allow the free growth of legumes in the second season to obtain high biomass and N yield.



The top growth of fallow vegetation provided 22 to 67 kg/ha of N, 4.0 to 7.9 of P, 22 to 46 of K, 23 to 41 of Ca, and 12 to 22 of Mg to the soil-plant system. Chromolaena odorata although poorer in leaf N than Sesbania contributed almost similar quantities of N in top growth due to the large amount of foliage dry matter produced by the former at Minkomeyos. This gave similar grain yield response of maize in the following season (Table 1). Thus, Chromolaena improved soil fertility and crop yields similar to fallow legumes. Imperata cylindrica, a dominant fallow vegetation at Yoke, was poor in N contribution compared to Sesbania and this was reflected in the response of the succeeding maize crop (Table 1). Addition of N fertilizer significantly increased the maize yield further.

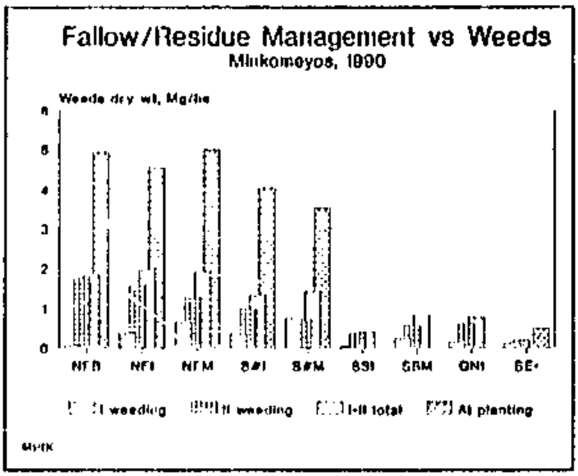
Table 1. Effect of type of fallow and residue management on grain yield of subsequent maize crop at three sites in southern Cameroon, 1989-1990.

1989 Fallow treatments		1990 March	1990 March season					
March	September	Residue management	Minkomeyos		Yoke		Ntui	
			Biomass N added	Maize yield	Biomass N added	Maize yield	Biomass N added	Maize yield
			---------------	--------	kg/ha	--------	--------	---------------
MZ	NF	B	57+	5508	39+	3107	32+	2762
MZ	NF	I	60	5246	32	2141	20	2395
MZ	NF	M	65	4878	41	1924	21	2812
MZ	SS/	I	43	4556	22	3148	18	2644
MZ	SS/	M	41	4406	28	3069	11	2418
MZ + SS	GN	I	57	5107	54	5484	63	4251
MZ + SS	GN + SS	M	68	4337	62	4325	53	2651
MZ	GN	I	4	4366	30	3811	8	1876
SE			11	460	6	336	5	289
p <			0.01	NS	0.01	0.000	0.000	0.000
CV, %			43	18	34	21	36	11
N - 0 kg/ha			-	4169	-	2791	-	2459
N - 60 kg/ha			-	5432	-	4036	-	2993
SE			-	154	-	129	-	50
p <			-	0.000	-	0.000	-	0.000

Fallow x N rate interaction for maize grain yield: NS

MZ = Maize; GN = Groundnut; SS = *Sesbania sesban*; NF = Natural fallow.
B = Burn; I = Incorporate; M = Mulch;
N = Nitrogen fertilizer applied as urea to the maize crop in 1990.
+ = Most of the fallow biomass N was lost by burning.
/ = *Sesbania sesban* planted without any land preparation after maize harvest was smothered by weeds.

Sesbania intercrop effectively shaded out the weeds for the succeeding maize crop (at least in the early part); weed density in plots previously planted to maize/groundnut was only slightly higher than that of Sesbania intercrop treatments, but far less than that of natural fallow (Figure 2). Burning appears to delay the emergence of Chromolaena but not that of Imperata.

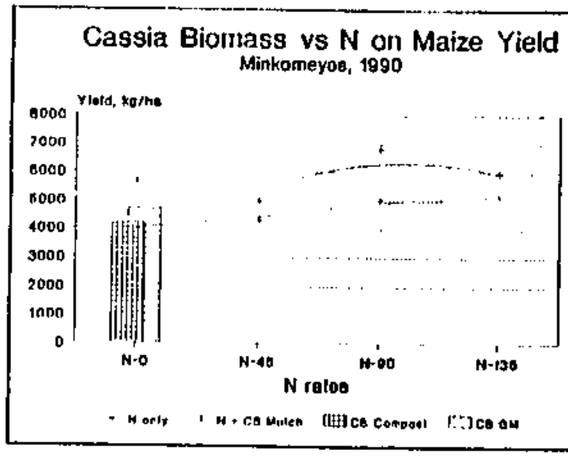


2.4.4.2. In-situ Mulch/Green Manure Production Through Cassia

The objective of this work is to test different arrangements of *Cassia spectabilis*, a naturalized tree legume, with food crops for the production of N-rich organic matter for soil fertility improvement. In this system, about 20% of the area is occupied by trees and the rest by food crops, and production of tree biomass and food crops occur at the same time. The first cutting of trees was done in March 1990 and the treatments were imposed at the same time. First year results will be available in March 1991.

2.4.4.3. Response of Maize and Soybean to Cassia Biomass and N Fertilizer

The aim of this study is to estimate the N contribution of *Cassia* mulch, green manure and compost at 2 t/ha dry weight equivalent, through a N response curve. The first season results show that *Cassia* compost was poorer than *Cassia* green manure which in turn was inferior to *Cassia* mulch in terms of maize grain yield response to applied biomass at 2 t/ha of dry matter (Figure 3).



2.4.4.4. Fertilizer Response of Improved Maize Varieties

The aim of these trials is to determine the response pattern of maize to N fertilizer under two levels of P or K. The rationale for conducting these trials is to find out how long we can cultivate maize in the forest zone soils without adding P or K which do not give consistent response in on-farm trials.

Yields were lower and maize response to fertilizers was poorer in the second season compared to the first season. Owing to high initial soil fertility, maize response to N was only up to 40 kg/ha at Minkomeyos in the first three seasons. P response was not significant at Minkomeyos in all the three seasons (Table 2). Application of N and P at Ntui site with soils of low inherent fertility gave significant increases in maize grain yield from the second season of cropping (Table 2). Highest grain yield at Ntui was obtained with 80 kg/ha of N fertilizer.

Table 2. Maize response to N rates at two P levels at two locations in Southern Cameroon, 1989 & 1990.

Fertilizer rates, kg/ha	MINKOMEYOS Maize grain yield, kg/ha (15% moisture) 1989 I season	1989 II season	1990 I season	NTUI Maize grain yield, kg/ha (15% moisture) 1989 I season	1989 II season	1990 I season
N levels, kg/ha						
0	5410	2436	4227	3493	937	3007
40	5755	3221	4643	3987	1748	4934
80	5842	3054	4546	4564	2062	5627
120	6654	3216	4826	3336	1547	4790
160	6512	3069	5351	3514	2055	5467
SE	481	185	321	314	255	365
p <	NS	0.05	0.05	NS	0.05	0.000
CV, %	23	18	19	20	37	19
P levels, kg/ha						
0	5885	2872	4591	3058	1554	4353
40	6184	3121	4847	4499	1785	5157
SE	305	117	203	199	161	231
p <	NS	NS	NS	0.05	NS	0.05
N x P interaction: NS				N x P interaction: NS		

At Yoke with low-K soils, maize response to N was good in all the three seasons, and K response became significant only in the third season of cropping (Table 3). An application of 120 kg/ha of N gave near maximum yield at this site.

Table 3. Maize response to N rates at two K levels at Yoke in Southern Cameroon, 1989 & 1990.

Fertilizer rates, kg/ha	Maize grain yield, kg/ha (15% moisture) 1989 I season	1989 II season	1990 I season
N levels, kg/ha			
0	2654	1421	2703
40	4751	2096	4123
80	5677	2533	4754
120	6015	2715	4707
160	5519	3273	4660
SE	413	156	212
p <	0.05	0.05	0.000
CV, %	25	18	14
K levels, kg/ha			
0	4781	2376	3744
50	5078	2410	4635
SE	280	99	134
p <	NS	NS	0.000
N x K interaction: NS			

There was no interaction between N and P or N and K levels. In summary, intensification of cropping in the forest zone requires the application of N fertilizers from the beginning, and P and K fertilizers after 2 to 3 seasons of cropping. These trials will continue at the same sites to see the evolution of fertilizer response pattern with time.

2.4.4.5. Maize/Groundnut/Soybean Association and Rotation

The objective of this trial is to determine the production efficiency of maize + groundnut or soybean cropping systems. Soybean, a new crop to the forest zone of Cameroon, needs to be fit into the existing cropping systems.

In rotation, maize preceded by groundnut gave higher yield as compared to the situation where soybean was the precedent crop (Table 4). This brings out the higher beneficial effect of groundnut on the following crop.

In intercrop systems, soybean competes much more with maize than groundnut does; hence the yield of maize in association with soybean was lower than that intercropped with groundnut (Table 4). The land equivalent ratio (LER) of these intercropping systems is more than 1 (except for the case of maize + soybean in 1989 first season and the case of maize + groundnut in the second season of 1989 at Minkomeyos), indicating the advantages of these systems in total production.

Unlike groundnut, soybean yields well in both the first and second seasons. Thus, soybean can be a good alternative grain legume to groundnut in the forest zone and attempts should be made to popularize this crop among farmers. More work is needed to incorporate soybean in local dishes and food preparations.

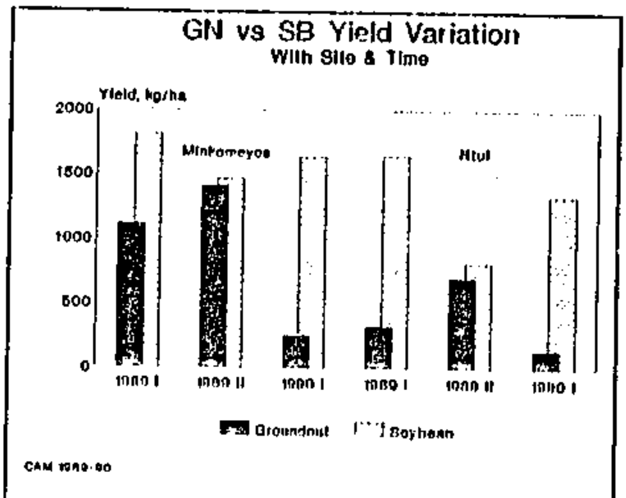


Table 4. Crop yields and land-use efficiency of maize + groundnut or soybean associations and rotation at two sites in the forest zone of Cameroon, 1989 & 1990.

CROPPING SYSTEMS		MINKOMEYOS				NIUI			
Season I	Season II	Maize, kg/ha	G'nut, kg/ha	Soybean, kg/ha	LER	Maize, kg/ha	G'nut, kg/ha	Soybean, kg/ha	LER
1989 First Season									
MZ + GN	SB	3994	813	-	1.45	2626	133	-	1.30
MZ + SB	GN	3247	-	534	0.88	2444	-	977	1.43
MZ	GN	6030*	-	-	1.00	3033*	-	-	1.00
MZ	SB	5067*	-	-	1.00	2839*	-	-	1.00
GN	MZ + SB	-	1223*	-	1.00	-	324*	-	1.00
SB	MZ + GN	-	-	1502*	1.00	-	-	1673*	1.00
GN	MZ	-	1003*	-	1.00	-	330*	-	1.00
SB	MZ	-	-	2120*	1.00	-	-	1618*	1.00
SE									
p <									
1989 Second Season									
MZ + GN	SB	-	-	1343*	1.00	-	-	813*	1.00
MZ + SB	GN	-	1129*	-	1.00	-	601*	-	1.00
MZ	GN	-	1684*	-	1.00	-	781*	-	1.00
MZ	SB	-	-	1586*	1.00	-	-	819*	1.00
GN	MZ + SB	1171	-	1181	1.27	876	-	595	1.10
SB	MZ + GN	1237	627	-	0.93	1013	455	-	1.09
GN	MZ	2662*	-	-	1.00	2427*	-	-	1.00
SB	MZ	2394*	-	-	1.00	2317*	-	-	1.00
SE		129	63	111	-	164	58	144	-
p <		0.000	0.000	NS	-	0.000	0.000	NS	-
1990 First Season									
MZ + GN	SB	3350	182	-	1.23	2202	89	-	1.20
MZ + SB	GN	3125	-	956	1.06	2121	-	746	1.12
MZ	GN	6815*	-	-	1.00	3885*	-	-	1.00
MZ	SB	6299*	-	-	1.00	3715*	-	-	1.00
GN	MZ + SB	-	277*	-	1.00	-	164*	-	1.00
SB	MZ + GN	-	-	1565*	1.00	-	-	1347*	1.00
GN	MZ	-	227*	-	1.00	-	122*	-	1.00
SB	MZ	-	-	1710*	1.00	-	-	1328*	1.00
SE		237	28	76	-	164	13	57	-
p <		0.000	NS	0.000	-	0.000	0.05	0.000	-

MZ = Maize; GN = Groundnut (Peanut); SB = Soybean; LER = Land Equivalent Ratio.
* Mean yield of two sole crops was used to calculate LER.

2.4.4.6. Cassava Based Cropping Systems

The objective of this trial is to test different arrangements of component crops such as maize and groundnut planted in association with cassava, with a view to avoid planting the same crops in successive seasons in the same piece of land.

Farmers' mixed cropping system (CS4) was compared to the systems of cassava intercropped with maize or groundnut in alternate rows during the first season only (CS1), paired row of cassava alternating 3m-wide maize or groundnut strips (CS2) during both seasons, or border planting of cassava with maize or groundnut inside the boundary in both seasons (CS3).

The results of 1989 indicate that maize yield was reduced by 19% to 35% in intercrop systems as compared to monocrop maize at both sites, and farmers' system gave the lowest maize yield in the first season (Table 5). Groundnut yield was reduced by 0 to 58% in relation to sole crop during the first season. In the second season, yield reduction due to association was 13 to 89% for maize and 12 to 58% for groundnut. Cassava root yield in intercropping systems was less by 31 to 82% compared to monocrop cassava, the lowest yields being in boundary planting of cassava (Table 5).

Production efficiency of association as defined by Area Harvests Equivalency Ratio (AHER) was greater than 1.00 for paired-row association of cassava with maize-groundnut (AHER = 1.08) or groundnut-maize (AHER = 1.04) sequence at Ntui. Other systems showed advantages (AHER = 1.12-1.14) only with groundnut-maize sequence at Ntui (Table 5). At Yoke, only paired row system of cassava with groundnut-maize sequence was advantageous by 14% compared to monocrops. Farmers' mixed cassava systems gave 2 to 15% higher productivity than total monocrops.

To sum up, in alternate row arrangement and farmers' mixed systems, no crops can be intercropped in the second season. Paired-row association gives moderate yields of cassava and first season crops, while boundary planting gives good yields of maize and groundnut in both seasons, but low yields of cassava. Selection of a particular cassava system will depend on the relative importance farmers attach to the three crops.

Table 5. Crop yields and production efficiency of cassava + maize + groundnut associations at Ntui in Southern Cameroon, 1989.

Season I	Season II	Season I Maize, kg/ha	Season I G'nut, kg/ha	Season II Maize, kg/ha	Season II G'nut, kg/ha	Season II Cassava, t/ha	AHER*
Ntui: 1989							
1. CS pure	CS	-	-	-	-	26.6	1.00
2. MZ pure	GN pure	3990	-	-	815	-	1.00
3. GN pure	MZ pure	-	502	1771	-	-	1.00
4. CS1+MZ	CS1	3195	-	-	-	14.8	0.96
5. CS2+MZ	CS2+GN	3227	-	-	339	12.4	1.08
6. CS3+MZ	CS3+GN	2737	-	-	715	4.7	0.96
7. CS1+GN	CS1	-	525	-	-	15.9	1.12
8. CS2+GN	CS2+MZ	-	377	374	-	14.9	1.04
9. CS3+GN	CS3+MZ	-	539	1212	-	6.9	1.14
10.CS4+MZ+GN*	CS4	1372	210	-	-	17.1	1.02
SE		247	39	269	87	1.9	-
p <		0.000	0.000	0.05	0.05	0.000	-
CV, %		17	18	48	28	27	-
Yoke: 1989							
1. CS pure	CS	-	-	-	-	14.6	1.00
2. MZ pure	GN pure	5316	-	-	852	-	1.00
3. GN pure	MZ pure	-	471	1441	-	-	1.00
4. CS1+MZ	CS1	3697	-	-	-	5.9	0.75
5. CS2+MZ	CS2+GN	3475	-	-	502	5.1	0.97
6. CS3+MZ	CS3+GN	3633	-	-	707	3.2	0.98
7. CS1+GN	CS1	-	426	-	-	7.0	0.93
8. CS2+GN	CS2+MZ	-	305	430	-	9.7	1.14
9. CS3+GN	CS3+MZ	-	283	1248	-	2.6	0.91
10.CS4+MZ+GN*	CS4	1092	332	-	-	10.1	1.15
SE		228	18	198	60	1.4	-
p <		0.000	0.000	0.05	0.05	0.000	-
CV, %		12	9	33	15	33	-
No. of harvests in one year		2	2	2	2	1	-

CS1 = Cassava: CS 1.5m CS; CS2 = Cassava: CS-CS 3m CS-CS; CS3 = Cassava on border of plot; CS4 = Cassava at random as in farmers' practice.
*AHER = Area Harvests Equivalency Ratio.

2.4.4.7. Maize Date of Planting vs. Improved Varieties

The aim of this trial is to identify maize varieties which can give stable yields when planted over a range of dates during the season and to fix the optimum period of planting for maize in the forest zone. This trial was conducted at three sites, viz., Minkomeyos, Ntui and Yoke, during the first seasons of 1989 and 1990. Six maize varieties were used: TZUT, EV 8435 SR, CMS 8503, CMS 8704, NDOCK 8701 and CMS 8501; the first three are intermediate (100-110 days) and the others late in growth cycle (110-120 days).

All the varieties reacted similarly to lateness in planting and grain yields decreased as planting got delayed. Any delay in planting more than 3-4 weeks after the first good rains resulted in serious yield losses. The interaction between varieties and time of planting was not significant for all the sites. In general, late varieties such as CMS 8501, CMS 8704 and NDOCK 8701 gave consistently higher yield than intermediate varieties for all planting dates at all sites. The mean yields of test varieties over all the locations and years (3 locations x 2 years) were as follows:

Variety	Growth cycle	Mean yield, kg/ha
TZUT	Intermediate	4054
EV 8435 SR	Intermediate	3763
CMS 8503	Intermediate	3871
CMS 8704	Late	4607
NDOCK 8701	Late	4373
CMS 8501	Late	4445

The poor yield in late planted maize was due to low plant density and/or high proportion of poorly filled or damaged cobs. Percent barren plants at harvest did not seem to be related to yield loss caused by late planting.

3. RICE RESEARCH UNIT

3.1 RICE BREEDING

3.1.1. INTRODUCTION

During 1990, the objectives of the rice breeding program remained unchanged with the development of high and stable yielding rice varieties for the major rice ecologies in Cameroon which include irrigated and upland ecosystems as the broad objective. The activities also remained unchanged with introduction of varieties, collection and evaluation of local germplasm and crossing continuing to play major roles. More emphasis was, however, placed on selecting from segregating populations promising agronomically improved varieties with resistance or tolerance to the major environmental and biological stresses such as low temperature, blast, sheath rot and glume discoloration. These stresses limit yields and cause instability in performance of improved varieties.

More emphasis was put on irrigated rice research. Irrigated rice is the most widely practiced production system in Cameroon. To solve specific problems, trials were conducted at the major production sites in collaboration with the rice development agencies and farmers' cooperatives. Varietal trials were, conducted at Mbo Plain (700 m) in the West, Ndop Plain (1200 m) in the North West, Yagoua (250 m) and Lagdo (300 m) in the Extreme North and North Provinces respectively. These zones represent most of the rice grow conditions in Cameroon.

In collaboration with IRA Scientists and the TLUs of the NCRE multilocation researcher and farmer managed trials were conducted at selected sites representing extremes of rice growing conditions in the country.

3.1.2 OUTPUTS AND ACCOMPLISHMENTS

GOAL: To increase rice production in Cameroon through the identification of suitable rice varieties for different AGROECOLOGICAL conditions.

