PN-ABS-623
70491

REPUBLIC OF CAMEROON
MINISTRY OF HIGHER EDUCATION, COMPUTER SERVICES AND SCIENTIFIC RESEARCH
(MESIRES)
INSTITUTE OF AGRICULTURAL RESEARCH
(IRA)

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 Mkolbisson 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-Hidaltitude 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 HP 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. Far 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 testerosses 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, Fbt(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 HSR 87	79	244	124	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 HSR 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	FOUHBOT	BANSOA	MFONTA	BABUNGO	MBANG MBIRNI	MAISCAH	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
EHSR	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	MFONTA	BABUNGO	MBANG MBIRNI	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

VARITY	LOCATIONS				
	FOUMBOT	BABUNGO	MBANG-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
HARARE 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)
HAP	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
POOI 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	16	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

VARIETY	LOCATIONS						
	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 H131	73	25[illegible]	135	1.4	1.7
Z28 X 89242	75	253	134	1.8	1.6
89223 X 89260	70	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 H131	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 fertili y 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-HSR 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 Callianda 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 1 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	1) 0-0-0	1) M+B - Bury Residue
2) Burn Residue underground	2) 50-60-30	2) M+B - Burn residue underground
	3) 100-120-60	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	1) Bury Residue
	2) 50-60-30	2) Burn Residue underground
	3) 100-120-60	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.

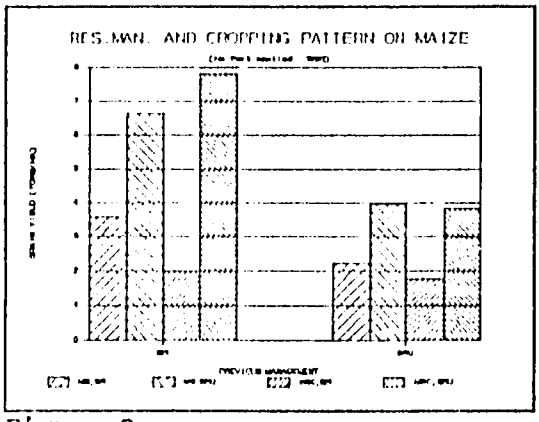


Figure 2

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..

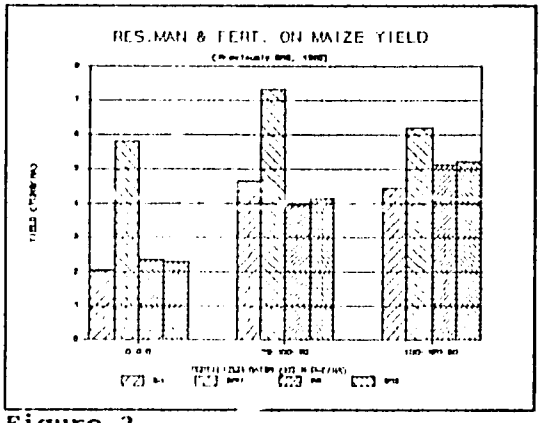


Figure 3

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 fertilizer 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 continued 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 lime. 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 later 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										
MSR-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					
MSR	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.

	RIDGE	FLAT	NO-TILL	(LSD .05)	CV
BAHPUL PLAIN					
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	38.4
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.

SOURCES	RATES (Tons/HA) 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	4.64	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)	November 30, 1990 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 CMS 8501, Mdock 8701, CMS 8710, CMS 8704, Pool 16 DR, CMS 8806 and TZUT. 1.2 TZEFY and CSP x L Bayitiri identify through SAFGRAD testing as good extra-early varieties.