Sub-Goal	Outputs	Accomplishment
1. To screen germplasm of local and exotic sources for release as varieties or for donor hybridization.	1. promising selections for further yield testing and use in the breeding program.	1.1 Six hundred and sixty four lines were screened in six observational nurseries under irrigated conditions at Mbo Plain (400) and Ndop Plain (14) and under upland at Mbo Plain (250). 1.2 Fifty six lines were selected from upland trials and several selections have been made from the irrigated trials at Mbo Plain.

Sub-Goal	Outputs	Accomplishment
2. To Characterize and conserve total genetic variability as a working collection.	2.1 Viable seeds of germplasm will be available.	2.1 Thirty-eight accessions were characterized for 48 morphorological traits.
	2.2 A catalogue of rice germplasm will be available.	2.2 A catalogue of above 38 varieties was produced in French.
		2.3 Samples of accessions are conserved in cold room at Santchou.
3. To screen available germplasm for resistance to low temperature and blast.	3. Promising lines for breeding and for use as varieties per se.	3.1 Over 1000 varieties/lines have been screened and several selections made for further testing.
4. To incorporate genes for improved agronomic and grain properties and resistance to low temperature and blast.	4. F_1 - F_5 population	4.1 Twenty-eight new crosses were made.
		4.2 Several lines with improved characteristics were selected.
5. To assess the yield potentials of selected lines.	5. Selections for advanced yield trials and elite variety trials.	5.1 Planned yield trials were successfully conducted.
		5.2 Several selections were made.
6. To test adaptability and acceptability of selections at different locations.	6. Confirm adaptability and suitability of elite lines.	6. Elite lines were tested in researcher managed trials.
		6.2 Farmer managed adaptive trials were also conducted.
7. To produce breeder's seed of recommended and promising elite lines.	7. Availability of pure genetic stock of elite lines and varieties.	7.1 Breeder's seed of elite lines were produced.
		7.2 Small samples of seeds of improved varieties were made available to researchers, parastatals and farmers on request.

3.1.3 OTHER ACTIVITIES

Two memoires "A Technique for rapid evaluation of low temperature tolerance in rice varieties" and "Characterisation morphophysiologique de quelques varietés de riz adaptées au Cameroun en vue de leur exploitation dans l'amélioration variétale" were written and presented to the University Centre of Dschang. These projects which are in partial fulfillment of the requirement for the degree of "Ingénieur des Travaux Agricole" were conducted by two students under the supervision of the rice breeders.

On-the-job training continued to play major role in the rice program as a means to strengthen the national research capability. During 1990, technicians and extension workers at all research sites received training on seed purification, multiplication and handling for distribution.

Three conferences were attended: The WARDA annual rice research review meeting at Bouake, Cote d'Ivoire April, 1990; the CORAF meeting in Niger in February, 1990, and the EEC/IITA on-farm adaptive trial meeting at IITA - Ibadan from 5-6 March, 1990. The rice breeder also participated in two rice monitoring tours to Rwanda in June (23-30th) and Guinea 23rd Sept to 3rd October, 1990.

The following papers have been published during 1990:

- Promising cold tolerant and high yielding rice lines for Ndop Plain, North West Cameroon. IRRI Technical Newsletter, 15 (3) 17-19.
- CICA 8 and ITA 222, new rice varieties for irrigated areas of Mbo Plain in West Cameroon, IRRI Technical Newsletter 15 (6) 14-15.
- CICA 8 in IRA/NCRE Information Bulletin No. 1.

Three other papers written during 1990 have been accepted for publication including "A survey of rice diseases in Cameroon".

3.1.4 RESEARCH FINDINGS

The findings reported are mainly based on data collected from upland rice research conducted at Mbo Plain (West) and Babungo (North West) and irrigated rice research conducted at Ndop Plain (North West), Yagoua (Extreme North) and Lagdo (North). Findings from irrigated rice research at Mbo Plain, which is the main experimental site in 1990, will be reported after harvesting in early January, 1991.

3.1.4.1 Methodology

The cultural practices adopted during 1990, were similar to that of previous years and unless otherwise stated the procedures for on station trials were as follows: Observational Nurseries (ONs) were established in single plots of two to four rows of 5 meters long; Observational Yield Trials (OYTs) were conducted in single plots of 2 to 3 meters x 5 meters. To allow for better comparison in OYTs, test entries were each planted in single plots but check entries were replicated after every ten test entries. All replicated yield trials such as Preliminary Yield Trial (PYTs) and Advanced Yield Trials (AYTs) were conducted in randomized complete block design (RCBD) with three or four replications, each plot being 3 m x 5 m.

Under irrigated conditions, seeds were raised on wet bed nurseries which were treated with complete fertilizer at the rate of 60-40-40 kg/ha (N, P_2O_5 and K_2O). Twenty one to twenty-five day-old-seedlings were transplanted at the rate of 2-3 seedlings per hill, spaced 25 cm x 15 cm or one seedling per hill and 25 cm x 25 cm spacing for F_1 plants and segregating populations. Fertilizers were applied at 60 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare. P_2O_5 and K_2O were applied as basal and N in 3 equal splits at the vegetative phase of the plant. Hand weeding was done between 20-30 days after transplanting. No protection against insect pests and diseases was done.

Under rainfed upland conditions, the seeds were drilled in rows 25 cm apart at the rate of 70 kg/ha. N was applied at the rate of 60 kg/ha in three equal splits. P_2O_5 and K_2O were applied as basal, each at the rate of 40 kg/ha. Weeding was done manually or combined with ronstar applied as a pre-emergence herbicide at the rate of 4 L/ha. a day after sowing.

At harvesting two border rows were removed along all four sides of the yield plots. Weight and moisture content of grains were recorded and yield calculated in kilograms per hectare at 14 percent moisture content. Other characters recorded include resistance to blast, brown spot, leaf scald, sheath rot and glume discoloration, tolerance to low temperature, seedling vigour, time of 50 percent flowering, time of maturity, number of effective tillers per sq. meter, height, panicle length and grain type.

3.1.4.2 Results

3.1.4.2.1 Irrigated Rice - Ndop Plain (1,200 m)

As in previous years, the rice breeding program for irrigated rice focused on developing agronomically improved varieties with sturdy culm, lodging resistant, high tillering with acceptable grain properties and tolerance/resistance to low temperature, blast, sheath rot and glume discoloration. In 1990, therefore, various observational and yield trials were conducted and segregating populations were evaluated.

3.1.4.2.1.1 Varietal Introduction - Observational Nursery

At the end of 1990, approximately 10,500 varieties have been introduced and screened for adaptation to the irrigated rice growing conditions in Cameroon. Selected introductions with high yielding ability, fertilizer responsiveness, tolerance to major diseases and suitable plant stature have been identified and are being exploited in the breeding program.

During 1990, only 14 lines previously selected from Mbo Plain (700 m) were further tested at Ndop Plain. All the lines were sown in an observational nursery on a site at Ndop Plain that is subjected to shallow flooding and low air/water temperature during the growing season. The entries were, therefore, exposed to low temperature stress from transplanting to harvesting and all showed poor adaptation. They were severely affected by sheath rot and glume discoloration and spikelet sterility was very high.

3.1.4.2.1.2 Yield Trials Of Promising Varieties/Advanced lines

In continuation with the testing of varieties/advanced lines selected in previous years, a number of observational yield trial (OYT), preliminary yield trial (PYT), advanced yield trial (AYT) and elite variety trials (EVT) were conducted during 1990.

Observational Yield Trial

Only one OYT of medium duration varieties was conducted during the 1990 wet season at the Bamunka experimental station at Ndop Plain. In this trial 27 test entries were tested against IR 7167-33-2-3. The test entries included nine advanced lines selected at Ndop Plain and/or Dschang from F_2 until uniformity was attained. The lines were selected from a cross performed in 1983 at IITA-Ibadan. The incidence of sheath rot and glume discoloration was mild during the season and yields were fairly high ranging from 2336 kg/ha in China 1039 to 6797 kg/ha in Tox 3145-Toc-34-3-3-1. Table 1 shows the performance of the top ten entries which is composed of 5 each of advanced lines and introduced varieties. Four advanced lines outyielded the check variety, IR 7167-33-2-3 by margins ranging from 11% to 25%. Some of the entries including Tox 3145-Toc-34-3-3-1 and Tox 3145-Toc-34-3-3-2 showed better tolerance to low temperature and resistance to the major diseases (Table 1).

Preliminary Yield Trial

Table 2 shows the grain yield and agronomic characters of the entries in the PYT of medium duration varieties. In this trial, six test entries including four advanced lines were tested against IR 7167-33-2-3 and Tainan V. No statistically significant difference was obtained among the entries and grain yields ranged from 4492 to 5598 kg/ha. The check variety, IR 7167-33-2-3 was top and three advanced lines, Tox 3145-Toc-34-3-3, Tox 3145-Toc-38 2-3 and Tox 3145 Toc 34 3 4 outyielded Tainan V. Tainan V was still the best variety in terms of its reaction to low temperature associated diseases such as blast, sheath rot and glume discoloration (Table 2). Percentage spikelet degeneration was, however, higher in Tainan V ranging from 10 25% per panicle. This may be responsible for the lower grain yield of Tainan V. All the entries were slightly longer in duration than Tainan V and IR 7167-33-2-3 and all were selected for further testing in advanced yield trial during 1991.

Advanced Yield Trial

Fifteen medium duration varieties/advanced lines were tested against IR 7167-33-2-3 and Tainan V. No significant difference was obtained among the varieties but nine entries including the check variety, IR 7167 33 2 3 which ranked eight yielded over 5,000 kg/ha (Table 3). Tox 3145-Toc-34-3-4 was top with grain yield 5411 kg/ha. This advanced line has consecutively performed well and ranked among the top three over the past three years. It is now being multiplied by UNVDA for distribution to farmers at Ndop plain in 1991. Tox 3145 Toc-34-3 4 has long, slender and translucent grain properties which are traits preferred by consumers in Cameroon. In 1988 a palatability test conducted at Ndop Plain placed Tox 3145-Toc-34-3-4 as the best variety in terms of its taste and appearance.

3.1.4.2.2 Upland Rice: Mbo Plain (700 m) Observational Nurseries Of New Introductions

Materials introduced and screened in Observational Nurseries (ONs) in 1990 were obtained through INGER-Africa. They were composed of 250 lines from 1990 AURPSS and AURON (Table 4).

AURPSS: The 150 entries in the African Upland Rice Preliminary Screening Set were tested against M 55 and IRAT 10 in the upland site at Santchou in Mbo Plain. Leaf blast, neck blast and leaf scald were severe during the season so the susceptible entries were easily discarded. Thirty one entries that showed good agronomic and grain properties with resistance to blast and leaf scald were selected for testing in observational yield trial in 1991.

AURON: The African Upland Rice Observational Nursery was sown against M 55 and IRAT 10 as check varieties. Twenty-five entries with acceptable grain properties and better phenotypic acceptability scores than the check varieties were selected for further testing in OYT in 1990.

Observational Yield Trial

An OYT comprising 66 test entries was conducted at Santchou with M 55 and IRAT 10 as the check varieties. The incidence of leaf blast, neck blast and leaf scald was severe. Twelve entries which outyielded the best check plot (M 55) by margins ranging from 22 % to 102 % were selected on this basis (Table 5). The top five varieties, UPL RI 7, Tox 3118-47-1-2-2-1, Tox 1767-3-1-1, Tox 3118-2-E2-2-1-1 and ITA 175 gave grain yields in excess of 3000 kg/ha. Grain yield of the 68 entries ranged from 743 kg/ha in IRAT 10 to 4238 kg/ha in UPL RI 7. A further 6 entries were selected for their good phenotypic acceptability scores and good grain properties. The 18 selections will be promoted to preliminary yield trial in 1991.

Preliminary Yield Trial

Twelve medium duration varieties were tested against M 55 and IRAT 10. The highest yielding entries were Tox 1769-3-1 and IR 14632-2-3 with yields of 3765 and 3200 kg/ha respectively (Table 6). Only Tox 1769 significantly outyielded M 55 which ranked fifth. Eight varieties significantly outyielded IRAT 10 which ranked seventh. The period of maturation of the test entries ranged from 103 days in IRAT 10 to 138 days in Tox 955-208-2-101-3-1 and plant height from 93 cm in IRAT 10 to 147 cm in IR 14632-2-3. All the entries showed moderate resistance to leaf scald and left blast but most were rated as resistant to neck blast and brown spot (Table 6).

Advanced Yield Trial - Early Duration (120-135 days)

In the AYT of 14 early duration varieties tested against M 55 and IRAT 10, grain yields ranged from 1160 kg/ha in IRAT 10 to 3731 kg/ha in UPL-41-7. UPL-41-7 significantly outyielded the remaining varieties including M 55 (2056 kg/ha) and IRAT 10 (1373 kg/ha) which ranked sixth and fourteenth respectively. All entries suffered slightly from leaf blast and leaf scald but showed resistance to neck blast and brown spot (Table 7).

All the entries were also early in duration but IRAT 170 (117 CM) and Tox 1012-12-28 (120 cm) were slightly tall. Panicles of all entries were well exerted and grain type long, slender and translucent except for IDSA 10 and IRAT 10 which had medium-long and short-bold grain type respectively.

African Upland Rice Advanced Trial

This is an international collaborative trial with INGER-Africa and conisted of 14 test entries tested against IRAT 10. Only one variety namely, ITA 301 outyielded IRAT 10 but not significantly. The general performance of the crop was poor and grain yield averaged 1360 kg/ha and ranged from 775 kg/ha in ITA 150 to 2017 kg/ha in ITA 301. Most entries were affected by leaf scald, leaf blast and neck blast but showed resistance to brown spot (Table 8).

3.1.4.2.3 Multilocational Research Managed Trials.

To further evaluate and distribute promising germplasm to scientists, two sets of National coordinated variety trials (NCVTs) were conducted during 1990: One set under irrigated and the other under upland conditions. The entries into each NCVT were selected from entries in previous station trials that had shown potential for high grain yield.

NCVT - Irrigated: The same 17 entries were tested against local check varieties at one site each in Mbo Plain, Ndop Plain, Lagdo and Yagoua. At the time of writing this report data had not been received from Mbo Plain as the materials are due for harvesting in early January, 1991.

In general, means for grain yields varied from 4693 kg/ha at Ndop (North West) to 5361 kg/ha at Yagoua in the Extreme North. The top five entries across locations were IR 7167-33-2-3, CISADANE, Tox 3344-Toc-3-4-1, CICA 8 and Tox 3344-Toc-34-3-2. Each of these varieties gave yields in excess of 4000 kg/ha at all locations tested (Table 9). The top three entries at Ndop Plain were the check variety, IR 7167-33-2-4, BKN 7033-3-3-2-2-3 and IR 7167-33-2-3. At Lagdo the highest yielding entry was an advanced line, Tox 3344-Toc-34-3-2, closely followed by another advanced line, Tox 3344-Toc-3-4-1 and CISADANE. The best entries at Yagoua were CICA 8, ITA 212 and ITA 222. They significantly outyielded and had better grain qualities than IR 46 the currently recommended variety for general cultivation in the Extreme North.

NCVT - Upland: The results of the NCVT - Upland grown at Santchou (Mbo Plain) and Babungo (Ndop Plain) are shown in Table 10. The top three entries at each location were IRAT 3250, ITA 120 and IRAT 109 at Ndop Plain, ROK 16, IRAT 216 and ITA 301 at Mbo Plain. A cross site the top entries were Rok 16, IRAT 112 and ITA 120.

3.1.4.2.4 Germplasm Characterization and Conservation

Evaluation of available germplasm was initiated in 1988 to establish the varietal types favoured by farmers and also to provide a basis for a crossing program. During 1990, 38 accessions were purified and characterized for 48 morphological, physiological and agronomic characteristics. At the end of 1990, 127 accessions have been purified and characterized. A catalogue of the 38 accessions have been produced in French. This was possible due to special project assigned to a student from the university center of Dschang. All the purified and characterized materials are conserved as a working collection in a cold room at Santchou in Mbo Plain.

3.1.4.2.5 Breeding Program

The breeding program was initiated in 1988 to incorporate desirable characteristics such as suitable agronomic traits, good grain properties and resistance/tolerance to low temperature and blast into already identified improved varieties.

New Crosses: Twenty-eight new crosses were made during the year bringing the total successful crosses to 92. Fourteen of the crosses involved tolerance to low temperature and good grain properties. Blast resistance was sought in 10 crosses and seedling drought and early maturity in 4 crosses.

Segregating Populations: A total of 2412 F_2 to F_5 populations were evaluated at Mbo Plain (1200 F_2 - F_5), Dschang (780 F_2 - F_5), Ndop Plain (400 F_1 - F_5), Yagoua (16 F_3 - F_4) and Lagdo (16 F_3 - F_4) durning 1990. On the whole, over 3000 individual plant selections were made and advanced to the next generation. Sixty-eight fixed populations were bulked harvested and will be promoted to observational yield trials in 1991.

Screening For Tolerance To Low Temperature: Since 1982, a total of 2,688 introduced varieties and over 2,000 segregating populations have been screened for tolerance to low temperature at Bamunka experimental farm in Ndop Plain and at Dschang. During 1990, pedigree lines with tolerance at both seedling and flowering stages of plant growth have been identified and included several selections from crosses such as Toc 3 (IR 35-366-90-3-2-1/IR 2853-10-3-1), Toc 7 (IR 64/IR45051-73-1-3), Tox 4213 Toc 35 (IR 7167-33-2-3/ITA 212) and Tox 4294-Toc 36 (IR 7167-33-2-3/ITA 222). The selections are showing improvement in agro-morphological traits and have long, slender grain type.

Screening For Resistance To Diseases: During 1990, breeders materials were assessed for their reaction to diseases. Donors with resistance to blast, sheath rot and glume discoloration are IRAT 13, Lac 23, Moroberekan, Rok 16, Cisadane, IR 7167-33-2-4, IR 11248-3-3-3 and IR 8608-125-3-3. Two donors with resistance to bacterial leaf blight are IR 46 and BKNLR 75000. Among the advanced lines that have shown some promise in reaction to fungal diseases are Tox 3344-Toc-34-3-4, Tox 3145-Toc-34-2-3, Toc 3-4 and Tox 3145-Toc 34-2-3.

Varietal Resistance To Insect Pests: During 1990, we screened over 50 varieties for resistance against the stalk-eyed fly and the most promising entries are Tainan V, ITA 222, Cisadane and several advanced lines including Tox 3344-Toc-34-3-4, and Tox 3145-Toc-34-2-3.

3.1.4.2.6 Breeders Seed Production

Seed purification and multiplication were carried out during 1990 to obtain breeders seed of recommended and promising elite lines and, therefore, fill seed requests from IRA Scientists and parastatals. Varieties from which breeder seed is being produced are IR 46, BKN 7033-3-3-2-2-3, Kaushing Sen Yu, CICA 8, Tainan V, IR 7167-33-2-3, ITA 212, ITA 222, CISADANE, Tox 3145-Toc-34-2-3, and Toc 3145-Toc-34-2-3.

Table 1. Performance of top ten entries in medium duration Observational Yield Trial conducted under irrigated conditions at Ndop Plain during 1990 wet season.

ENTRY	GRAIN YIELD KG/HA	50% FLOWER (DAYS)	PLANT HEIGHT (CM)	REACTIONS TO (0-9)** LEAF BLAST	NECK BLAST	SHEATH ROT	GLUME DISC.
Tox 3145-Toc-34-3-3-1	6797	118	94	3	3	3	1
Tox 3145-Toc-34-3-3-2	6692	128	94	3	3	1	1
Tox 3145-Toc-34-3-3-3-1	6568	118	95	5	5	3	1
Tox 3145-Toc-2-4-1-1-1	6045	122	99	4	3	5	5
IR 7167-33-2-3*	5430	112	103	5	3	3	3
Tox 3144-Toc-2-4-2-1-2	5184	122	99	5	3	3	3
IR 18482-PLP$_3$-3-1-2-1-1-1	5046	103	115	4	3	3	3
NR 10073-167-3-1-3	4855	99	112	4	1	3	1
B 4449D-12-SR-1	4707	119	103	3	3	3	3
IR 13105-60-30-3-1-2-1	4707	100	106	4	3	3	3
Mean of 28 Entries	4508						

* Check variety.

** Scoring based on the IRRI Standard Evaluation System for rice, 1988.
Toc - Tropical oryza Cameroon - Cameroon nomenclature for varieties developed in the country.

Table 2. Performance of medium duration entries in Preliminary Yield Trial conducted under irrigated conditions at Ndop Plain during 1990 wet season.

ENTRY	GRAIN YIELD (KG/HA)	PLANT HEIGHT (CM)	50 % FLOWER (DAYS)	REACTION TO (0-9)** LEAF BLAST	NECK BLAST	SHEATH ROT	GLUME DISC.
IR 7167-33-2-3*	5598	98	104	5	3	1	3
Tox 3145-Toc-34-3-3	5569	96	114	3	3	3	1
Tox 3145-Toc-38-2-3	5358	90	115	3	3	3	3
Tox 3145-Toc-34-3-4	5202	94	116	3	3	1	3
Tainan V*	5197	80	100	2	1	1	1
Tox 3145-Toc-34-3-3-3-1	5117	96	117	3	5	1	3
B 29839-SR-29	4916	94	108	3	3	3	1
IR 14632-65-2	4492	97	107	3	5	1	1
Mean of 8 Entries	5181						
L.S.D. (5 %)	-ns.						
C.V. (%)	11.0						

* Check varieties.

** Scoring based on Standard Evaluation System for rice, IRRI, 1988.

Table 3 Performance of medium duration entries in Advanced Yield Trials conducted under irrigated conditions at Ndop Plain during 1990 wet season.

ENTRY	GRAIN YIELD (KG/HA)	PLANT HEIGHT (CM)	50% FLOWER (DAYS)	REATIONS TO (0-9)** LEAF BLAST	NECK BLAST	SHEATH ROT	GLUME DISC.
Tox 3145-Toc-34-3-4	5411	96	120	3	3	1	1
IR 15579-135-3	5381	110	114	2	3	3	1
Tox 3145-Toc-15-2-1	5175	93	120	3	3	1	1
Tox 3145-Toc-34-3-3	5170	96	119	3	3	1	1
Tox 3145-Toc-34-2-3	5145	92	125	3	3	1	3
Tox 3145-Toc-34-3-1	5061	94	121	4	3	1	1
Tox 3145-/toc-38-2-3	5048	86	121	3	3	1	1
IR 7167-33-2-3*	5040	99	115	4	3	1	3
IR 2061-522-6-9	5006	101	117	3	3	1	3
B 2881-F-SR-62-5	4990	85	113	3	3	1	3
B 2982B-SR-62-3-1-4	4981	99	116	3	3	1	3
IR 13045-104-1	4657	106	112	4	3	1	1
B 29839-SR-29	4582	92	121	4	5	3	2
B 4449D-126-SR-61	4580	89	114	3	3	1	2
IR 14632-65-2	4520	97	118	5	3	1	1
Tox 3344-Toc-3-4-1	4536	108	126	3	3	1	1
Tainan V*	3798	86	111	2	1	1	3

Mean of 17 Entries	4887
L.D.S. (5 %)	ns.
C.V. (%)	11.77

* Check varieties.

** Scoring is based on the Standard Evaluation System for rice, IRRI, 1988.

Table 4 Number of entries and selections from various INGER-Africa Nurseries screened under rainfed upland conditions at Mbo Plain during 1990 wet season.

NURSERY	DATE OF SEEDING	NUMBER OF ENTRIES	NUMBER OF SELECTIONS
- African Upland Rice Preliminary Screening set, AURPSS - 1990	20-6-90	150	31
- African Upland Rice Observational Nursery, AURON - 1990	20-6-90	100	25
Total		250	56

Table 5 Performance of the top twelve entries and the check variety in early duration Observational Yield Trial conducted under upland conditions at Mbo Plain, 1990 wet season.

ENTRY	GRAIN YIELD (KG/HA)	PLANT HEIGHT (CM)	50% FLOWER (DAYS)	REACTION TO (0-9)** LEAF BLAST	NECK BLAST	BROWN SPOT	LEAF SCALD
UPL RI 7	4238	100	98	3	1	1	3
Tox 3118-47-1-2-2-1	3864	104	115	1	5	1	1
Tox 1767-3-1-1	3663	110	101	1	3	1	1
Tox 3118-2-E2-2-1-1	3523	95	111	4	3	1	5
ITA 175	3325	110	99	3	3	1	3
WABIS 7	2994	113	95	3	1	1	5
Tox 3108-43-1-3-2-3	2984	97	115	5	5	1	5
ITA 165	2882	107	82	3	1	1	3
ITA 301	2732	102	100	3	1	1	5
TG R 68	2676	115	86	3	1	1	5
Tox 3118-4-E2-3-5-3	2664	100	115	4	5/7	1	5
IR4505-4-1-15	2573	115	106	4	3	1	5
M 55* (Mean of 8 entries)	1876	100	99	3	1	1	5
IRAT 10* (Mean of [illegible] entries)	1493	70	72	3	5	1	5
Mean of 68 entries	2047						

* Check varieties - Mean of replicated plot.

** Scoring for diseases based on Standard Evaluation System for Rice, IRRI, 1988.

Table 6 Performance of early duration entries in Preliminary Yield Trial conducted under upland conditions at Mbo Plain during 1990 wet season.

ENTRY	GRAIN YIELD (KG/HA)	PLANT HEIGHT (CM)	50% FLOWER (DAYS)	REACTION TO (0-9)** LEAF BLAST	NECK BLAST	LEAF SCALD	BROWN SPOT
Tox 1769-3-1	3765	104	99	3	1	5	1
IR 14632-2-3	3200	147	103	3	1	5	1
IRAT 104	2728	125	103	3	1	5	1
Tox 1870-24-103-1-1-3	2382	128	90	3	3	5	1
H 55	2310	132	93	3	1	5	1
TGR 78	2130	129	99	3	1	5	1
Tox 955-208-2-101-3-1	2070	116	108	4	1	5	1
Tox 1857-102-2-1	2015	132	100	3	1	5	1
Tox 1941-13-102-1	1889	109	99	3	1	5	1
IDSA 17 (IRAT 269)	1740	110	78	3	1	5	1
IRAT 10*	1546	93	73	3	3	5	1
Mean of 12 Entries	2231						
L.S.D. (5 %)	608						
C.V. (%)	14.1						

* Check variety.

** Scoring according to the Standard Evaluation System for rice, IRRI, 1988.

Table 7 Performance of entries in early duration Advanced Yield Trials conducted under upland conditions at Mbo Plain during 1990 wet season.

ENTRY	GRAIN YIELD (KG/HA)	PLANT HEIGHT (CM)	50% FLOWER (DAYS)	REACTIONS TO (0-9)** LEAF BLAST	NECK BLAST	LEAF SCALD	BROWN SPOT
UPL 41-7	3734	108	83	3	1	5	1
IRAT 216	2771	105	95	3	1	5	1
IDSA 6 (IRAT 216)	2733	100	93	3	1	5	1
IRAT 170	2089	117	93	3	1	5	1
ITA 301	2067	96	95	3	1	5	1
M 55*	2056	100	93	3	1	5	1
IDSA 10	1895	107	75	3	1	5	1
IRAT 144	1849	100	76	3	1	5	1
1379-3	1824	113	92	3	1	5	1
IRAT 132	1706	107	93	3	1	5	1
IRAT 140	1672	103	93	3	1	5	1
ITA 128	1670	110	97	3	1	5	1
ITA 305	1559	95	96	3	1	5	1
IRAT 10*	1373	88	73	3	1	5	1
Tox 1012-12-28	1253	120	99	3	1	5	1
IRAT 112	1160	105	75	3	1	5	1
Mean of 16 Entries	1963						
L.S.D. (5%)	772						
C.V. (%0	207						

* Check varieties.

** Scoring based on the Standard Evaluation System for Rice, IRRI, 1988.

Table 8 Performance of entries and the check variety in African Upland Rice Advanced Trial conducted under upland conditions at Mbo Plain during 1990 wet season.

ENTRY	GRAIN YIELD (KG/HA)	PLANT HEIGHT (CM)	50% FLOWER (DAYS)	REACTIONS TO (0-9)** LEAF BLAST	NECK BLAST	LEAF SCALD	BROWN SPOT
ITA 301	2017	102	99	3	1	5	1
IRAT 10*	1982	90	72	3	3	5	1
IRAT 112	1875	104	76	3	3	5	3
ITA 321	1790	114	99	3	1	5	1
IDSA 10	1702	100	80	3	1	5	1
IRAT 147	1679	123	101	3	1	5	1
IDSA 16	1302	100	76	3	3	5	1
IRAT 136	1216	99	111	3	1	5	1
H 55	1128	103	99	3	1	5	1
Tox 1012-12-28	1117	95	102	3	1	5	1
ITA 130	1069	130	97	3	1	5	1
ITA 132	1060	110	94	3	1	5	1
Tox 1011-4-A2	856	90	72	3	3	5	1
ITA 135	836	109	91	3	1	5	1
ITA 150	775	115	75	3	3	3	1
Mean of 15 Entries	1360						
L.S.D. (5%)	588						
C.V. (%)	22.6						

* Check vareity.

** Scoring for diseases based on Standard Evaluation System for Rice, IRRI, 1988.

Table 9 Performance of entries in National Coordinated variety trial conducted under irrigated conditions at Ndop Plain (North West), Lagdo (North) and Yagoua (Extreme North) during 1990 wet season.

ENTRY	GRAIN YIELD (KG/HA			
	NDOP	LAGDO	YAGOUA	MEAN
IR 7167-33-2-3*	5127	4956	6154	5412
CISADANE	4845	5214	6120	5393
Tox 3344-Toc-3-4-1	4548	5447	6181	5392
CICA 8	4518	4539	6794	5284
Tox 3344-Toc-34-3-2	4596	6050	4974	5207
IR 7167-33-2-4	5582	4392	5304	5093
BKN 7033-3-3-2-2-3**	5221	4888	5104	5071
Nang Ng Riep 75	4423	4470	6224	5039
ITA 222	4816	3910	6388	5038
KAUSHIHNG SEN YU	4836	5027	5191	5018
ITA 212	4140	4469	6319	4976
ITA 301	4652	4050	6173	4958
IR 46 ***	4782	4876	5182	4933
Tainan V	3487	5493	4991	4657
B 2161C-MR-57-1-3-1	4955	4748	4236	4646
Tox 3145-34-2-3	4315	4748	4604	4556
B 29838-SR-51-1-1-2	4741	4120	3984	4282
RNR 29692	5093	4050	2587	3910
Mean of 18 Entries	4693	4747	5361	4937
L.S.D. (5%)	449	564	708	
C.V. (%)	14.45	13.63	10.88	

* Check variety at Ndop Plain.
** Check variety at Lagdo.
*** Check variety at Yagoua.

Table 10 Performance of entries in National Coordinated variety trial conducted under upland conditions at Santchou - Mbo Plain and Babungo - Ndop Plain during the wet season of 1990.

ENTRY	GRAIN YIELD (KG/HA) BABUNGO	SANTCHOU	MEAN
ROK	2150	2884	2517
IRAT 112	3250	1507	2379
ITA 120	2950	1654	2302
ITA 128	2675	1913	2294
IRAT 109	2900	1591	2246
IRAT 161	2153	2144	2149
IRAT 79	2475	1787	2131
IRAT 216	1650	2509	2080
IRAT 109	2350	1712	2031
ITA 208	2200	1828	2014
IRAT 10*	2075	1920	1998
ITA 301	1528	2348	1938
IRAT 132	2300	1315	1808
ITA 257	1625	1416	1521
Mean of 14 Entries	2306	1895	2101
L.S.D. (5%)	357.2	599.11	
C.V. (%)	10.84	16.51	

Check variety.

3.2. RICE AGRONOMY

3.2.1. INTRODUCTION

The emphasis of the rice agronomy unit research was given to the management of fertilizer practices and to fertilizer products as well as to cultural management practices of selected rice varieties aimed to support the varietal improvement program. It also oriented part of its program on cropping systems component techniques and rice-based cropping patterns. Three locations were chosen in 1990 corresponding to the rice ecologies of the Western highland: Dschang farm, Mbo Plain and Ndop Plain.

A total of 14 trials (8 in the first season and 6 in the second season) were planned for Mbo Plain. In Ndop, 12 experiments with 5 in the first and 7 in the second season were established. Dschang received only 1 trial on station in the first season added to the laboratory studies. All the trials as planned were planted and only the first season trials data are compiled for this report writing because all the second season, and especially rice trials, are still in the field since they will reach their maturity stage and be harvested in late December 1990 and January 1991.

Climatic conditions with total rainfall and rainfall distribution during the year were about normal. The only problem faced was the post-harvest management of trial products due to the misfunction of the dryer leading to the deterioration of some products like beans, soybean and maize.

3.2.2. OUTPUTS AND ACCOMPLISHMENTS

Our 1990 trials are the on-going experiments of 1989 so that the goals remained the same that is to improve irrigated rice yields through better agronomic practices and identify suitable rice-based cropping pattern to improve total farm income.

GOAL: To improve irrigated rice yields through better agronomic practices and identify suitable rice-based cropping patterns to improve total farm income.

Sub-Goal	Outputs	Accomplishments
1. Identify optimum dates of planting to achieve stable and high yields in new cultivars.	1. No data yet available.	1. Waiting for results.
2. Identify best fertilizer products and fertilization practices to optimize rice yield.	2. Data not yet compiled.	2. Waiting for results.
3. Identify optimum plant spacings for promising selection.	3. Waiting for data.	3. Waiting for results

Sub-Goal	Outputs	Accomplishments
4. Identify better harvest time to improve milled-rice out-turns.	4. Trial still on the field.	4. Waiting for results.
5. Identify economic control techniques for scirpus sp in irrigated rice plots at Ndop Plain.	5. Trial at maturing stage.	5. Waiting for results.
6. Estimate soil nutrient availability and plant uptake by crops in relation to fertilizer application.	6. First year data on available P indexes for a long-term P response trial at Dschang.	6. Results not yet available.
7. Identify appropriate rice based cropping patterns and component technology suited to specific ecology.	7. Data for year 3 at Mbo and Ndop Plains.	7. Two rows of rice alternating with one row of soybean at appropriate spacing is the most profitable pattern for rice-soybean association at Mbo Plain. Better maize, cowpea, sweet potatoes, cassava, fertilizer needs and cropping patterns of these crops for better performance were identified.

3.2.3. OTHER ACTIVITIES

Researchers of the agronomy unit participated in the IRA 1989-1990 Regional Program Planning Meeting in January 1990 at Bamenda. The unit also participated in the IITA/USAID rice reseach evaluation in August in Dschang. The unit participated with their article in the publication of the leaflet "CICA 8" and prepared the "Guide of Rice Cultivation in Cameroon" for future publication.

- A cassava panel was organized at IRA-Antenna Santchou for five cassava clones already tested for their yield performance, on September 3rd 1990.
- Seeds of some selected cowpea lines adapted to 3 ecologies (Mbo Plain, Ndop Plain and Babungo) were sent by the unit to the IRA headquarters for further extension.
- Mr. Birang a Madong took part at Mbo Plain to the IITA E.E.C. on-farm Project evaluation held in October 1990.
- Dr. Roy attended the American Society of Agronomy meeting in the USA in October 1990.
- The unit presented the 5 year activity report at the internal coordination meeting held at IRA-Dschang in November 2nd 1990.

3.2.4. RESEARCH FINDINGS

The findings reported are mainly based on data collected on the first cycle trials which are mostly rainfed upland trials. Findings from the second cycle trials cannot be available since they concern irrigated rice trials.

3.2.4.1 Materials and Methods

3.2.4.1.1 Treatments

Rainfed upland trials: The rainfed upland triais in the three locations concern experiments on rice-based cropping patterns and cropping systems component technology development. They include fertilizer response in maize, soybean, applied phosphate response in maize, soybean and phaseolus beans, yield evaluation on various varieties and clones of cowpea, sweet potato and cassava, and maize-soybean, and rice-soybean intercropping under rainfed upland conditions.

3.2.4.1.2 Water Management In Plots

The upland trials of the first season were completely rainfed.

3.2.4.1.3 Experimental Designs

The experimental design for the first season trials was Randomized Complete Block. The number of replications varied from 4-6. Plot sizes varied from 22.5 to 50 square meters.

3.2.4.1.4 Test cultivars

Recommended varieties for the various ecologies were used except those for varietal evaluation and selection. Names of varieties are given in individual tables.

3.2.4.1.5 Soil Analysis

The available soil P content for the Applied Phosphate trial in maize, soybean and bean was obtained by analyzing the soils samples at IRA-Dschang Agronomy laboratory following "selected methods of soil and plant analysis (IITA manual series no. 1, December 1979).

3.2.4.1.6 Statistical Analysis of Data

The traditional analysis of variance was used as well as the test of significance using the STATITCF statistical program for all field and harvested data.

3.2.4.2 RESULTS

The only results as we said earlier are those of the first season trials concerning rainfed upland experiment the second season rice trials are still in the field at the moment these results were compiled.

3.2.4.2.1 Fertilizer Response In Maize

This trial aimed to determine fertilizer needs on newly developed maize varieties for optimum yield in Mbo and Ndop Plains soils ecologies and to confirm magnesium and/or sulfur deficiency in maize at Mbo Plain.

At Ndop Plain the trial was conducted in early April 1990 in irrigated rice plot (harvested in January 90). It is the second year of this experiment. The maize response to fertilizer was highly significant (see treatments and results in table 1) to the various rates. This result confirms the last years indicating that residual effect of fertilizer applied on rice is very low on following upland crops. For this season, the 90-90-60 (N-P_2O_5-K_2O) gives the best yield and is therefore recommendable.

At Mbo Plain, the difference among treatments was also highly significant. Variety CMS 8501 gave the maximum response to fertilization relatively to variety CMS 8704. The last year's findings concerning magnesium and/or sulfur deficiency in maize seems to be confirmed since plots receiving 200 kg/ha of sulpomag present more vigorous and green plants (see results in table 2).

3.2.4.2.2 Fertilizer Response In Soybean

This is the second year of this trial in Ndop Plain and the first season in Mbo Plain where this crop is newly introduced. At Ndop Plain results show a high response of soybean to fertilizer (see table 4). The maximum yield performance was obtained with an application of 100 kg P_2O_5. This result agrees with that observed with maize following irrigated rice, assuming that upland crop does not benefit from residual fertilizer of the irrigated rice crop.

In Mbo Plain, the trial was grown on upland plots. The result show a very low yield of soybean due to the fact that the soybean germination was very low. This explains the high CV obtained in table 5. But taking into account the last years results, the present results show the need of P_2O_5 for soybean.

3.2.4.2.3 Effect Of Maize-Soybean And Rice-Soybean Crop Associated Patterns On Their Grain Yields.

These association patterns experiments were conducted at Mbo Plain under upland conditions. It is the third year for the maize-soybean pattern. Results (on table 3) indicate that the association is more beneficial to maize when combined with an application of phosphate. In fact difference among treatments is highly significant. The optimum maize yield is obtained when 2 rows of maize alternate with one row of soybean receiving 250 kg/ha of phosphate.

Conversly, the various treatments with soybean do not show any significant difference. The association does not profit soybean. The high coefficient of variation is explained by the bad germination of soybean seeds used.

The second year rice-soybean experiment indicates that the 2 rows of rice alternating with one row of soybean is more profitable for rice. The appropriate spacing is shown in table 10. Last year results reveal that this pattern did not generate a significant decrease in soybean yield. But this year we were not able to confirm this result because of the poor germination of soybean.

3.2.4.2.4 Grain Yields Of Crops In Rice-Based Two-Cycle

This experiment aimed to develop appropriate rice-based cropping pattern for specific ecology in order to improve total farm income and sustain land productivity. Results will not be reported for this year since second season rice trials will be harvested in January 1991. At Ndop Plain the study was conducted with an irrigated rice-based system and is running its third year. We conduct this experiment in Mbo Plain with upland rice-based system for the same time. The various patterns and partial results are on table 6 and 7.

The yield responses indicate that the trends conform with those obtained during the two past years. In both locations pure maize or pure soybean or maize-soybean association (even if soybean had poor germination) give substantial gross income to add to the one rice will generate.

3.2.4.2.5 Cowpea Grain Yield Evaluation

Yield evaluation trials of cowpea lines selected in different ecology last year in a varietal cowpea evaluation was conducted at Santchou (Mbo Plain), and Ndop Plain (Bamunka and Babungo). In Mbo Plain, the Mutant geant 31-1-2 followed by IT 85D-2/9 have outyielded the other lines (see results and varieties in table 9). In Ndop Plain, at Bamunka farm like at Babungo, the local variety called Mankon Local gives the best yield performance (see results and varieties in tables 8 and 14).