SUB-GOAL	METHODS	ACCOMPLISHMENTS
2. Population improvement of already released varieties through S_1, 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_1 recombination of 22 lines from CHS 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 CHS 8501, CHS 8704, Pool 16 DR, CHS 8806, Suwan I (W), Ndock 8701, CHS 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_3 (6.5t/ha). The poorest entry was an extra-early variety TZEE-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_4 (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_3 (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 Fne 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 1 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 1 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 I SR testcrosses were evaluated at 3 locations: Yaounde, Ntui and Sanguere. The entries consisted of about 100 S_1 lines derived from the Suwan I SR BC_1 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, Bezeola 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 inhred	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. MCRE/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. MCRE 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. MCRE Single yellow crosses	3	94	3	4	3	7
6. Tester Single crosses	3	120	3	3	3	6
7. MIR 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 ISR S4	300	Advance to 355	"
11. TZB SR S4	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. CHS 8501	2 ha	Minkomeyos, Sanguére
2. CHS 8704	5 ha	Ntui, Ndock
3. CHS 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 Trials 1st season	2nd season	Total
FOREST				
1. Nkolbisson	8	13	17	30
2. Ntui	8.5	62	6	68
3. Hamo	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. Houda	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	4.4	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-SE	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	Houda*	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	Houda	M.Galke	Touboro	Sanguere	Maroua	Soucoundou	Means DTS	PAH	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. TZB 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-PAYITIRI 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		Soucoundou		Maroua		Means		
	PAH	Yield	PAH	Yield	PAH	Yield	DTS	PAH	Yield
1. FARAKOBA 88 Pool DR (H.D)	55	7.9	53	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_6	51	7.1	52	6.5	48	4.9	52	50	6.2
10. E.V. 8731 SR BC_6	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	Sanguere	Ndock	Ntui	MEANS		
					DTS	PAH	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	Sanquere	Means DTS	PAH	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	Sanquere	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. TZM-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	Sanquere	Mayo Galke	Touboro	Mean DTS	PAH	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	Sanquere	Ndock	Means DTS	PAH	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	Ntui	Yaounde	Sanguere	Means DTS	PAH	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	4.8	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	59	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. 3428-19 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 MCRE 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 MCRE 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 MCRE 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 DTS	PAH	Yield	% Best 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)
8428-19	-	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: NIR Single Crosses

Parent in Commun	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	9450 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	4.1	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	Ntui	6 (8)	6 (8)	11 (14)	9 (12)
	Soucoundou	12 (16)	9 (12)	10 (13)	10 (13)
E_2	Ntui	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	33	Exp_1 23-1				
I, II, III		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		9030 (3.5)	line 77	0.3
		line 80 line 87	2.9	4001 (3.5)	(6.5)	
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 Yoke, 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, Mdock 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.

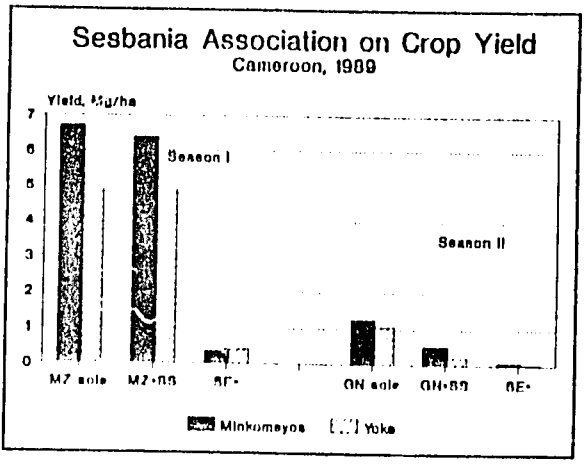
Assistance to Peace Corps Volunteers: I assisted technically and supplied seeds/planting materials to German and US volunteers working in Gabon and Central African Republic. I also reviewed the Agroforestry Proposal for 1990s prepared by Peace Corps, Cameroon.

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.

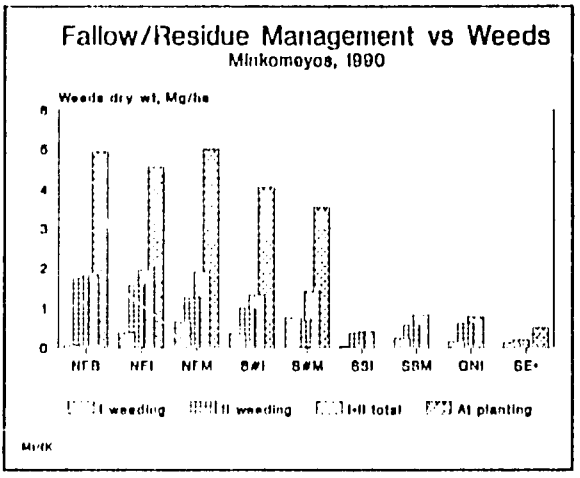
Table 1. Effect of type of fallow and residue management on grain yield of subsequent maize crop at three sites in southern Cameroon, 1989-1990.

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	5248	32	2441	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.

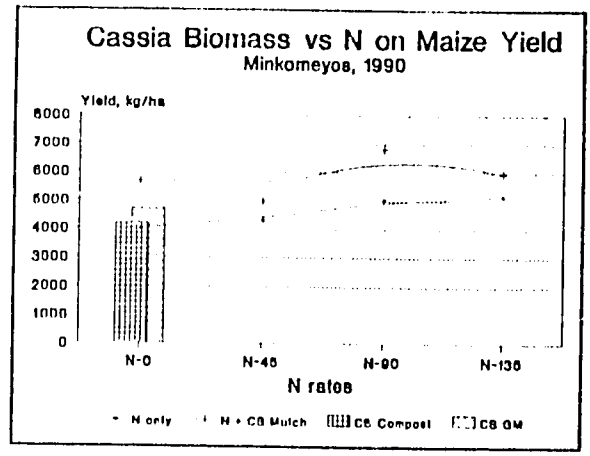


2.4.4.2. In-situ Mulch/Green Manure Production Through Cassia

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.