3.2.4.2.6 Yield Evaluation Of Three Sweet Potato Clones

This evaluation of TIB1, 1111 and local Santchou clones is conducted for the third time under Mbo Plain soil climatic conditions to evaluate their yield performance. The trial was held with no major problem. The results compiled in table 12 does not show any significant difference among the three clones planted without any fertilizer. This year the two improved clones TIb1 and 1112 outyielded the local one and both seem to be well adapted to Mbo soil conditions. Further experiments are necessary to indicate the most adaptable.

3.2.4.2.7 Yield Performance Evaluation Of Five Cassava Clones

Planted in April 1989, five cassava clones were evaluated for their varietal yield performance in observational plots at Mbo Plain soil climatic conditions. Results on table 13 do not indicate any significant difference among clones.

Table 1: Fertilizer response in maize variety early white in an irrigated rice-based cropping pattern[1] (Ndop Plain 1st cycle 1990).

Fertilizer rate (kg/ha) N	P_2O_5	K_2O	Grain kg/ha Yield	Plant height Cm	Plant harvest No./Plot
0	0	0	2810	2.09	198
30	30	20	3322	2.32	212
60	60	40	3764	2.29	233
90	90	60	4310	2.22	234
120	90	60	4269	2.48	233
F (Variety)			**	ns	ns
F (Fertilizer)				ns	
F (Var x Fert)			ns	ns	ns
SEM + :			396.74	0.23	
C.V. (%)			11 %	9.9 %	

1: Average of four replications
*: Significant at the 5 % level
**: Significant at the 1 % level
ns: Non significant

Table 2 Fertilizer response in maize variety CMS 8704 and CMS 8501 Mbo Plain 1990 1st Cycle (4th crop)[1]

Fertilizer (kg/ha) N	P_2O_5	K_2O	Sulpo mag	Grain yield kg/ha	Plant Ht. (Cm)	Plant harvest no/plot	Early harvest no/plot
				CMS 8704			
0	0	0	0	2670	100	165	147
60	60	40	0	3755	112	173	144
60	60	40	200	3707	123	174	147
90	60	60	0	4922	127	173	166
90	60	60	200	4895	131	173	170
Mean				3990	118.6	171	155
				CMS 8501			
0	0	0	0	3959	135		129
60	60	40	0	4606	131		150
60	60	40	200	5907	152		167
90	60	60	0	4831	131		165
90	60	60	200	6420	143		180
Mean				5145	138.4		158
F (CMS 8704)				**	ns	ns	ns
F (CMS 8501)				**	ns	ns	ns
SEM (CMS 8707) +				774.89	23.38		
SEM (CMS 8501) +				942.99	12.15		
CV (CMS 8704) %				19.4	19.7		
CV (CMS 8501) %				17.9	8.8		

Table 3 Effect of maize-soyabean association patterns and phosphate levels on maize (variety CMS 8501) and soybean (var sj 320) grain yield. Mbo Plain 1990, 1st cycle (3rd crop)[1]

Cropping	P_2O_5 (kg/ha)	Maize - maize Yield (kg/ha)	Early harvest no/plot	Plant height cm	Soybean - soybean Plant harvest no/plot	Yield kg/ha
Maize pure P_{11}	0	2669	66	88.5		
Maize pure P_{12}	50	3184	70	100.5		
Maize pure P_{13}	200	3147	87	118		
Soybean pure P_{21}	0				50	356
Soybean pure P_{22}	50				77	496
Soybean pure P_{23}	200				76	606
Maize-soybean$_2$ P_{31}	0	2432	43	107	27	120
Maize-soybean$_2$ P_{32}	50	3131	48	119.25	22	104
Maize-soybean$_2$ P_{33}	200	3989	58	130.25	22	89
Maize-soybean$_3$ P_{41}	0	2273	45	105	30	136
Maize-soybean$_3$ P_{42}	50	3036	53	110.25	28	152
Maize-soybean$_3$ P_{43}	200	3595	58	133.5	18	64
Mean		3046	59	112.5	39	236
F		**	*	ns		
SEM +		718.19				
C.V. (%)		21.4				

1. Average of four replications
2. Intercrop
3. Planted together

*: Significant at the 5 % level
**: Significant at the 1 % level. NS: Non significant

Table 4 Fertilizer response in soybean variety sj 320 in a two cycle irrigated rice base cropping patterns in Ndop Plain 1st cycle 1990[1]

Fertilizer rates (kg/ha) N	P_2O_5	K_2O	Grain yield (kg/ha)	Plant harvest no/plot	Plant height (cm)
0	0	0	2226	110	63.5
30	50	0	2036	113	70.5
30	100	0	2576	100	72.75
30	150	0	2226	116	71.25
30	100	30	1969	109	69
F			ns	ns	
SEM +			271.38	16.12	
C.V. (%)			12.3	14.7	

1. Average of four replications
* : Significant at the 5 % level
** : Significant at the 1 % level
ns : Non significant

Table 5 Fertilizer response in soybean (var. sj 320) in a soybean-rice. Upland rice-based cropping pattern[1]. Mbo Plain 1990

Fertilizer (kg/ha) N	P_2O_5	K_2O	Grain yield[2] (kg/ha)	Plant harvest no/plot
0	0	0	682	100
30	50	0	1020	119
30	100	0	922	101
30	150	0	579	59
30	100	30	887	59
Mean			818	88
F			ns	ns
SEM +			435.14	33.04
C.V. (%)			50.1	37.7

1. Average of four replications
* : Significant at the 5% level
** : Significant at the 1 % level
ns : Non significant.
2 : Soybean plots had poor germination resulting in poor yield and high C.V.

Table 6 Grain yields of different crops in irrigated rice-based two cycle cropping patterns[1]. Ndop Plain 1st cycle (1990)

Cropping pattern 1st cycle	2nd cycle	1st cycle grain yield kg/ha Maize	soybean	peanut	bean	cowpea	rice	LER
Maize pure	rice	4620						
Soybean pure	rice		2160					
Peanut pure	rice			966				
Local bean pure	rice				1298			
Cowpea pure	rice					759		
Maize/soybean[2]	rice	3470	961					
Maize/peanut[2]	rice	4414		433				
Maize/bean[2]	rice	4431			769			
Maize/cowpea[2]	rice	4081				333		
Mixed crop								
Maize/bean/peanut	rice	2177		455	800			
Mean		38655	15605	618	955	546		

1. Average of four replications
2: Intercrop

Table 7 Grain yields of different crops in upland rice-based two cycle cropping patterns. (Nho Plain 1990 1st cycle)[1]

Cropping patterns		1st cycle grain yields (kg/ha)					2nd cycle rice yield (kg/ha)	
1st cycle	2nd cycle	maize	soybean	peanut	cowpea	rice	rice	LER
Maize pure	rice	2790						
Soybean pure	rice		1006					
Peanut pure	rice			1255				
Local bean pure**	rice							
Cowpea pure	rice				1100			
Maize/soybean*	rice	2705	381					
Maize/peanut*	rice	951		556				
Maize/bean*	rice	2110						
Maize/cowpea*	rice	1870			778			
Traditional (mixed crop)								
Maize/cowpea/ peanut	rice	1172		175	475			
Rice	rice					1291		
Grass fallow	rice							
Mean		19335	518	662	784	1291		

1. Average of four replications
* : Intercrop
** : Local bean completely damage by Aschoshita fungus at flowering stage.

Table 8 Cowpea grain yield in replicated yield trial Ndop Plain 1990

Variety	Grain yield (kg/ha)				
	I	II	III	IV	Mean
TVX 1850-01E	1820	2000	1774	1734	1832
Tardif 22	1462	1148	994	820	1106
Mutant Janne claire	1708	1300	1203	1117	1332
Mankon local	1928	1920	1668	2197	1928
F					*
SEM +					202.02
C.V. (%)					13

*: Significant at the 5 % level
**: Significant at the 1 % level

Table 9 Cowpea grain yeild in replicated yield trial. Mbo Plain 1990

Variety	Grain yield (kg/ha)				
	I	II	III	IV	Mean
Mutang geant 31-1-2	1555	1362	1150	1460	1381.75
IT 85F-2020	1330	695	632	1250	976.75
IT 85F-953-3	700	500	675	637	628
IT 85D-219	1225	1250	1125	1425	1256.25
IT 82E-32	1100	1167	1250	1125	1160.5
F					*
SEM +					184.82
C.V. (%)					17.2

* : Significant at the 5 % level
** : Significant at the 1 % level

Table 10 Effect of upland rice (IRAT 10) and soybean (sj 320) associations on their yield performance[1]. Mbo Plain 1990 (2nd year).

Association Pattern	Rice yield (kg/ha)	Soybean[2] yield (kg/ha)	Plant harvest no/plot
Rice pure (in rows of 30 cm)	2991	-	-
Soybean pure (40 cm x 25 cm)	-	826	83
One row rice and one row soybean	2803	120	22
Two rows rice and one row soybean	3326	60	12
Two rows rice and two rows soybean	1850	270	35
Mean	2742.5	319	38
F	*	**	
SEM +	795		
C.V. (%)	24	91	

1. Average of six replications
2. Soybean plots had poor germination resulting in poor yield and high C. V.

* : Significant at the 5 % level
** : Significant at the 1 % level
ns : Non significant

Table 11 Response to applied phosphate in maize, soybean and phoseolus bean - Dschang farm 1990 (1st year)[1]

Phosphate level kg/ha	Maize Grain yield kg/ha	Maize plant harvest no/plot	Soybean Grain yield kg/ha	Soybean Plant harvest no/plot	P. Bean Grain yield kg/ha	P. Bean Plant harvest no/plot
0	4007	143	691	356	731	399
50	4234	149	699	263	817	410
200	4289	147	1063	367	810	407
Mean	4176	146	817	328	786	405
F	**		*		ns	

SEM + 236.60
C.V. (%) 12.3 %

1. Average of four replications

* : Significant at the 5 % level
** : Significant at the 1 % level

Table 12 Yield performance of selected potato clones at Mbo Plain[1] 1st cycle 1990.

Clones	Tuber yield (t/ha)				
	I	II	III	IV	Mean (t/ha)
TIB 1	36.16	31.83	17.99	18.66	26.16
Local Santchou	19.83	33.83	18.16	21.5	23.3
1112	34.33	21.83	35.16	28.66	30.0
F					ns
SEM +					6.89
C.V. %					25.4

1. Average of four replications. Grown in 12 m x 5 m plots without fertilizer application.

Table 13 Yield performance of five cassava fresh tuber clones in Mbo Plain soil climatic conditions

Clones	Fresh tuber yield ton/ha					
	I	II	III	IV	Total	Mean
8017	65	24.4	23.5	41.4	154.4	38.6
8034	59	55.6	54.1	38.5	207.2	51.8
Local red Santchou	23.75	32.7	41	52.3	149.7	37.4
8061	42.3	23.5	45	46.4	157.2	39.3
Sangale	32.9	35	32.5	27.9	128.3	32.1

F: ns
SEM + 12.63
C.V. 31.7 %

Table 14 Cowpea grain yield in replicated yield trial[1] Babungo 1990 1st cycle.

Varieties	Grain yield (kg/ha)				Mean
	I	II	III	IV	
Mankon Local	1725	1750	1900	1550	1731.25
Tardiff 22	1375	1200	1350	1125	1262.50
Mutant Precoce	1175	1275	1000	1150	1150.00
TVX 1850-01E	1400	1275	1300	1325	1325.00
IT 85F-2020	900	1050	950	1075	993.75
IT 823-32	650	725	400	875	662.25
IT 83D-219	900	825	1000	800	881.2
Vita 7	1100	1150	1275	1175	1250
F					*

C.V. 11 %
SEM + 127.23
* Significant at the 5 % level.

4. CEREALS AGRONOMY RESEARCH UNIT

4. 1. INTRODUCTION

The NCRE Cereals Agronomy Unit, based at IRA/Garoua, conducted in 1990 a set of field experiments on the agronomy of maize (**Zea Mays**), and Sorghum (**Sorghum bicolor**), in the lowland savanna and the highland plateau of Adamaoua of North Cameroon. Two kinds of research were carried out by our team: a- on-station experiments at two main locations: Djalingo (lowlands) and Mbang Mbirni (highlands); b- On-farm test/demonstrations conducted in 13 villages of the West and South East Benoue regions, and 4 locations in the Adamaoua province. A special research operation: **"maïs de case pour période de soudure"** green maize as a compound crop for hunger period was successfully undertaken with more than 800 farmers. Finally, during this period, the Unit carried out several seed multiplications of the NCRE maize varieties, soybean, pigeon peas and Crotalaria.

The 1990 cropping season was characterized by an erratic and reduced rainfall regime. In most locations, rain establishment was late (end of June), and ended at the end of September. This reduced rainfall pattern was associated with a drastic reduction in cereals yield in both provinces - and more so in the Far-North province. Crops were negatively affected by dry spells, insect pests, weeds (including Striga), and soil erosion. Late planting or replanting was necessary in many cases.

4.2 OUTPUTS AND ACCOMPLISHMENTS

GOAL: To develop improved and appropriate packages of cultural practices for cereal farmers in the context of the different cropping systems used in the main cereal growing zones of northern Cameroon.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. To improve water and soil management and conservation for increased cereals under the main cropping systems used in lowland savanna.	1. Fifth of 5 years: preliminary recommendations on tied-ridging and tillage methods for land preparation in the lowland savanna.	1. Study to determine the effect on maize and sorghum of 3 methods of land preparation, and their interaction with tied ridging indicated that conventional tillages outyielded significantly chisel and no tillage. Tied-ridging was superior to simple ridging. Interaction tillage x tied-ridging was significant for both crops.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
2. to improve the fertilization management of cereals under the main cropping systems used in the region.	2. Fifth of 5 years tentative recommendations on secondary nutriends as well as agronomic matter.	2.1 Experiments conducted on early maturing maize with different rates of N x population densities indicated that the best treatments were: 130 kg N/ha and 62, 500 plants/ha. The best timing for N, sidedress application seems to be at 20 - 25 days after maize emergence. 2.2 Research conducted with different rates of dreche and tourteau de coton showed a maize grain yield advantage (over fertilizer only) of + 203% for dreche, and + 231% for tourteau de coton. Both sources seem promising as supplement to chemical fertilizer
3. To evaluate the impact of different seed and soil treatments on cereals establishment and performance.	3. Fifth of 5 years: recommendations on specific sources and rates of seed and soil treatments which increase average yields of maize and sorghum.	3. Research conducted on impact of seed treatment on crop establishment and yield of maize and sorghum confirmed that the seed treatment Marshal 25 ST 2% lead to a better stand, more seedling vigor and yield increase over the check of maize (+45%) and sorghum (+161%). Interaction seed treatment x preceding crops was significant.
4. To increase yields of cereals though improved cultural practices when grown in monocropping, intercropping and crop rotation systems (under low and high input)	4. Fourth of 5 years: preliminary recommendations on specific cultural practices which could increase yields of maize and sorghum.	4. Research conducted on the effects of graded steps of improved technologies on 2 varieties of maize and sorghum showed a 32 - 47% fertilizer contribution, a 19 - 30% seed treatment contribution, and 11-14% tillage contribution relative to total yields depending on crops and varieties. A combination of treatments gave the highest yield increases of (up to 482%) for maize and (up to 241%) for sorghum.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
5. To improve weed and Striga management in the lowland savanna.	5. Year Two of a five year study. It is expected to develop recommendations on weed control and Striga management to the farmers of the sudan guinea savanna.	5.1 Weed control experiments conducted with early and medium maturing varieties showed a differential response to the treatments. The best treatments were weed free, weeding at 2 + (4 or 5 weeks after crop emergence, weeding 3 weeks after emergence and herbicide + weeding 4 weeks after emergence.
		5.2 Research on the effect of different trap crops on Striga incidence and yield of maize and sorghum indicated that the best crops were Crotalaria, cowpea and cotton on the Striga infested soil of Djalingo as compared to groundnuts, bambara groundnuts, soybean and pigeon peas.
6. On farm testing.	6. Information about the performance of the newly available streak resistant maize varieties and the effect of tillage managment systems on maize before recommendation to farmers.	6. On farm testing/demonstration conducted with SODECOTON in 13 villages with 5 improved maize varieties under two different tillage management systems indicated no significant difference between both tillage systems. There were significant differeces between varieties. Interaction varieties x locations was also significant.

4.3 OTHER ACTIVITIES DURING 1990

A- Researchers of the Unit participated in the following activities :

- The IRA/North Planning Meeting held at IRA/Maroua in January 1990.
- The IRA/SODECOTON/MINAGRI planning meeting held at IRA Maroua.
- Two field days for extension agents of SODECOTON and Projet NEB in August 1990.
- Preparation and implementation of the Monitoring Tour of the SAFGRAD Maize Network (September 1990). Fifteen researchers of 10 different countries participated in this tour.
- The evaluation of the "Projet Garoua I" in September 1990.
- The Annual Meeting of the American Society of Agronomy, San Antonio, Texas,in October 1990.
- The IITA Workshop on Striga research methodology (October 1990).

- The Annual Meeting of the Cameroon Biosciences Society November - in December 1990.
- A set of joint research activities on Striga involving the Unit, IITA Maize Research Program and the University of Hohenhein (GTZ).

B- The following technical papers were prepared by the unit and presented at different meetings..

- "Effect of Graded Steps of Improved Technologies on maize and sorghum in the lowland savanna of North Cameroon" (21 pages).
- "Fiche Technique pour la production intensive du maïs dans la région de savane de basse altitude du Nord Cameroun" 2e edition/13 pages.
- "Note Technique Sommaire pour une culture intensive de variétés de maïs TZPB-SR et CMS-8501 dans la region de savane de basse altitude du Nord Cameroun (900 - 1300 mm.)" Note technique No. 5.

4.4 RESEARCH FINDINGS

4.4.1 Study on land preparation methods and minimum tillage on maize and sorghum in the lowland savanna (1990)

This research operation which started in 1986 was carried out at Djalingo with maize and sorghum as test crops. In 1990, three tillage methods for land preparation were tested : a- conventional tillage (plow + harrow) as recommended by SODECOTON; b- Chisel, c- no-tillage. Tied-ridging versus simple ridging was used as subplots. The main objectives of this research work were: a- to evaluate the interaction tillage methods x tied ridging; b- to study the interaction between the 2 factors and two varieties of maize and sorghum. The maize varieties used were: TZPB-SR (115 days cultivar) and CMS 8806 (a 95 - days cultivar). The sorghum varieties used were: improved CS-95 and local Damougari.
Results of this experiment are summarized in table II. It was found among other things that:

A- In the case of Maize :

1- Land preparation; There were significant differences among the tillage methods with respect to grain yield and plant stand. Conventional tillage was significantly superior to chisel and no tillage. However, there was no significant difference between the chisel and no tillage treatments. As compared to conventional tillage, chisel tillage showed a yield decrease of 1.56 t/ha (-24%) for maize CMS-8806, and a decrease of 0.77 t/ha (-11%) for maize TZPB-SR.

2- Tied-ridging; The treatments with tied-ridging significantly outyielded those with simple ridging. This response may be related to different water stress associated with the erratic rainfall regime of the 1990 cropping season.

3- Interaction; There was a significant interaction between tillage and varieties - which would imply that these varieties with different maturity cycles did not respond the same way to the tillage methods. There was no significant interaction between tillage methods, and tied-ridging.

B- **In the case of Sorghum**: The same general trends as for maize with respect to land preparation, tied ridging and interaction were obtained. However, there was no yield difference between both varieties. There were significant differences among the tillage methods. Conventional tillage outyielded no tillage and chisel tillage. No tillage outyielded chisel tillage.

Table II. LAND PREPARATION X TIED RIDGING ON MAIZE AND SORGHUM GRAIN YIELD IN THE LOWLAND SAVANNA OF NORTH CAMEROON, DJALINGO 1990.

Tillage Methods	Ridging	Maize CMS-8806 t/ha	Maize TZPB-SR t/ha	Sorghum CS-95 t/ha	Sorghum Damougari t/ha
I Conventional	+ Tied	6.60	7.08	3.29	2.67
II Conventional	+ simple	5.96	6.12	2.13	2.05
III Chisel	+ Tied	5.20	6.40	1.37	1.48
IV Chisel	+ Simple	4.24	5.26	1.09	1.23
V No	+ Tied	5.28	6.20	1.68	1.94
VI No	+ Simple	3.30	5.0	1.08	1.30
Average		5.18	6.01	1.77	1.78

For Maize : C.V. = 7%; $F_{Till.}$ = N.S.; $F_{Var.}$ = N.S.; $F_{Tied\ Ridg.}$ = N.S.
$F_{Till.\ x\ Var.}$ = N.S.; $F_{Till\ x\ Tied\ Ridg.}$ = N.S.

For Sorghum : C.V. = 13%; $F_{Till.}$ = N.S.; $F_{Tied\ Ridg.}$ = N.S.; $F_{Var.}$ = n.s.
$F_{Till.\ x\ Tied\ Ridg.}$ = S.; $F_{Till.\ x\ Var.}$ = N.S.

4.4.2 Improvement of crop establishment on maize and sorghum through seed treatment in the lowland savanna.

This study which started in 1987 in a sandy Alfisol at Djalingo has been conducted with 2 maize and sorghum varieties under a system of minimum tillage with no land preparation. In 1987, six crops were planted (one sixth of a hectare per crop): cotton, groundnuts, maize, cowpea, Crotalaria and weed fallow. In 1988 each main plot was split into 2 subplots. Maize and sorghum were planted in each plot in an effort to evaluate the impact of these preceding crops on crop establishment and the effect of seed treatment on both crops. In 1990 (like in 1989) the two seed treatments used were: seed treatment Marshal 25 ST at the rate of 2 kgs of Marshal per 100 kgs of seed versus no seed treatment. The maize varieties used were: TZPB-SR (long cycle) and CMS-8053 (medium cycle). The sorghum varieties used were improved CS-95 versus local Damougari. The main objectives of this study were: a- to test the interaction seed treatment x variety; b- to test the interaction preceding crops x seed treatment. Partial results are shown in the following tables III a and b. The results indicate among other things that:

A- **Maize**: The use of Marshal seed treatment was associated with significant grain yield increases. Maize plants in the treated plots had a much better stand establishment, seedling vigor, better growth rate and yield. Average grain yield increases for TZPB of 2.14 t/ha

(+45%) over the checks, and 1.84 t/ha (+46%) for CMS-8503 over the checks were recorded in this experiment. There was a highly significant difference between preceding crops. As noted in 1988 and 1989, the best preceding crops were: Crotalaria and groundnuts. A better crop establishment and crop performance were observed after these 2 crops even when the seed was not treated. The interaction seed treatment x variety was not significant. Like in 1989, the interaction seed treatment x preceding crops was significant which would imply that the impact of seed treatment varied with preceding crops. Analysis conducted on maize stover yield showed the same trends as for grain yield. The increase in grain and stover yield was mainly due to a better plant stand associated with the use of seed treatment with Marshal ST at 2%.

B- **Sorghum**: The same general trend was observed except that there was no significant yield difference between both varieties. Plant stands were reduced in the plots with no seed treatment. Average yield increase due to seed treatment of 0.99 t/ha (+161%) for CS-95 and 0.83 t/ha (+153%) were recorded in this experiment. The best preceding crops were also: Crotalaria and groundnuts.

Table III.a. EFFECTS OF TWO SEED TREATMENTS ON MAIZE GRAIN YIELD AS AFFECTED BY 6 DIFFERENT PRECEDING CROPS IN THE LOWLAND SAVANNA (1990)

Preceding Crops :	Cotton t/ha	Crotalaria t/ha	Groundnuts t/ha	Fallow t/ha	Cowpea t/ha	Maize t/ha	Average t/ha
I TZFB Not treated	3.91	6.43	5.31	4.15	4.45	4.03	4.71
II TZFB treated	6.21	7.62	7.39	6.31	7.15	6.43	6.85
III CMS-8503 Not treated	3.37	5.65	3.8	3.49	3.64	3.67	3.94
IV CMS-8503 Treated	5.70	7.27	6.43	4.69	5.52	5.04	5.78
Average	4.80	6.74	5.73	4.66	5.12	4.79	5.32

Note : Seeds were treated with the seed treatments Marshal 25 ST (Carbosulfan) at the rate of 2 kg/100 kg of seeds.

The different preceding crops were planted and havested in 1987

C.V. 11%; $F_{Prec.\ crops}$ = H.S.; $F_{Var.}$ = H.S.; FT_{ST} = H.S.
$F_{ST\ x\ Var.}$ = n.s.; $F_{ST\ x\ Prec\ crops}$ = S.

Table III b. EFFECTS OF TWO SEED TREATMENTS ON SORGHUM GRAIN YIELD AS AFFECTED BY DIFFERENT PRECEDING CROPS IN THE LOWLAND SAVANNA (1990)

Preceeding Crops :	Cotton t/ha	Crotalaria t/ha	Groundnuts t/ha	Fallow t/ha	Cowpea t/ha	Maize t/ha	Average t/ha
I CS-95 Not treated	0.31	0.60	0.52	0.63	0.66	0.6	0.55
II CS-95 Treated	1.15	0.67	1.18	1.35	1.15	1.5	1.44
III Damougari Not treated	0.45	0.62	0.62	0.76	0.37	0.42	0.54
IV Damougari Treated	0.87	1.73	1.64	1.3	1.29	1.41	1.37
Average	0.70	1.16	1.15	1.01	0.87	0.98	0.98

Note: Seeds were treated with the seed treatment Marshal 25 ST (Calbusulfan) at the rate of 2 kg/100 kg of seeds.
CS-95 is an improved variety and Damougari is a local variety.

The different preceding crops were planted and harvested in 1987

C.V. = 8%; $F_{Prec.\ crops.}$ = N.S.; $F_{Var.}$ = n.s.
$F_{Prec.\ crops\ x\ Var.}$ = N.S.; $F_{ST\ x\ Var.}$ = n.s.
$F_{Prec.\ crops\ x\ Var.\ x\ ST}$ = N.S.

$F_{ST.}$ = N.S.
$F_{ST\ x\ Prec.\ x\ crops}$ = N.S.

4.4.3. Effect of Different rates of "Tourteau de coton" and "Dreche" on Maize Yield in the Lowland savanna of North Cameroon (1990)

Preliminary trials were conducted at 2 locations (Djalingo and Sanguere) to evaluate the possible use of "Tourteau de Coton" (cotton cake) mixed with simple superphosphate (by SODECOTON), and sun dried "dreche" brewery residue as a source of supplementary fertilizer for maize. Each product was applied banded one week after emergence of maize at the rates of 0, 200, 400 and 800 kg/ha in combination with a medium level of fertilizer (90 N -40 P_2O_5 - 49 K_2O kgs/ha) on two sandy soils (Alfisols) of the sudan-guinea savanna. The maize variety used as test crop was CMS 8501. Results are shown in the table IV.

There was a significant grain yield difference among the treatments. The combined use of fertilizer and dreche increased yield up to: 2.79 t/ha (+102%) over the treatment with fertilizer only. The best rate of dreche seemed to be 800 kg/ha. The use of fertilizer and tourteau de coton cause a yield increase of up to + 3.36 t/ha (+133%) over the treatment with fertilizer only. The best rate of tourteau in this experiment seemed to be 800 kg/ha. In general, as the amount of dreche and tourteau de coton increased, grain yield of maize CMS-8501 increased. The same trend was noted for stover yield. On the average, there was a greater response at Sanguere than at Djalingo. Preliminary results showed that these two by products are promising as a supplementary source of fertilizer in some zones of the lowland savanna. More research will be conducted on this subject.

Table IV. EFFECT OF DIFFERENT RATES OF TOURTEAU DE COTON AND DRECHE ON MAIZE GRAIN YIELD IN THE LOWLAND SAVANNA OF NORTH CAMEROON, (1990).

Treatments	Dajlingo Grain Yield of TZPB (t/ha)	RGY %	Sanguere Grain Yield of TZPB (t/ha)	RGY %
1. - Fertilizer (control)	1.73	49	1.04	38
2. + Fertilizer	[illegible].50	100	2.71	100
3. + Fertilizer + 200 kg dreche/ha	4.18	119	3.43	127
4. + Fertilizer + 400 kg dreche/ha	4.62	132	5.04	186
5. + Fertilizer + 800 kg dreche/ha	5.13	147	5.50	203
6. + Fertilizer + 200 kg tourteau/ha	4.54	130	3.29	121
7. + Fertilizer + 400 kg tourteau/ha	5.26	150	5.16	190
8. + Fertilizer + 800 kg tourteau/ha	5.57	159	6.34	234

Note : The fertilizer used was : 90 N + 40 P_2O_5 + 40 K_2O kg/ha.
Dreche and tourteau de coton was applied banded along with fertilizer one week after planting.
At Djalingo : $F_{TR.}$ = S. C.V. = 6% LSD (0.05) = 0.38 t/ha.
At Sanguere : $F_{TR.}$ = S. C.V. = 7.5% LSD (0.05) = 0.43 t/ha.

4.4.4 Graded steps of improved technologies on maize and sorghum.

This research work which started in 1987 was conducted in 1990 at Dajlingo and Mbang Mbirni (highlands) in order to study the response of 2 maize and 2 sorghum varieties (Djalingo) to different improved technological components when applied singly or in combination. The two maize varieties used were TZPB-SR (a long cycle) and CMS-8503 (medium cycle). The Sorghum varieties used were the improved CS-95 and Local Damougari. The improved technologies components are conventional tillage for land preparation (as recommended by SODECOTON), seed treatment (Marshal 25 ST at 2%), and fertilization (130 N - 60 P_2O_5 - 60 K_2O kg/ha) for maize, and 80 N + P_2O_5 + 40 K_2O kg/ha for sorghum.

A- Summary of results are shown in the table Va and Vb.

At Djalingo:

Maize and sorghum crops showed significantly increased grain yield as compared to the control treatments whenever these improved technologies were applied singly or in combination. The magnitude of the response varied with crops and varieties.

B- The lowest yields were obtained when no improved technology was used while the highest yields resulted from a combined use of all the three strategies. Yield increases over the checks of 5.98 t/ha (+482%) for maize and up to 1.63 t/ha (+241%) for sorghum. A package of improved technologies was necessary to achieve the yield potential of those varieties (local and improved, short and long cycle).

C- There was a graded response of both crops to these improved strategies. On the average, the impact of fertilizer was greater than that of seed treatment and that of conventional tillage. The impact of seed treatment was greater that of conventional tillage. In the case of maize, the relative contributions to total yield of the different technologies were as follows: the contribution of fertilizer varied from 43% to 47%, that of seed treatment from 26 to 30%, and that of tillage from 11 to 12%.

<u>In the case of sorghum</u>: The relative contribution due to fertilization was 32%; that of seed treatments varied from 19 to 24%; that of tillage was 14%.

4) There were some positive interactions among the improved strategies as well as between these factors and varieties indicating a synergistic and beneficial effect of these factors with respect to each crop.

Table V a. EFFECT GRADED STEPS OF IMPROVED TECHNOLOGIES ON THE GRAIN YIELD OF TWO MAIZE VARIEITIES IN THE LOWLAND SAVANNA, DJALINGO 1990

Treatments			Varieties	No Tillage (A)	With Tillage (B)	(A + B)/2	B - A
	Fertilizer	seed treatment		t/ha	t/ha	t/ha	t/ha
I	No	No	CMS-8503	1.15	1.43	1.29	0.28
			TZPB	1.33	1.90	1.62	0.57
II	With	With	CMS-8503	5.65	6.65	6.15	1.0
			TZPB	6.80	7.80	7.30	1.0
III	No	With	CMS-8503	2.01	2.76	2.39	0.75
			TZPB	2.22	2.60	2.41	0.38
IV	With	No	CMS-8503	2.78	3.84	3.31	1.06
			TZPB	3.38	4.75	4.07	1.37
			Average	3.17	3.97		

$F_{Till.}$ = N.S.; C.V. 8%; $F_{Var.}$ = N.S.; $F_{Till. x Fert.}$ = N. S.
$F_{Fert.}$ = N.S.; $F_{Var. x Fert.}$ = N.S.; $F_{ST.}$ = N.S.; Fert. x ST. = N.S.

<u>Table V. b</u> EFFECT OF GRADED STEPS OF IMPROVED TECHNOLOGIES ON THE GRAIN YIELD OF TWO SORGHUM VARIETIES IN THE LOWLAND SAVANNA, DJALINGO,1990

Treatments			Varieties	No Tillage (A)	With Tillage (B)	A + B	B - A
	Fertilizer	Seed Treatment		t/ha	t/ha	t/ha	t/ha
I	No	No	CS-95	0.9	1.12	1.01	0.22
			Damougari	0.51	0.81	0.66	0.30
II	With	With	CS-95	2.12	2.67	2.40	0.55
			Damougari	1.61	2.11	1.86	0.50
III	No	With	CS-95	1.17	1.59	1.38	0.42
			Damougari	1.01	1.09	1.05	0.08
IV	With	No	CS-95	1.54	1.90	1.72	0.36
			Damougari	1.06	1.37	1.22	0.31
			Average	1.24	1.58		

$F_{Till.}$ = N.S. C.V. = 15%; $F_{Var.}$ = N.S; $F_{Till. x fert.}$ = S.; $F_{Var. x Fert.}$ = S.
$F_{Fert.}$ = N.S.; $F_{Fert. x ST.}$ = N.S.; $F_{ST.}$ = N.S.

4.4.5 <u>On-farm testing and demonstration with minimum tillage (sodecoton) 1990.</u>

Effect of 2 tillage management systems on the performance of 5 maize varieties in the lowland savanna of North Cameroon.

A set of trials were conducted in cooperation with SODECOTON during the 1990 cropping season in farmers' field (1/4 of a hectare each) in 13 villages of the West and South East Benoue regions. The main objectives of this study were:

a- to evaluate two systems of maize production management conventional tillage versus no tillage management system, in farmers' fields located at different locations of the West and South East Benoue regions;

b- to compare the performance of 5 improved varieties under both production systems;

c- to test the interaction variety x management systems in the different locations;

d- to demonstrate improved cultural practices for intensive maize production to the farmers of this region.

The ultimate goal of this research is to develop **practical and appropriate conservation farming technologies** in order to achieve and sustain relatively good and stable maize yield in the lowland savanna. It was decided to conduct this on-farm experiment after the successful on-station testing of a minimum tillage system of maize production.

The conventional tillage management system as recommended by SODECOTON to farmers involves plowing and harrowing the land before planting, as well as the use of mechanical implements for management operations (weeding, earthing-up etc...). The minimum tillage system tested involves no land preparation with mechanical implements. Only a total herbicide (BASTA 4 l/ha) was applied at planting in combination with the pre-emergent herbicide (used by the farmers). Primextra 4 l/ha, and then earthing up of the soil after application of sidedress urea one month after maize emergence. An additional 23 kg N/ha was applied to no tillage as N deficient symptoms observed. A mulch is made with the weeds residue that was killed by the total herbicide at planting. The conventional tillage system of management is well known to favor soil erosion in the fragile sandy Alfisols (sols Ferragineux tropicaux) of the lowland savanna. This method also requires the use of tractor and animal traction with implements which is relatively expensive for the small farmers. Furthermore, the use of machinery (because of mechanical breakdown and other factors) may cause delay in the farming operation with subsequent yield reduction.

The five maize varieties used were: CMS-8501 (already extended to the farmers), CMS-8710, TZPB SR (a streak resistant version of TZPB) already extended to the farmers. Results of these on-farm experiments are shown in table VI.

It was found among other things that:

a- **Tillage systems:** There was no significant difference between management systems which would indicate a system of minimum tillage could be productive in farmers fields. However some conditions should be fulfilled mainly the use of an effective herbicide (a herbicide combination), good seed treatment and additional N particularly if the preceding crops were non leguminous crops. This may be explained by the fact that the root system was relatively more superficial than that in the conventional tillage which loosened the soil and created a more favorable seedbed at short term. On-station trials indicate that minimum tillage worked better after Crotalaria and groundnuts. Furthermore the mulch during its breakdown may have tied-up the N momentarily. An effective seed treatment is necessary as the crop establishment is relatively more difficult under the no tillage and there is more soil insect damage.

b- **Variety** : In general, the performance of the 5 maize varieties was relatively good under both systems of production in most locations which would indicate that these varieties seem adapted to both systems. There was a significant difference among the varieties. No significant difference between the 3 longer cycle varieties CMS-8501, TZPB, and CMS-8710. These varieties outyielded the shorter cycle varieties CMS-8503 (103 days) and POOL 16 DR SR (95 days). However, many farmers have shown interest in these varieties because of their earliness.

CMS-8503 gave a yield decrease of 0.25 t/ha (- 5%). POOL 16 DM SR - 0.70 t/ha (- 16%) with respect to CMS-8501.

c- **Locations**: There was a significant difference among the locations. The highest yields were found at the 3 locations near Ndock sector. There was a significant interaction between locations and varieties which indicated that the varieties responded differently at the different locations.

Analysis of number of maize ears showed a significant difference as to the locations, and tillage systems. The interaction (systems of production x varieties) was significant which would indicate that the maize varieties produced different numbers of ears in the different system of production.

Due to the interest of this subject and the promising results obtained, this study will be repeated to confirm these results.

Table VI. RESPONSE OF 5 IMPROVED VARIETIES TO 2 DIFFERENT TILLAGE MANAGEMENTS IN 13 VILLAGES OF THE LOWLAND SAVANNA OF NORTH CAMEROON, 1990 - GRAIN YIELD T/HA.

Treatments	Sanguere	Djalingo	Ouro Lavane	Doukea	Koum	Gouga	Ndourou	Vogzom	Mbem	Ngoumi	Mbodo	Mbogdoro	Lagaye	Average t/ha
CMS-8501 Conv.Till.	5.58	3.86	4.0	3.92	3.60	4.08	5.17	4.36	5.33	3.31	4.73	4.42	3.80	4.32
CMS-8501 Min. Till.	5.40	3.83	4.20	3.76	3.44	3.22	5.39	5.23	4.63	3.12	5.35	3.38	3.87	4.22
TZPB-SR Conv.Till.	4.60	4.31	4.52	4.03	3.83	3.27	5.80	4.13	5.41	3.09	4.50	3.42	3.85	4.21
TZPB-SR Min. Till.	4.10	4.16	3.88	3.90	3.58	3.17	5.78	5.19	4.43	3.00	4.09	3.48	3.48	4.02
CMS-8701 Conv.Till.	4.30	3.50	3.63	4.10	3.78	3.35	5.98	5.39	5.77	3.35	3.73	4.31	3.20	4.18
CMS-8701 Min. Till.	4.98	3.73	4.04	4.43	3.64	3.51	5.95	5.34	4.62	3.10	4.11	3.44	3.26	4.17
CMS-8503 Conv.Till.	4.33	4.10	3.60	3.63	3.31	3.76	5.77	4.40	4.95	3.14	4.18	3.94	3.37	4.04
CMS-8503 Min. Till.	4.18	4.24	3.50	3.48	3.45	3.80	5.09	4.84	5.0	2.95	4.90	3.86	2.85	4.01
POOL 16 Conv.Till.	3.78	3.34	3.51	2.83	3.16	3.20	4.89	3.56	4.77	3.48	4.42	3.40	2.60	3.61
POOL 16 Min. Till.	3.58	3.28	3.00	3.24	2.85	3.00	5.00	4.81	4.10	2.66	4.08	3.35	2.83	3.52
Average	4.48	3.84	3.78	3.73	3.46	3.43	5.48	4.73	4.90	3.12	4.41	3.70	3.31	4.03

Note : These trials were conducted in farmers' fields (2500 m² each one) located in the West and South East Benoue regions in cooperation with the development agency SODECOTON

$F_{Var.}$ = N.S.; LSD $(0.05)_{Var.}$ = 0.395 t/ha; $F_{Tillage\ management}$ = N.S.; $C.V._{Trial}$ = 9%
$F_{Location}$ = N.S.; LSD $(0.05)_{Loc.}$ = 0.56 t/ha; $F_{Loc.\times Var.}$ = N.S.; LSD $(0.05)_{Loc\times Var.}$ = 0.56 t/ha;
$F_{Var.\times Till.}$ = N.S.

4.4.6 Weed Control on Maize in the Lowland Savanna of North Cameroon 1990.

This set of experiments on weed control was carried out in an effort to improve our understanding and recommendations regarding weed management for maize varieties of different maturity cycles.

A- Effect of Different Times and Types of Weed Control on Maize Performance.

These trials were conducted at Djalingo and Sanguere in order to evaluate the differential response of an early maturing maize variety versus an medium maturing maize variety to different times and types of weeding. After several years of maize production in the lowland savanna of North Cameroon, a change in the weed population and weed distribution was observed in many locations. Some types of weeds like Commelina, Cyperus, have become a serious constraint in many farmers' fields. There was a need to re-evaluate our recommendations for weed control which were based on previous experiments conducted many years ago. Furthermore, there is a lack of information concerning the weed damage and management with the early maturity maize grown in our agroecological conditions. The treatments involved several manual weedings with hoes as well as the use of pre-emergent herbicide LASSO GD (4 l/ha). Results are shown in the tables VII a.