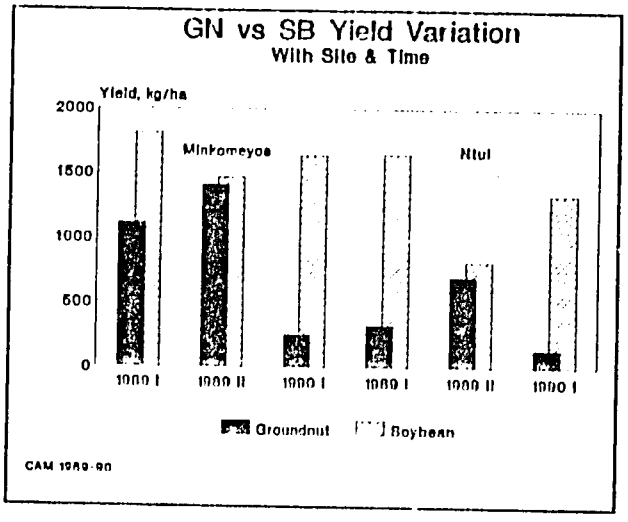


Table 4. Crop yields and land-use efficiency of maize + groundnut or soybean associations and rotation at two sites in the forest zone of Cameroon, 1989 & 1990.

CROPPING SYSTEMS		MINKOMEYOS				NTUI			
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).

Productica 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		Season II			AHER*
		Maize, kg/ha	G'nut, kg/ha	Maize, kg/ha	G'nut, kg/ha	Cassava, t/ha	
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 IITA 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 3734 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_3 - 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	88	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
H 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
M 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	2234						
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. (%)	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
NI 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 Hiep 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-HR-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 104*	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 research 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 T1B1, 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 T1b1 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] (Mdop 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	Maize - maize				Soybean - soybean	
	P_2O_5 (kg/ha)	Yield (kg/ha)	Early harvest no/plot	Plant height cm	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]. Mdop 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. (Mbo Plain 1990 1st cycle)[1]

Cropping patterns		2nd cycle 1st cycle grain yields (kg/ha)					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	954		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 Mdop 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	113	691	356	731	399
50	4234	119	699	263	817	410
200	4289	147	1063	367	810	407
Mean	4176	116	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	
Hankon 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	1400	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 + 234% 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 grounduts, 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 Cameroon (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%; $F_{Till.}$ = H.S.; $F_{Var.}$ = H.S.; $F_{Tied\ Ridg.}$ = H.S.
$F_{Till.\ x\ Var.}$ = H.S.; $F_{Till\ x\ Tied\ Ridg.}$ = H.S.

For Sorghum : C.V. = 13%; $F_{Till.}$ = H.S.; $F_{Tied\ Ridg.}$ = H.S.; $F_{Var.}$ = n.s.
$F_{Till.\ x\ Tied\ Ridg.}$ = S.; $F_{Till.\ x\ Var.}$ = H.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 TZPB Not treated	3.91	6.43	5.31	4.15	4.45	4.03	4.71
II TZPB 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 harvested 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 Harshal 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%; $F_{Prec. crops.}$ = H.S.; $F_{Var.}$ = n.s.
$F_{Prec. crops \times Var.}$ = H.S.; $F_{ST \times Var.}$ = n.s.
$F_{Prec. crops \times Var. \times ST}$ = H.S.

$F_{ST.}$ = H.S.
$F_{ST \times Prec. \times crops}$ = H.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	Djalingo 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	3.50	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 Djalingo 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%.

In the case of sorghum: 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 VARIETIES IN THE LOWLAND SAVANNA, DJALINGO 1990

Treatments			Varieties	No Tillage (A)	With Tillage (B)	$\frac{A + B}{2}$	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		

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

Table V. b 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		

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

4.4.5 On-farm testing and demonstration with minimum tillage (sodecoton) 1990.

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 Lawane	Doukea	Koum	Gouga	Ndourou	Voqzou	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	3.53	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