The major weeds observed in our fields were: Commelina, Cassia, Cleome, Hibiscus, Cassia, Leucas, Ipomoea and Striga. The weed pressure was greater at Djalingo than at Sanguere where the soil was eroded. The weed population was relatively high in the control plots and caused a severe yield reduction as compared to the weed free treatments. There were significant differences between the treatments as well as between the 2 varieties. On the average, the impact of weeds was more severe in the early variety CMS 8806. It is partially due to its short stature which favors light penetration through the canopy.

There was a significant interaction between the weeding treatments and variety which would imply that the two maize varieties differ in their response to weed control. The best treatments for the early maturing variety CMS 8806 were weed free, weeding at 2 and 4 or 5 weeks after emergence (WAE) and herbicide + weeding at 4 W A E. For the medium maturing variety CMS 8501 the best treatments were weed free, weeding 3 weeks after emergence, herbicide + weeding 4 W A E, weeding 2 + (4 or 5) W A E.

B. Effect of Different Trap Crops on Striga Incidence and the Performance and Yield of Maize and Sorghum Grown in a Striga Infested Soil in the Lowland Savanna of Northern Cameroon.

This research started in 1989 and has been carried out on a sandy Alfisol well infested with Striga at Karité near Djalingo. In 1989, six trap crops were planted: cotton, groundnut, cowpea, Crotalaria, bambara groundnuts and soybean. In 1990, maize and sorghum were planted (in split plots) after these trap crops (used as preceding crops). The main objectives of this study were:

a) to evaluate the impact of different trap crops on the Striga incidence and the performance and yield of maize and sorghum when grown in a Striga infested field of the sudan - guinea savanna of North Cameroon.
b) to monitor at short and long term the Striga incidence and damage on maize and sorghum grown in rotation with these trap crops.
c) to monitor the evolution of the Striga seed bank in the soil after rotation with different trap crops.
d) to collect enough data to make recommendations to farmers as to the best trap crops which could help alleviate the Striga damage on maize and sorghum in Striga infested soils.

Results are shown in Table VII b. It was found among other things that:

1) **Maize:** Striga hermonthica caused severe injury on maize plants in most plots. Plant vigor, growth and development were negatively affected by Striga. Visual symptoms of Striga damage were evident at an early stage of maize growth. Yield of grain and stover were lower than expected. The magnitude of yield reduction due to Striga varied according to different trap crops. There were significant differences between the treatments.

Based on maize vigor and yield, the best trap crops for maize appeared to be (in decreasing order) Crotalaria, cowpea and cotton. Grain yields, stover yields and maize prolificacy were relatively better when maize was planted after these trap crops. As compared to Crotalaria, the grain yield decrease of maize was 16% after cotton, and 34% for groundnut; while stover decrease yield was 30% after cotton, and 46% after groundnuts. Maize had a relatively low performance when planted after the other trap crops used in the trial (groundnuts, soybean, pigeon peas, and bambara groundnuts). Similar results were observed after groundnuts in another experiments in a nearby field. Maize had a reduced stand and vigor after bambara groundnut and pigeon peas. This was partly due to termite damages in these plots.

Regarding the Striga count, on the average, the amount of emerged Striga was higher after groundnuts and lower after bambara groundnuts and pigeon peas. Although the Striga count was relatively high after Crotalaria and cowpea, the impact of Striga was apparently, not so severe on maize in these treatments.

2) **Sorghum:** As compared to maize, Sorghum Damougari was less affected by Striga in its vegetative development and organs. Striga seems to have had more impact in the panicle, size and weight of grain of sorghum. Consequently the yield was reduced to a lesser degree than maize. **Based on crop vigor and yields** the best trap crops for sorghum seemed to be (in decreasing order): Crotalaria, cotton and cowpea. After the other trap crops: soybean, pigeon peas, and bambara groundnuts, the performance of sorghum was not satisfactory. The sorghum performance after groundnuts was satisfactory as compared to maize performance. More research is needed to confirm these results and to understand the differential impact of these trap crops.

Concerning the Striga count, for the sorghum crop the amount of emerged Striga was relatively higher after cowpea, groundnut, and cotton. However, the impact of Striga was not so severe on sorghum yield after these trap crops.

VII a. RESPONSE OF MAIZE VARIETIES TO DIFFERENT TIMES AND TYPES OF WEED CONTROL IN THE LOWLAND SAVANNA OF NORTH CAMEROON, SANGUERE, DJALINGO 1990 - GRAIN YIELD (T/HA.

Weed Control Treatments	Sanguere				Djalingo			
	CMS-8501	RGY%	CMS-8806	RGY%	CMS-8501	RGY%	CMS-8806	RGY%
1. No Weeding	3.98	100	3.01	100	1.99	100	1.77	100
2. Keeping plot weed free	6.85	172	5.57	185	6.02	303	4.99	262
3. Weeding at 2 W A E	5.22	131	4.46	148	3.93	197	3.33	188
4. Weeding at 3 W A E	6.23	157	4.77	158	4.47	225	3.89	220
5. Weeding at 4 W A E	5.26	132	3.77	125	4.30	216	3.92	221
6. Weeding at 5 W A E	4.57	115	3.18	106	3.50	176	3.39	192
7. Weeding at 6 W A E	4.60	116	3.60	120	3.35	168	3.04	172
8. Weeding at 2 + 4 W A E	5.88	148	4.80	159	5.14	258	3.54	200
9. Weeding at 2 + 5 W A E	6.09	153	5.05	168	5.10	256	4.26	241
10. Herbicide only	4.95	124	4.19	139	4.28	215	3.80	215
11. Herbicide + weeding 4 W A E	6.18	155	4.77	158	4.97	250	4.54	256

Note : W A E : Week after maize emergence.
Weeding was done with a hoe. Herbicide used was LASSO GD (4 l/ha)
RGY% : Relative Grain Yield in %

For Sanguere : F_{TR} = N.S.; $F_{Var.}$ = N.S.; $F_{Var. \times TR}$ = N.S.; $LSD_{TR.}$ = 0.38 t/ha; C.V. 9%.
For Djalingo : F_{TR} = N.S.; $F_{Var.}$ = N.S.; $F_{Var. \times TR}$ = S.; $LSD_{TR.}$ = 0.35 t/ha; C.V. 10%.

Table VII b. EFFECT OF DIFFERENT TRAP CROPS ON STRIGA INCIDENCE AND ON PERFORMANCE OF MAIZE AND SORGHUM GROWN IN A STRIGA INFESTED SOIL ON MAIZE AND SORGHUM.

Trap Crops (as preceding crops).	Maize Grain Yield (t/ha)	Maize Prolificacy	Maize Stover t/ha	Average Striga count on Maize (2.40 m²)	Sorghum Grain Yield (t/ha)	Sorghum Stover Yield (t/ha) (2.40 m²)	Average Striga count on Sorghum (per 2.40 M²)
1- Cowpea	4.70	0.76	2.70	43	2.78	3.30	130
2- Groundnuts	3.31	0.69	1.59	101	2.56	3.01	106
3- Cotton	4.21	0.86	2.04	64	2.92	3.06	98
4- Pigeon peas	2.25	0.64	1.39	24	2.03	2.38	11
5- Soybean	2.69	0.70	1.65	66.2	1.93	2.81	14.4
6- Bam. ground.	2.52	0.60	1.36	7.3	1.73	2.78	33.6
7- Crotalaria	5.03	0.87	2.90	55	2.96	3.33	91

For grain yield of Maize : $F_{TR.}$ = N.S.; C.V. = 16%; Stover Maize : F = N.S.; C.V. = 17%; $LSD_{(0.05)}$ = 0.49 t/ha
For Sorghum grain yield : F_{TR} = S.; C.V. = 15%; LSD (0.05) = 0.53 t/ha; Stover Sorghum : F = N.S.; LSD (0.5) = 0.52 t/ha

5. SORGHUM AND MILLET RESEARCH UNIT

Sorghum and pearl millet are the major cereals cultivated throughout the three provinces of northern Cameroon. The combined production of sorghum and pearl millet during the 1988-89 crop season reached 515,621 metric tons in the North and Extreme North Provinces. Rainy season sorghum (June-October) constituted about 70% of total production. Transplanted sorghum grown in the postrainy season (October-February), called "Muskwari", and pearl millet (June-October) constituted 25% and 5% of total production. The area under pearl millet is limited in comparison to that of sorghum. Average yields of rainy season sorghum and muskwari are 1195 kg/ha and 1140 kg/ha, respectively. The average yield of pearl millet is 928 kg/ha.

5.1 SORGHUM AND MILLET BREEDING

5.1.1. INTRODUCTION

This is the ninth year of the sorghum and pearl millet improvement program. The primary objective continues to be breeding suitable cultivars of sorghum and millet that give higher yields with greater stability across a range of environments. These cultivars should be resistant to diseases and pests of good grain quality acceptable to farmers and tolerant/resistant to Striga hermonthica and drought stress. Attention is being given to the development of sorghum and pearl millet varieties as well as sorghum hybrids as agreed upon at the regional program planning meeting held in Maroua during January, 1990.

With the onset of rains in June, the sorghum and millet research began in Maroua at Guiring Research Station and seven other locations in the northern-Cameroon: Tchatibali, Guetale, Soucoundou and Sanguere sub-stations; Yoldeo and Ndonkole farmer's field and Lagdo Gounougou. The research activities cover two ecological zones as determined by rainfall. Zone I has a rainfall range of 300-800mm where both sorghum and millet are grown. Zone II has rainfall range of 800-1200mm and sorghum is grown.

The total rainfall received at Guiring, Tchatibali, Guetale, Soucoundou and Yoldeo during the 1990 crop season was 566.2, 618.0, 766.0, 955.0, and 402.8mm, respectively. The total amount of rain received this year was considered to be abnormal/drought in all locations and the distribution was erratic causing moisture stress during the phases of crop growth. The stress was particularly severe at Guiring, Yoldeo and Tchati-bali where the soil is light textured and holds a limited quantity of available moisture.

The erratic rainfall pattern again indicates that the breeding program should continue to develop short cycle cultivars of sorghum and pearl millet (less than 90 days) for Zone-I. Similarly, considering the long term rainfall pattern Zone-II, sorghum varieties of medium maturity (100-130 days) should be preferred to avoid late season rainfall coinciding with grain development which causes grain mold.

The sorghum and pearl millet improvement program also faced the following major problems during the 1990 crop season:

A. Seed storage continues to be the major problem because of high temperature in March - May which affects the viability of breeding materials. Therefore, there is an urgent need of cold storage for breeding materials at IRA, Maroua.

B. Non-availability of recent literature, books and periodicals on sorghum and pearl millet crops of various disciplines in the IRA, Maroua library retarded researchers professional development.

5.1.2 OUTPUTS AND ACCOMPLISHMENTS

GOAL: To increase sorghum and pearl millet production through the development of improved cultivars and hybrids in North Cameroon.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
A. RAINY SEASON SORGHUM BREEDING		
1. Varietal development program for different ecological zones within North Cameroon.	1. Presently the Genetic materials are in F1 to F5 generations. It will require another 2.5 years for testing.	1.1 36 F1 crosses were developed in the Line x Tester mating design involving fifteen parents. Also 10 F6 bulk involving Striga resistant parents were selected under Striga infested conditions for regional trials of West and Central Africa.
		1.2. 81 F2 crosses, 77 F3 progenies, 157 F4 progenies, 9 F5 progenies and 54 F6 progenies from various crosses were selected and threshed separately to achieve the long term objective of this sub-goal.
2. Varietal testing program for different ecological zones in the North Cameroon.	2. Cultivar available, IRA research report and impact of farmer's level of developed cultivars.	2.1 The West African Sorghum Trial from ICRISAT, Mali of 20 entries tested at Guiring and Sanguere. None of the entries outyielded national check varieties S-35, CS-61 and CS-95.
		2.2 The International Sorghum Variety and Hybrids Adaptation Trials tested in this crop season helped us to identify four superior hybrids which gave more than 12% higher yield than national check varieties CS-54.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
		2.3 The multilocation sorghum variety trial early duration in Far North provinces indicated that genotypes Magawhite, ICSV-111, CS-54, Barlang and CS-210 gave consistently higher yield performance over locations in this zone. Similarly in the medium duration trials none of the genotypes gave higher yield as compared to check variety CS-95 but the genotypes namely CS-214 and CS-251 were observed to be tolerant to grain mold.
3. To identify a genotype holding a good level of Striga resistance out of the developed agronomically elite breeding materials under heavy Striga infestation.	3. Cultivar available resistance to Striga hermonthica for direct use in the national program as parents or varieties.	3.1 Test of National Sorghum Striga Nursery conducted this year again confirmed that CS-95, has as much or more resistant to Striga hermonthica as the resistant variety Franida.
		3.2 Test of the West Africa Sorghum Striga Trial conducted for the third year showed S-35, ICSV-1079 and ICSV-1164 to have similar or more resistance to Striga hermonthica as the resistant variety Franida.
4. Hybrids development program including (A,B and R lines) for different ecological zones in the North Cameroon.	4. This is the fifth year for this program and will need at least one more year.	4.1 During 1990 crop season, the sorghum program has succeeded in developing 110 new hybrids. Also their parents (A,B and R lines) were maintained.
5. Hybrid testing program.	5. Fourth year of testing and will need one more year to identify hybrid having 20% higher yield than existing best cultivars.	5.1 The CSHON and WASHAT including check varieties S-35, CS-95 and CS-54 were evaluated at Guiring and Sanguere. Hybrids ICSH-89007,DCSH-22 and 25 outyielded all the check varieties more than 2% at Guiring, whereas the hybrids ICSH-89011, ICSH-780, DCSH-25, and H-8920 gave more than 30% at Sanguere. They also have good plant type and resistance.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
6. Development of Nucleus/Breeder's seed of promising sorghum cultivars.	6. Breeders seed available to sorghum researchers and seed multiplication agency to reach to the farmers.	6. The nucleus seed of 30 selections were developed for various trials. Also twenty promising local and developed selection breeder's seeds were multiplied for sorghum researchers and multiplication agencies.
B. MUSKWARI SORGHUM BREEDING		
7. Varietal testing program of Muskwari sorghum.	7. Cultivars available with defined traits.	7.1 The data compilation of the muskwari germplasm planted during 1989-90 are in progress.
C. PEARL MILLET BREEDING		
8. Varietal development program of pearl millet for the semi-arid zone of North Cameroon.	8. Presently genetic materials are in F6 generation. It will require a year to have genetic materials ready for testing.	8. Fifty eight advanced generations progenies were harvested and threshed separately after final selection for future advancement and testing. High 1000 grain weight and earliness compared with check Mouri, resistant to major three diseases and effective tillering were observed as desirable traits.
9. Varietal testing program of pearl millet.	9. Cultivar available like IKMV-8201 having desirable traits and higher yield than local cultivars. To achieve 10-15% higher yield than existing cultivars in a year period.	9.1 The multiplication variety adaptation yield trial including check IKMV-8201 and Mouri evaluated at three locations in Far-North province. The newly developed short cycle varieties yield highest at Guetale which is pearl millet growing zone. The varieties namely CPM-24, CPM-21 and CPM-11 gave more than 1% higher yield than exotic check variety IKMV-8201 and more than 25% than local check Mouri.

5.1.3 OTHER ACTIVITIES

The IITA breeder visited ICRISAT, India during the month of March, 1990 to discuss the 1989 results and 1990 Work Plan. He also delivered a seminar on muskwari sorghum improvement program in Cameroon. The trip was linked with home leave. National Sorghum Breeding Program technician Mr. Bilangsou Emmanuel left for ICRISAT headquarters, India for 9 months training in sorghum breeding field techniques during March, 1990 and joined the national program during the first week of Dec., 1990.

Mr. Kenga Richard, the national counterpart Sorghum Breeder, had attended the Regional Sorghum group meeting at Kano, Nigeria from 10-12 September, 1990. The NCRE Sorghum Breeder attended the Steering Committee meeting of West and Central Africa Network of SAFGRAD/ICRISAT during May, 1990 at Niamey, Niger. Both breeders also attended the Regional Pearl Millet Workshop at Niamey, Niger and presented a paper entitled "Progress of Pearl Millet Research in North-Cameroon". The NCRE sorghum breeder also assisted the sorghum network coordinator to review the Tchad national sorghum program in Oct., 1990.

Composite soil samples from sorghum breeding fields at Guiring, Ndoukole, Tchatibali and Yoldeo-1 (sorghum) and Yoldeo-2 (pearl millet) were sent to IITA, Ibadan, Nigeria for mechanical and chemical analysis. The results have not yet been received.

5.1.4 RESEARCH FINDING

5.1.4.1 Sorghum_Breeding

The details of sorghum and pearl millet breeding experiments conducted during 1990 rainy season with date of sowing, number of entries, number of replications, plot size, and locations are given in Table 1. All the experiments were conducted in a replicated trial, except F1 and advanced generations. Fertilizer application (60 Kg N 20; Kg P205 and 20 kg K20/ha) was uniform for all the experiments. Nitrogen was applied in two split doses, whereas P205 and K20 were applied before sowing. The plant density was kept at 83,333 plants per hectare having a row to row distance of 80 cm and plant to plant distance of 15cm. Four to five seeds were sown per hill but at final thinning one plant per hill was maintained. Wherever a gap occurred, they were filled by transplanting seedlings.

Data on days to 50% flowering, plant height, days to maturity, plant count after final thinning, plant and panicle weight and grain yield were recorded and statistically analyzed for all the yield trials. In addition, data on other traits like early vigour, scores on diseases, pests, peduncle exsertion, lodging and senescence etc. were also recorded. The results will be presented in the 1990 Sorghum and Pearl Millet Improvement Program's Annual Report of IRA. The results in brief are presented below:

5.1.4.1 West_African_Sorghum_Variety_Adaptation_Yield_Trial_(WASVAT)-1990 (Early_Duration-ICRISAT,_Bamako,_Mali)

Twenty entries were evaluated at Guiring, Maroua. S-35, a contribution from our program in Cameroon, were chosen as local check variety. Data on grain yield and other traits of selected entries are given in Table 2. The F test was found to be significant at 1%

level for all the traits. Entry S 35 ranked first and yielded 6749 kg/ha followed by CS-61 (6595 kg/ha), ICSV-1079 BF (6520 kg/ha) and CS-54 (6262 kg/ha). The other check varieties ICSV-111 IN and Nagawhite ranked 4th and 7th and yielded 6312 and 6229 kg/ha., respectively. The variety Nagawhite was observed to be susceptible to various foliage diseases, whereas the genotypes S-35, CS-61, ICSV-1179 BF, CS-54 and ICSV-111 IN were observed to be resistant to foliage diseases like grey leaf spot (Cercospora Sorghii), Oval leaf spot (Ramulispora sorghicola), shooty strip (Ramulispora sorghii), leaf anthracnose (Colletotrichum graminicola), and leaf tar spot (Phyllachora sorghii); resistant to grain disease particularly long smut (Tolyposporium ehrenbergii) and Stem borer (Chilo partelus). Moreover, they also matured early (less than 90 days) and were medium in plant height and higher in 1000 grain weight (Table 2).

5.1.4.1.2. West African Sorghum Variety Adaptation Yield Trial (WASVAT)-1990 (Medium Duration-ICRISAT-Bamako, Mali)

Twenty entries including check variety CS-61, a contribution from our program in Cameroon, were evaluated at Sanguere (North province). The data on grain yield and other traits of selected entries are presented in Table 2. The F test was found significant at 1% level for all the traits, except plant count after final thinning indicating wide genetic variability for these traits. The introduced varieties SEPON-82,F2-20 and ICSV-1063 outyielded the Cameroon developed variety CS-95 and local check CS-61 more than 3 percent. The genotype SEPON 82 ranked first and yielded 2487 kg/ha followed by F2-20 (2470 kg/ha), ICSV 1063 (2404 kg/ha), and CS 95 (2362 kg/ha). The local check CS 61 ranked 6th and yielded 1945 kg/ha. These were observed to be resistant to various foliage diseases and pests, medium in maturity cycle and medium in plant height.

5.4.1.3. West African Sorghum Hybrid Adaptation Yield Trial (WASHAT)-1990 (ICRISAT-Kano, Nigeria)

Twenty entries including the highest yielding improved check varieties S 35 and CS 95 were evaluated at Guiring and Sanguere, respectively. The data on grain yield and other traits of selected entries are presented in Table 2. The F test was significant at 1% level for all the traits. Considering the grain yield, none of the hybrids outyielded the check variety S-35 at Guiring, whereas at Sanguere, the hybrids ICSH-89001 ranked first and yielded 3858 kg/ha followed by ICSH 780 (3616 kg/ha) and ICSH-89012 (3583 kg/ha). The check variety ICSH-111 and CS 95 ranked 13th and 20th and yielded 2745 and 1062 kg/ha at Sanguere (North province), respectively. These hybrids were also observed to be medium in maturity, semi dwarf in plant height, possessed semi loose and long panicle with good exsertion and smaller grains compared with check varieties CS 95 and ICSV 111.

5.1.4.1.4 International Sorghum Variety and Hybrid Adaptation Yield Trial (ISVHAT)-1990 (ICRISAT-CCRN, India)

Thirty six entries including a local check variety CS-54 were evaluated at Guiring, Maroua. The data on grain yield and other traits of selected entries are presented in Table 2. The F test was found to be highly significant at 1% level for all the traits. Considering the grain yield, the hybrids ICSH 566 ranked first and yielded 7012 kg/ha followed by ICSH-110 (6716 kg/ha), CS-251 (6663 kg/ha) and ICSH-88038 (6608 kg/ha). The local check variety

CS-54 ranked 8th and yielded 6216 kg/ha. Moreover, considering the yield, three hybrids out-yielded the local check variety CS-54 in this trial, whereas it ranked among the best four varieties. In addition, newly developed varieties of our national program appeared to be promising in this trial.

5.1.4.1.5 Characterization of Sorghum Test Locations Environment Trial (CSTLET)-1990 (ICRISAT-CCRN-Patancheru, India).

Twelve entries were evaluated in this trial including S-35 a contribution of our Cameroon national program at Guiring, Maroua. The data on grain yield and other trials of selected entries are given in Table 2. The F test was significant for all the traits under study. Considering the grain yield (kg/ha), the entry Nagawhite ranked first and yielded 6390 kg/ha followed by S-35 (6250 kg/ha), ICSH-111 (5293 kg/ha) and IRAT-204 (5218 kg/ha). The varieties Nagawhite and IRAT-204 were observed to be susceptible to various foliage diseases, whereas variety S-35 was observed to be resistant to various foliage diseases, early in maturity, medium in plant height and highest in 1000 grain weight among the genotypes evaluated under this trial.

5.1.4.1.6. Cameroon Sorghum Hybrid Observation Nursery (CSHON)-1990

Thirty entries including local check varieties S-35, CS-54 and CS-95 were tested at Guiring and Sanguere locations with three replications. Considering the grain yield (kg/ha) and other desirable traits two hybrids namely DCSH-22, DCSH-25, DCSH-24, H-3320 and H-8318 were selected at both locations (Table 2). At Guiring, these hybrids outyielded the best local check varieties CS-54 more than two percent, whereas at Sanguere, they outyielded the best check S-35 more than 30%. The above mentioned high yielding hybrids were observed to be early in maturity, semi-dwarf to medium in plant height, possessed longer and semi-loose panicle, smaller in 1000 grain weight compared with local check varieties. Moreover, these hybrids were observed to be resistant to various foliage diseases, pest, lodging and good in overall plant characters.

5.1.4.1.7 National Sorghum Striga Nursery (NSSN-1990)

Twenty one entries including resistant check Framida and a susceptible check CK60B were grown at Ndonkole (near Maroua), on a farmer's field where the Striga population was very high. The objective of this trial is to identify a sorghum line resistant to Striga hermonthica under field conditions. To build up sufficient Striga population, Striga seed were added every year since 1987 before sorghum planting. A checker board layout developed at ICRISAT for field screening against Striga was used. The data on grain yield (kg/ha) and other traits are presented in Table 3. The F test was found significant at 1% level for all the traits, except Striga count at 60 days after planting, Striga count at harvest and plant count at harvest. The genotype CS-251 ranked first and yielded 5362 kg/ha followed by CS-210 (4983 kg/ha), CS 95 (4750 kg/ha), CS 278 (4701 kg/ha) and resistant check Framida (4266 kg/ha). The resistant check Framida ranked 11th among the twenty one entries tested. The susceptible check ranked 21st and yielded 928 kg/ha. The new selections namely CS-251 and CS-210 outyielded the earlier tested genotypes namely Framida, CS-54, and S-35. The genotype CS-95 again confirmed their resistance to Striga hermonthica rather than the hitherto known resistant check variety Framida (Table 3), whereas CS-251 and CS-210 appeared to be tolerant to Striga hermonthica. More over, genotypes CS-251 and CS-210 are an early maturity group (90 days) and CS-95 is 105 days maturity, possessing desirable morphological traits, good in grain quality aspects and resistant to most diseases. These genotypes will be reconfirmed during the 1991 crop season under this trial.

5.1.4.1.8. West and Central Africa Sorghum Striga Trial (WCSST)-1990

Twelve entries including a resistant check Framida (ICSV-1001 BF), and local check S-35 were evaluated at Ndonkole on a farmer's field where Striga population was very high during 1989 crop season as sorghum was cultivated. This trial was conducted in the same field after addition of Striga seed before sorghum planting to build up sufficient Striga population. The data on grain yield and other traits are presented in Table 3. The F test was not found significant at the 1% level for all the characters under study except days to flowering. Considering the grain yield, the genotypes ICSV-1164 BF, ranked first and yielded 4291 kg/ha followed by ICSV-1079 BF (4286 kg/ha), ICSV-1112 BF (3942 kg/ha) and S-35 (3755 kg/ha) resistant check ICSV 1001 BF or Framida ranked 6th and yielded 2880 kg/ha. The genotypes namely ICSV-1079 BF, ICSV-1061 BF, ICSV-1112 BF, and S-35 appeared to be similar in resistance like ICSV-1001 BF or Framida (Table 3).

5.1.4.9. Multilocation Sorghum Variety Adaptation Yield Trial (MSVAT) (Early Duration-Far-North Province)

Based on 1988 and 1989 results, twenty five entries were evaluated on the same locations of 1990 crop season namely Yoldeo, Tchatibali and Soucoundou. The data on grain and other traits were statistically analyzed. The pooled analysis of variance for all the characters also followed and it revealed that F tests due to genotype and genotype x location were significant at 5% level indicating that there were differences among genotypes as well as between the locations. The mean performance of grain yield over locations and other traits are presented in Table 4. Considering the grain yield over location, the genotypes Nagawhite ranked first and yielded 3256 kg/ha followed by ICSV 111 (3037 kg/ha), CS 54 (2691 kg/ha), Barlang (2642 kg/ha) and CS-210 (2633 kg/ha). The genotypes Nagawhite and Barlang were observed to be susceptible to various foliage diseases and chalky in grain aspect, whereas the genotypes ICSV-111, CS 54, and CS 210 were observed to be resistant to various foliage diseases. They also matured early (less than 90 days) and were higher in 1000 grain weight. Therefore, these genotypes CS 54, ICSV 111 and CS 210 should be further used for agronomically and on farm testing in the Far North province.

5.1.4.1.10. Multilocation Sorghum Variety Adaptation Yield Trial (MSVAT)- 1990 (Medium Duration)

The objective of this trial was also to find ideal types of genotypes in the sub-humid zone. Twenty new selections including a check variety CS-95 were evaluated at three locations namely Lagdo, Gounougou, IRA sub stations of Sanguere and Soucoundou. The pooled analysis of variance for all characters revealed that F test due to genotype and variety x location were significant at 1% level indicating that there were differences among genotypes as well as between the locations. The mean performance of grain yield and other traits over locations of selected entries are presented in Table 5. Considering the grain yield over locations, the check variety CS-95 ranked first and yielded 2534 kg/ha followed by CS-244

(2395 kg/ha), CS-251 (2184 kg/ha), CS-233 (2110 kg/ha) and CS-124 (2042 kg/ha). These selections were observed to be resistant to foliage diseases and pests, low in grain mold scores as compared with CS-95, more than 90 days in maturity cycle, medium in plant height and at par in grain aspects with CS-95 and good in panicle exsertion. In addition, the selection CS-251 has white pericarp whereas, CS-124 and CS 244 has brown pericarp with white endorsperm. The genotypes CS-251 and CS-244 reconfirmed their superiority in terms of low grain mold scores and at par in grain yield with CS-95 give further scope for agronomic studies to increase the sorghum production in North province.

5.1.4.2. Hybridization and Selection Program

The long term objective of this program is to improve local varieties through artificial hybridization followed by selection. The breeding program is directed to meet two broad objectives (1) development of improved early varieties (less than 90 days) for the semi-arid zone (less than 900mm rainfall) and (2) development of improved medium maturity varieties (100-140 days) for the sub-humid zone (more than 900mm rainfall).

5.1.4.2.1 Hybridization Program

Thirty local and exotic varieties were identified during the 1989 crop season at various locations having maturity duration of 85-180 days, good in agronomic and other desirable traits, resistant/tolerant to various diseases, pests and Striga aspects. These were grown at Guiring Station. Crosses were made by hand emasculation and artificial pollination during crop season. A total of 36 F1 crosses were developed in a Line x Tester mating design without reciprocals and more than 120 seeds of each cross were obtained. These F1 crosses will be grown during 1991 crop season for genetic studies and the selfing program will be followed to obtain F2 seed.

5.1.4.2.2 Selection Program

F1 Generation

Eighty one F1's crosses were grown at Guiring Research Station during the 1990 crop season. Selfing was followed for all the crosses to advance them to F2 generation. They will be grown at Guiring and Sanguere according to maturity cycle with the plant population of 2500 to 3000 plants of each cross to follow the selection program during 1991 crop season.

F2 Generation

Thirteen crosses were grown at Guiring during 1990 crop season to follow the selection program. The selected plant were tagged and selfed in each cross. A total of 77 single plants were harvested from all crosses after final selection at Guiring. These single plants were threshed separately and their F3 single plant progenies will be grown during the 1991 crop season for further selection.

F3 Generation

Three hundred and thirty one single plant progenies in F3 generation were grown at Guiring. Selection and selfing were followed during the crop season. In all, 157 progenies were harvested separately after final selection. These progenies were threshed separately and their F4 progenies will be grown during the 1991 rainy season for further selection.

F4 Generation

A total of 22 progenies selected during the 1989 rainy season were grown at Guiring. Selection and selfing were followed during the crop season. In all, 9 progenies were harvested separately after final selection and threshed separately. These will be evaluated during the 1991 rainy season according to their maturity cycle in different zones.

F5 Generation

A total 102 progenies of 31 crosses selected during 1989 were grown at Guiring during the 1990 crop season. In all, 54 progenies of 21 crosses were harvested and threshed after final selection. These will be evaluated during the 1991 rainy season under uniform progeny yield trials in both zones according to their maturity cycle.

In addition, nineteen F5 bulk populations which were selected from the crosses having Striga tolerant parents during the 1989 rainy season from Striga infested fields at Ndonkole were grown at the same field where Striga population was very high. In all, 10 F6 bulk populations were selected after selfing and selection during the crop season. These will be used for the West and Central Africa Sorghum Striga Trial for the 1991 crop season for the Regional Sorghum Network.

Population Improvement Program: The 225 populations introduced from ICRISAT, India program were grown in single row plots with two replications in isolation. During the crop season, random matings were allowed among these population and selections were followed at harvesting. In all, 225 were maintained and will be grown during 1991 crop season.

5.1.4.2.3 Hybrid Development Program

The objective of this program is to identify male sterile lines as well as restorers to develop hybrids superior to open pollinated varieties suitable for rainfed and irrigated conditions in different ecological zones of Northern Cameroon. To meet this objective, 48 B/A pairs of sorghum from different program of ICRISAT, Texas A&M University and Mexico along with open pollinated promising selections were grown at Guiring. During the crop season 22 B/A pairs of sorghum and all the R lines were maintained by selfing and artificial pollination. Moreover, 110 new F1 hybrids were developed. These will be grown during the 1991 rainy season along with the best performing hybrids this year to study their yield performance as well as for further selection.

5.1.4.3 Muskwari (Transplanted Sorghum) Program

In all, 210 accessions of local muskwari sorghum collected during 1988-89 crop season jointly in collaboration with ICRISAT, Genetic Resources Unit and our national team throughout the North-Cameroon were transplanted on 16 Oct., 1989 at IRA Salak to be further evaluated, classified, and maintained. The data on quantitative agronomic and qualitative traits are recorded during Jan.-Feb., 1990. The data are under compilation and statistical analysis.

5.1.4.4. Pearl Millet Breeding Program

All pearl millet experiments approved were planted on July 10-20, 1990 at Guiring and other locations. No fertilizer was applied. The plant density was kept at 41,666 plants per hectare having a row to row distance of 80 cm and plant to plant distance of 30 cm. Three to four seeds were sown per hill. At final thinning, one plant per hill was maintained for all the pearl millet experiments. The results are presented and discussed below in brief.

5.1.4.4.1 Advanced Generations

All 58 advanced generations selected during the 1989 were grown during 1990 crop season at Guiring. The selection and selfing program was followed during the crop season. The 56 progenies were harvested separately and threshed for further evaluation during the 1991 crop season.

5.1.4.4.2 Multilocation Pearl Millet Variety Adaptation Trial (MPMVAT-1990):

On the basis of the 1989 encouraging results of this trial, fourteen entries including new check varieties namely IKMV-8201 and Mouri were repeated at the same locations namely Tchatibali, Yoldeo and Guetale during 1990 crop season in the Far-North province. The data on quantitative traits were statistically analyzed for each of the three locations as well as over locations. The F test was found significant for all the locations except Tchatibali. The data for grain yield and other traits over locations of selected varieties are presented in Table 6. Taking into consideration the grain (kg/ha), the improved short cycle selections yielded lower than local check Mouri at Tchatibali, whereas they yielded highest at Guetale and Yoldeo locations. The genotype CPM-24 ranked first and yielded 2319 kg/ha followed by CPM-21 (2301 kg/ha), CPM-14 (2291 kg/ha) and check variety IKMV-8201 (2282 kg/ha). The local check Mouri ranked 12th and yielded 1775 kg/ha. Most of local varieties tested in this trial are more than 95 to 110 days maturity cycle whereas newly developed varieties were early in maturity (85 to 90 days), tolerant to ergot, smut and downy mildew. To conclude, this trial will be repeated during the 1991 crop season on the same locations to reconfirm the results for recommendation of pearl millet varieties in different zones within Far North Province.

TABLE 1: LIST OF SORGHUM AND PEARL MILLET TRIALS AND NURSERIES PLANTED DURING 1990 RAINY SEASON

A: RAINY SEASON SORGHUM:

SERIAL NUMBER	NAME OF TRIAL/NURSERY	DATE OF SOWING	NO.OF ENTRIES	PLOT SIZE (M^2)	NUMBER OF REPS	LOCATION
1.	WASVAT-90 (EARLY)	30.6.90	20	16	3	GUIRING
2.	WSVAT-90 (MEDIUM)	6.7.90	20	16	3	SANGUERE
3.	WASHAT-1990	30.6.90	20	16	3	GUIRING
		6.7.90	30	16	3	SANGUERE
4.	ISVHAT-1990 (MEDIUM)	30.6.90	36	16	3	SANGUERE
5.	CSILET-1990	30.6.90	12	16	3	GUIRING
6.	CSHON-1990	29.6.90	30	16	3	GUIRING
		6.7.90	30	16	3	SANGUERE
7.	NSSH-1990	5.7.90	21	8	4	NDONKOLE
8.	WCASST-1990	5.7.90	12	8	3	NDONKOLE
9.	NSVAT-1990 (EARLY-EXTREME NORTH PROVINCE)	12.7.90	25	16	3	TCHATIBALI
		12.6.90	25	16	3	SOUCOUNDOU
10.		19.6.90	25	16	3	YOLDEO
11.	NSVAT-1990 (MEDIUM-NORTH PROVINCE)	9.7.90	20	16	3	GOUNOUGOU
		5.7.90	20	16	3	SOUCOUNDOU
		6.7.90	20	16	3	SANGUERE
12.	CROSSING PROGRAM	27.6.90	30	80	-	GUIRING
13.	MAINTENANCE OF MALE STERILE LINES & HY.DEVE.	27.6.90	48	9	-	GUIRING
14.	F1 GENERATION	29.6.90	81	4	-	GUIRING
15.	F2 GENERATION	29.6.90	13	200	-	GUIRING
16.	F3 GENERATION	29.6.90	331	16	-	GUIRING
17.	F4 GENERATION (BULK)	29.6.90	22	16	-	GUIRING
18.	F5 GENERATION	29.6.90	102	16	-	GUIRING
19.	F5 GENERATION (BULK)	5.7.90	19	24	-	NDONKOLE
20.	BREEDER SEED MULTIPLI-CATION OF SORGHUM AND MILLET VARIETIES	30.6.90	20	200	-	GUIRING
B.	PEARL MILLET					
21.	NEWVAT-1990 (EXTREME NORTH PROVINCE)	13,&16.7.90	14	16	4	TCH., & GUETALE YOLDEO
22.	F5 GENERATION	13.7.90	58	20	-	GUIRING

Table 2: WEST AFRICA AND INTERNATIONAL SORGHUM VARIETY AND HYBRID ADAPTATION YIELD TRIAL-1990

TRIAL	SELECTED ENTRIES	DAYS TO 50%** FLOWERING	PLANT HEIGHT** (CM)	1000 GRAIN** WEIGHT (GRAMS)	GRAIN YIELD* (KG/HA)	%INCREASE OVER BEST CHECK
WASVAT (EARLY)	CS-54	56	207	36.6	6262	-
	CS-61	56	194	37.7	6595	-
	ICSV-1079	59	211	21.2	6520	-
	ICSV-111	56	215	36.9	6312	-
	S-35 (CHECK)	56	218	34.0	6779	
	L.S.D. AT 5%	54	29.7	4.4	1143	
	C.V. (%)	5.5	8.4	8.7	12.3	
WASVAT (MEDIUM)	SEPON-82	55	160	18.9	2487	5.2
	F2-20	71	178	25.2	2470	4.5
	ICSV-1063	69	187	26.8	2404	1.6
	CS-95	63	192	29.3	2362	-
	CS-61 (CHECK)	68	186	27.8	1945	
	L.S.D. AT 5%	7.8	29.6	3.9	596.8	
	C.V. (%)	6.4	8.4	10.1	27.8	
WASHAT (GUIRING)	ICSH-89007	55	178	22.2	7325	2.0
	ICSH-507	55	210	22.2	6679	-
	ICSH-89004	56	200	22.7	6620	-
	ICSH-89014	55	220	27.5	6495	-
	S-35 (CHECK)	55	225	32.9	7179	
	L.S.D. AT 5%	2.3	20.8	3.1	847.9	
	C.V. (%)	2.7	6.7	8.4	8.9	
WASHAT (SANGUERE)	ICSH-89011	62	178	22.5	3858	40.5
	ICSH-780	58	170	23.9	3616	31.7
	ICSH-89012	62	169	22.5	3583	30.5
	ICSH-89006	66	180	21.3	3583	30.5
	ICSV-111 (CHECK)	67	198	27.9	2745	
	L.S.D. AT 5%	4.8	27.1	3.4	1498	
	C.V. (%)	4.8	10.2	9.6	34.5	
ISVHAT	ICSH-566	55	226	23.2	7012	8.4
	ICSH-88058	55	216	23.7	6608	2.1
	ICSH-110 (CHECK)	53	202	26.7	6470	
	ICSV-111	55	229	32.5	6425	
	CS-54 (CHECK)	58	222	32.9	6216	
	L.S.D. AT 5%	1.5	43.6	3.5	880.4	
	C.V. (%)	1.6	11.6	8.4	9.9	
CSTLET	NAGAWHITE	55	208	25.0	6390	2.2
	CSH-11	59	190	20.8	5293	-
	IRAT-204	51	143	28.2	5218	-
	S-35 (CHECK)	57	209	31.8	6250	
	L.S.D. AT 5%	3.3	19.6	3.4	731.4	
	C.V. (%)	3.7	6.8	9.0	10.4	

Table 2 Continued

TRIALS	SELECTED ENTRIES	DAYS TO 50%** FLOWERING	PLANT HEIGHT** (CM)	1000 GRAIN** WEIGHT (GRAMS)	GRAIN YIELD* (KG/HA)	% INCREASE OVER BEST CHECK
CSHON (GUIRING)	DCSH-22	57	276	30.0	7141	3.19
	DCSH-25	59	287	30.0	7015	1.4
	DCSH-24	58	273	28.0	6697	-
	CS-54 (CHECK)	58	238	32.6	6920	
	L.S.D. AT 5%	3.7	31.9	4.2	1302.0	
	C.V. (%)	3.9	9.1	9.6	13.5	
CSHON (SANGUERE)	H8320	59	148	19.0	3825	39.3
	H8318	62	156	19.7	3808	38.7
	DCSH-25	62	214	23.5	3583	30.5
	DCSH-24	62	238	27.1	3400	23.8
	S-35 (CHECK)	64	212	26.4	2745	
	L.S.D. AT 5%	5.2	36.5	2.7	1001.3	
	C.V. (%)	5.1	12.2	7.6	24.2	

*SIGNIFICANT AT 5% LEVEL; ** SIGNIFICANT AT 1% LEVEL.

Table 3: NATIONAL SORGHUM STRIGA RESEARCH PROGRAM (SCREENING)-1990
LOCATION: NDONGKOLE, NEAR MAROUA.

TRIALS	SELECTED	DAYS TO 50%** FLOWERING	1000 GRAIN** WEIGHT (GRAMS)	STRIGA COUNT AT 60 DAYS	STRIGA COUNT AT HARVEST	GRAIN YIELD** (KG/HA)
HSSN	CS-251	59	30.2	124166	114583	5362
	CS-210	56	35.2	131250	101666	4983
	CS-278	55	29.0	139166	152916	4704
	CS-95 (RES.CHECK)	56	29.9	147916	154583	4750
	FRAMIDA (RES.CHECK)	59	28.5	37916	42916	4266
	CK60B (SUS.CHECK)	53	23.0	247917	335000	928
	L.S.D. AT 5%	2.6	3.8	--	--	1101
	C.V. (%)	2.7	8.4	78.3	83.4	16.3
WCASST	ICSV-1164 DF	57	-	451562	347395	4291
	ICSV-1079 DF	59	-	154166	59895	4286
	S-35 (L.CHECK)	57	-	186458	83854	3755
	FRAMIDA (RES.CHECK)	60	-	96354	89583	2880
	L.S.D. AT 5%	4.6		--	--	--
	C.V. (%)	4.2		86.8	119.3	37.4

** SIGNIFICANT AT 1% LEVEL

Table 4: Multilocation Sorghum Variety Adapation Yield Trial-1990 (Early Duration-Far-North Province).

SELECTED ENTRIES	DAYS TO 50%** FLOWERING	1000 GRAIN** WEIGHT (GRAMS)	GRAIN YIELD (KG/HA) YOLDED**	TCHATIABLI**	SOUCOUNDOU	OVERALL MEAN	RANK
NAGAWHITE	62	25.5	3433	3400	2937	3256	1
BARLANG	67	28.1	2979	1995	2966	2647	4
GUEDENG-GUELING	67	29.9	2866	2341	2591	2600	6
CS-210	66	27.4	2983	2916	1881	2633	5
ICSV-111	63	26.5	2837	3375	2900	3037	2
CS-54 (CHECK)	62	28.0	2866	2704	2504	2691	3
S-35 (CHECK)	64	27.3	2616	2683	2316	2538	7
DAMOUGARI (CHECK)	67	24.3	2379	1016	2229	1875	21
MEAN	68	24.8	2565	2180	2039	2263	
L.S.D. AT 5%	4.9	4.1	572.8	1045	-	1010	
C.V. (%)	4.5	10.4	13.6	29.2	42.2	28.7	

** SIGNIFICANT AT 1% LEVEL.

Table 5: Multilocation Sorghum Variety Adaptation Yield Trial -1990 (Medium Duration-North Province).

SELECTED ENTRIES	DAYS TO 50% FLOWERING	PLANT HEIGHT	GRAIN YIELD (KG/HA) SOUCOUNDOU**	SANGUERE**	LAGDO** GOUN.	OVERALL MEAN	RANK
CS-244	62	215	2416	2588	2260	2395	2
CS-251	63	198	2083	2629	1810	2184	3
CS-233	63	233	1916	2762	1651	2110	4
CS-124	63	190	2500	1725	1901	2042	5
CS-333	64	226	1750	1908	2034	1897	6
ICSV-210	69	188	1833	2408	1312	1851	7
CS-95 (CHECK)	60	202	2666	2529	2407	2534	1
MEAN	67	211	1423	1668	1753	1615	
L.S.D. AT 5%	7.4	37.0	500.6	1206.5	459.8	775.8	
C.V. (%)	6.8	10.9	21.3	43.8	15.9	30.0	

* SIGNIFICANT AT 5% LEVEL; ** SIGNIFICANT AT 1% LEVEL.

Table 6: Multilocation Pearl Millet Variety Adaptation Yield Trial-1990 (Far-North Province).

SELECTED ENTRIES	DAYS TO 50%** FLOWERING	GRAIN YIELD (KG/HA)			OVERALL MEAN	% INCREASE OVER BEST CHECK
		YOLDEO*	TCHATIBALI	GUETALE**		
CPM - 24	55	2225	1346	3387	2319	1.66
CPM - 21	56	1912	1431	3559	2301	0.87
CPM - 14	57	1775	1609	3190	2291	0.40
CPM - 16	55	1925	1328	3459	2237	-
IKMV-8201 (CHECK)	56	1512	1759	3571	2281	
MOURI (CHECK)	69	1034	1481	2809	1775	
OVERALL MEAN	61	1567	1563	2962	2030	
L.S.D. AT 5%	5.5	765.2	706.0	905.7	773.0	
C.V. (%)	6.4	34.2	31.6	21.4	27.5	

* SIGNIFICANT AT 5% LEVEL; ** SIGNIFICANT AT 1% LEVEL.

5.2 SORGHUM AND MILLET AGRONOMY

5.2.1 INTRODUCTION

Most of the agronomic trials on sorghum and millet were conducted at the new IRA farm at Mouda, Ndonkole (on farmers field), Tchatibali, Guetale and Salak. In the fifth year of NCRE phase II, the research activities were expanded to tackle most of the major production constraints of sorghum and millet.

The major production constraints which were identified for rainy season sorghum includes low and poor inherent soil fertility, low and erratic distribution of rainfall, problem of the parasitic weed Striga, pests and diseases, limited use of animal traction and post harvest handling losses. For post rainy season transplanted sorghum (muskwari), the major production constraints are limited residual soil moisture in the profile, manual land clearing of weeds after rainy season and manual transplanting.

5.2.2 OUTPUT AND ACCOMPLISHMENTS

GOAL: To develop improved agronomic practices that will lead to higher and stable yields of sorghum and pearl millet.

Sub-Goal	Outputs	Accomplishments
RAINY SEASON CROPS		
1. Study on soil water conservation and fertility improvement through integrated approach of crop, leguminous trees.	1. Knowledge of optimum land management system to alleviate soil water conservation and maintenance of soil fertility in far-North province.	Experiment was planted with cowpea for uniform cropping. Tree and pigeon pea have been established according to treatment. Treatment crops will be grown in 1991 cropping season as an alley crop and tree-crop association. It is presumed that trial will continue for at least 4-5 years.
2. Develop fertilizer management practices for sorghum in different cropping systems.	2.1 Optimum rates on N,P and K for sorghum grown in different systems.	(a) Soil samples from sub-plots were collected, processed and sent to IITA for analysis. (b) Optimum yield of sorghum was obtained with 40:20:20 in most of the systems tested. (c) Lower rate of fertilizer needed in sorghum/groundnuts association

Sub-Goal	Outputs	Accomplishments
	2.2 Efficient production system.	Sorghum and other crops in association were planted in June. The results indicate that crop associations are more efficient systems of production of sorghum as compared to pure cultivation of sorghum.
	2.3 To reduce production risk under a sorghum/based system.	
	2.4 To find out the benefit of planting local/improved sorghum in different ratios.	Experiments were planted at three locations (Mouda, Tchatibali and Guetale). Data yet to be analyzed.
3. Identify appropriate cost effective technologies for rainy season sorghum and millet.	3.1 Quantification of payoffs to different inputs so as to recommend to farmers having different resource levels.	Results indicate that there is significant response to variety, fertility and tillage practices. A significant interaction between variety, fertility and tillage practices was obtained.
	3.2 Improved agronomic practices for millet.	Local millet variety Mouri was found to be inferior as compared to IKMV-8201 and CMP-17 at two locations. Late planting produced significantly lower yield compared to normal planting.
4. Develop management practices to reduce yield losses due to _Striga_, weed and insects.	4.1 Practices that reduce _Striga_ infestation.	All the field experiments on _Striga_ were carried out at Ndonkole. (1) Results indicate that crop associations such as cowpea and sorghum when planted within rows or on same hill are effective in controlling _Striga_. 2. Urea spray (20% solution) was found effective in killing _Striga_ plant beside other chemicals such as 2,4-D, Paraquat and Garlon. 3. Improved sorghum variety such as CS-54 or S-35 along with one preemergence herbicide and one spray of 2,4-D to _Striga_ was very effective in controlling _Striga_ and other weeds.

Sub-Goal	Outputs	Accomplishments
MUSKWARI SORGHUM		
5. Improve muskwari yield and evaluate the potential of double cropping on Vertisols in Far-North and North provinces.	5.1 Agronomic practices that may increase muskwari yields.	Rainy season crops were planted in June/July. Result of maize and cowpea indicates that there was no significant difference in yield of maize and cowpea when planted either on flat or ridge/furrow systems. Muskwari is in progress.
	5.2 Sequential double cropping technology that increases cropping intensity by 100% on some Vertisols.	
	5.3 To increase the productivity of Vertisols.	Results obtained on farmers field indicate that maize planted for green cobs was very effective in terms of total return followed by maize for grain and least was with cowpea.
6. Evaluation of animal-drawn equipment.	Low cost weeding, seeding, and ridging.	The animal-drawn implement (field leveller and plough) were evaluated and did well. It needs to be modified to reduce the draft.
7. Institutional development.	7.1 Counterpart scientist and 2 to 3 technicians trained.	One field technician was in training at ICRISAT, India. The other field technicians and counterpart agronomist are being trained regularly on-the job.
	7.2 Creation of facilities for ensuring soil analysis.	We have received laboratory equipments which are being installed. Some equipments are being used in the field (field thermometer and tensiometers).
8. Professional improvement.		1) Had visited ICRISAT, India during home leave in April, 1990. 2) Attended ASA Meeting in San Antonio, Texas, USA in October, 1990.

5.2.3 OTHER ACTIVITIES

The present report covers the research activities of Sorghum and Millet Agronomists located in Maroua (Far North province of Cameroon). Workplan in detail is available in the NCRE document "Annual Workplan for 1989-90". The rainy season trials especially those planned for long term, crop association and mixed cropping were conducted on the IRA farm at Mouda and on IRA sub-stations at Guetale and Tchatibali. Soils at Mouda are gravelly, and Alfisols with a shallow profile of 20-30cm deep, below which a hard compacted disintegrating parent material exists. In general, soils are poor in organic matter, total N, available P and high in available-K content. Texturally, soils are sandy loam with water holding capacity of about 75-100mm in the rooting zone.

Soils at Guetale are alluvial with sandy loam texture and low in total-N and organic matter. The level of P and K are optimum. Soils at Tchatibali are sandy in texture with low total-N, organic matter, available P and K. In general, soil at Tchatibali is poor in soil fertility and crop productivity.

Trials on Striga were conducted on a Striga infested field near Ndonkole (a farmers field taken on lease). The soil is sandy clay loam with fertility status similar to that of Mouda.

Trials on post rainy season sorghum (muskwari) were conducted at the watershed site at Mouda and Salak on Vertisols having high clay content and water holding capacity (150-200mm of available water), low in N and very low in available P.

The 1990 rainy season can be characterized as abnormal in the sense that rainfall distribution was very erratic. At Mouda a total rainfall of 683mm was received between 25 June and 30 August and prior to 25 June and after 30th August rainfall was very inadequate for planting in June and for maturity of crops in September. However, the total rainfall was normal (864.5mm).

5.2.3.1 Opportunities for Professional Development

Mr. R. Ndikawa, the Cameroonian counterpart attended the Sorghum open day workshop organized by ICRISAT, West African Sorghum Improvement Program at Kano, Nigeria from 11-12 September, 1990

Dr. L. Singh attended and presented a paper in the ASA Annual meeting at San Antonio, Texas from 21-26 October, 1990.

Agronomists participated in the reconnaissance survey carried out by TLU, Maroua during the year, 1990. The on the job training was continued for technical staff and field technicians in the area of sorghum and millet agronomy.

Mr. Ngue, Technicien d'Agriculture (T.A.) received a 8 months training at ICRISAT Headquarter at Hyderabad (India) from 23rd March to 22nd November, 1990 in the area of management of field experiments in semi-arid tropics.

5.2.4. RESEARCH FINDINGS

a) Rainy Season Crops

5.2.4.1. Sorghum Response to Fertilization under Different Cropping Systems.

Objectives were (1) to quantify the response of sorghum to various fertilizer levels grown in contrasting cropping systems (2) to monitor soil fertility changes under various cropping systems.

5.2.4.1.1 Methods: The present experiment was started in 1987 at Mouda on a permanent site with different cropping systems in main plots and seven fertility treatments applied only to sorghum in sub-plots of a split plot layout with three replications. The intercrop was sown in a row arrangement of 1 sorghum to two groundnut at 40cm spacing. Cotton cultivar GlandLess was established at a density of 83333 plants/ha and fertilized at the recommended rate of 200 Kg/ha of 22-10-15 compound fertilizer. Groundnut cultivar IB-66 was sown at 40x20cm spacing and fertilized with 100 Kg/ha of single superphosphate. The component crops in intercropping were fertilized proportional to the area they occupied in the system.

Soil samples (0-15cm depth) collected from each plot before sowing and fertilizer application in 1990 were air dried, powdered and sieved to pass through 0.5mm sieve. Samples were sent to IITA for analysis and results are still awaited.

5.2.4.1.2 Results: Yield data on sorghum grain presented in Table 2 indicate that continuous cropping of sorghum year after year on the same piece of land will produce less yield at any given fertilizer rate as compared to where sorghum planted either after groundnuts or cotton or in association with groundnut. It can be noted from the data in Table 2 that response to nitrogen lication was low without of phosphorus application. Also continuous cropping of sorghum may bring out serious problems of Striga (parasitic weed) and buildup of other diseases and pests. A crop rotation of cotton-sorghum or groundnut-sorghum or sorghum/groundnut association will be more advantageous in terms of total yield and less depletion of soil fertility. There were no significant yield increases in sorghum beyond 40 Kg N/ha with 20 Kg each of P2 05 and K20/ha in any given cropping systems. During the year 1990 due to terminal drought (especially in September) reduction in groundnut yield was obvious. However, sorghum yield was not affected as the variety planted was of 90 days maturity cycle (S-35).

5.2.4.2 Long and Short Cycle Sorghum Association with Groundnut Cowpea and Millet:

The objective is to determine the beneficial effect of growing long and short cycle sorghum in association with various legumes and millet.

5.2.4.2.1 Method: Two sorghum cultivars (one long cycle local Walaganari with maturity cycle of 125 days and a short cycle improved S-35 of maturity cycle 90 days) were intercropped with millet (IKMV-8201 of 80 days maturity cycle), groundnut (IB-66 of 100 days maturity cycle) and cowpea (VYA of 80 days maturity cycle). The crops were sown at appropriate times as per recommendation. Sorghum and millet were fertilized with 40 Kg N and 20 Kg each of P2 05 and K20/ha. Groundnut and cowpea were fertilized with 100

Kg/ha of single superphosphate (18% P205). The row spacing was 80 cm for sorghum, millet and cowpea and 40 cm for groundnut. A plant population of 62500/ha for sorghum and cowpea, 25000/ha for millet and 125000/ha for groundnut were maintained. In crop association, the population of millet, Cowpea and groundnut was reduced to half in proportion to the area occupied by each crop in association.

5.2.4.2.2 Results: It can be observed from the data presented in Table 3 that yield in general is low primarily because of a very low P level of the soil at Mouda. It is evident from the results that a crop association such as sorghum+groundnut or sorghum+cowpea or even sorghum+millet is advantageous compared to growing them pure. Behaviour of millet either with short or long cycle sorghum was alike and could be due to the fact that the millet variety IKMV-8201 matures in 80 days. The association of cowpea with long cycle sorghum was found better in terms of total yield as compared to a short cycle association (Table 3). Association of groundnut with short or long cycle sorghum produced similar yields. The best land equivalent ratio (LER) was obtained by growing sorghum+millet (short cycle millet).

5.2.4.3 Effect of Improved Agricultural Technologies on Sorghum Performance: The objective was to evaluate the impact of different technological components on sorghum production when applied singly or in combinations and identify viable technologies for general recommendation.

5.2.4.3.1 Method: The technology package was divided into four components viz variety, fertility, plant population and soil preparation. The description of local and improved levels are described in Table 4. Factorial combinations of all the four factors were evaluated in a randomized block design with three replications.

5.2.4.3.2. Results: The effects of each factor and its interaction with others were examined. Although the soils at experimental site were not homogenous, the overall effects between varieties were consistent. Under high input (fertilizer) a proper tillage is needed as compared to low input for improved variety. Overall there was significant difference between local (Damougari) sorghum and S-35 (improved) (Table 4). The interactions effect of variety, fertility and tillage was found to be significant. Contribution of fertility towards increased yield was much higher compared to other factors tested in this study. At low level of fertility the contribution of increased plant population was negligible but at high fertility level, the contribution of increased plant population was impressive, especially in improved sorghum varieties.

5.2.4.4 Effect of Intercropping and herbicides on Striga control in sorghum: Objectives were (1) to identity the best crop combinations with sorghum to reduce the harmful effect of Striga and (2) to find chemicals (herbicides) which could be used efficiently and effectively for controlling Striga in sorghum.

5.2.4.4.1 Methods: Two different experiments were conducted at Ndonkole on a farmers field. The first experiment involved testing of different intercrop mixtures with two sorghum varieties (Damougari a local one and S-35 an improved cultivar). The second experiment was carried out to test the effectiveness of several herbicides including use of a concentrated solution of urea to control Striga in sorghum. Details of treatments are given in respective tables.

5.2.4.4.2 Results: It was observed that intercropping of sorghum with millet or soybean or cowpea is effective in reducing Striga population and produced impressive yields of both crops in association. Planting cowpea and sorghum on the same hill or within the same row may pose some practical problems but seems promising in terms of reducing Striga population as compared to planting cowpea and sorghum in alternate rows. In sorghum/millet association, the Striga emergence was zero in the rows of millet indicative of non-parasitization of millet by present strains of Striga hermonthica (Table 5). The variety S-35 seems to be more tolerant to Striga compared to local Damougari. In general, the emergence of Striga in S-35 was low compared to Damougari. On average each Damougari plant was surrounded by 10 Striga plant as compared to only 4 per sorghum plant in S-35.

Among herbicides, 2,4-D, Garlon and Paraquat were found to be very effective in controlling the Striga in sorghum (Table 6). A directed spray of concentrated urea (20% solution) was found very efficient in controlling Striga and improving sorghum yield. The effectiveness of urea spray was higher in S-35 compared to local variety Djigari.

The emergence of Striga plants in Djigari was higher as compared to S-35 (Table 7). Lower emergence of Striga was observed in 2,4-D and Paraquat sprayed plots in both varieties of sorghum. Although the late emergence of Striga in urea sprayed plots was high it did not reduce the grain yield of sorghum in both varieties. Study needs further verification including different concentrations and more than one spray.

5.2.4.5 Evaluation of Packages for Striga Control in Sorghum:

The objective was to test the available package of practices in order to minimize the harmful effect of Striga on sorghum.

5.2.4.5.1 Method: The experiment was carried out at Ndonkole using 5 treatments including one farmers practice. The details of the treatment combinations are given in Table 8 along with results.

5.2.4.5.2 Results: Results presented in Table 8 indicate that Striga emergence in general was very low in most of the treatments except in treatment-5 where local farmers practices and variety was used. In this study a high dose of N fertilizer (80 Kg N/ha) was used. The high level of N might have caused low emergence of Striga and high grain yield.

Use of a tolerant sorghum variety (S-35) with pre-emergence herbicide at planting at high fertility level followed by spray of Trichlopyr (3l/ha) seems to be an effective and efficient way of controlling Striga in sorghum (Table 8). Study needs further investigation.

5.2.4.6. Comparative Performance of Sorghum Cultivars including hybrids under graded fertility level in Striga and non Striga infested field: The objective was to evaluate two hybrids received from the Seed Multiplication Project of USAID, Garoua along with improved open pollinated sorghum variety S-35 and local Damougari under Striga and non Striga infested conditions.