$F_{Var.}$ = H.S.; LSD $(0.05)_{Var.}$ = 0.195 t/ha; $F_{Tillage\ management}$ = n.s.; $C.V._{Trial}$ = 9%
$F_{Location}$ = H.S.; LSD $(0.05)_{loc.}$ = 0.56 t/ha; $F_{Loc.\ x\ Var.}$ = H.S.; LSD $(0.05)_{Loc\ x\ Var.}$ = 0.56 t/ha;
$F_{Var.\ x\ Till.}$ = 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} = H.S.; $F_{Var.}$ = H.S.; $F_{Var. \times TR}$ = H.S.; $LSD_{TR.}$ = 0.38 t/ha; C.V. 9%.
For Djalingo : F_{TR} = H.S.; $F_{Var.}$ = H.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 m^2)	Sorghum Grain Yield (t/ha)	Sorghum Stover Yield (t/ha) (2.40 m^2)	Average Striga count on Sorghum (per 2.40 M^2)
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	1.85	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 : $F_{TR.}$ = H.S.; C.V. = 16%; Stover Maize : F = H.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 = H.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 Nagawhite, 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-244 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 Framida. 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 Framida.
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 Houri, 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 Houri 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 CFH-24, CFH-21 and CFH-11 gave more than 1% higher yield than exotic check variety IKMV-8201 and more than 25% than local check Houri.

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, Ndonkole, 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 anthrancnose (Colletotrichum graminicola), and leaf tar spot (Phyllachora sorghii); resistant to grain disease particularly long smut (Toly-posporium 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-88058 (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 aspect 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-1064 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.	CSTLFT-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-	12.7.90	25	16	3	TCHATIBALI
	EXTREME NORTH PROVINCE)	12.6.90	25	16	3	SOUCOUNDOU
10.		19.6.90	25	16	3	YOLDEO
11.	NSVAT-1990 (MEDIUM-	9.7.90	20	16	3	GOUNOUGOU
	NORTH PROVINCE)					
		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	27.6.90	48	9	-	GUIRING
	STERILE LINES & HY.DEVE.					
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-	30.6.90	20	200	-	GUIRING
	CATION OF SORGHUM AND					
	MILLET VARIETIES					
B.	PEARL MILLET					
21.	MPMVAT-1990 (EXTREME	13,&16.7.90	14	16	4	TCH., & GUETALE
	NORTH PROVINCE)					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	6195	-
	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	198	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: NDONKOLE, 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)
	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 BF	57	-	451562	347395	4291
	ICSV-1079 BF	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	3100	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
DAHOUGARI (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	-	1040	
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	2093	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) YOLDEO*	TCHATIBALI	GUETALE**	OVERALL MEAN	% INCREASE OVER BEST CHECK
CPM - 24	55	2225	1346	3387	2319	1.66
CPM - 21	56	1912	1431	3559	2301	0.87
CPM - 14	57	1775	1609	3490	2291	0.40
CPM - 16	55	1925	1328	3459	2237	-
IKMV-8201 (CHECK)	56	1512	1759	3571	2281	
HOURI (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 (Houda, 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 IIAU, 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 identify 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 [illegible] 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 on 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.

5.2.4.6.1 Method: Two experiments (one at Ndonkole in a Striga infested field and another at Mouda in a non-Striga infested field) were carried out using two hybrids (8319 and 8320), S-35 (an open pollinated improved cultivar) and a local Damougari sorghum. These four cultivars were tested at 4 levels of N (0,30,60 and 90 Kg N/ha). The fertilizer treatments were in main plots and sorghum cultivars as sub-plots using a split plot design with 3 replications. Grain, and stover yields were recorded at harvest whereas the Striga counts at Ndonkole was made weekly starting the 8th week after planting.

5.2.4.6.2 Results: Results presented in Table 9 on yield performance indicate that hybrids were better than the open pollinated sorghum S-35. At Ndonkole where the field is heavily infested with Striga the yield of hybrids were even less than the local sorghum Damougari (Table 9). At Mouda the performance of hybrids at high fertility levels was at par with S-35 and better than the local variety Damougari. It is worth mentioning here that soils at Mouda are very low in soil fertility with shallow profile depth (ranging between 20-30cm) and gravelly In field observation it was noted that the lodging rate of sorghum towards grain filling stage was very high (70-90%) in hybrids as compared to S-35 and local varieties. The high rate of lodging caused poor grain filling and reduction in yield.

5.2.4.7 Comparative performance of Improved and Local Millet cultivars under different planting dates and fertility levels:

The Objective of the trial is to find the yield performance of improved millet cultivars in comparison to local ones when planted at different times and at different fertility levels in two different environments.

5.2.4.7.1 Method: Two experiments (one at Mouda and another one at Guetale) were carried out using three millet cultivars (Mouri as local, IKMV-8201 and CPM-17) with two fertility levels (20:10:10 and 40:20:20 kg/ha of N, P205 and K20 respectively), and two planting dates (last week of June and 2nd week of July). The 12 treatment combinations were tested in randomized block design with 4 replications. The biometric observations and yield were recorded from net plot size of $32m^2$.

5.2.4.7.2 Results: Results on grain yields of millet cultivars presented in Table 10 indicate that local variety Mouri is inferior in yield performance compared to improved millets IKMV-8201 and CPM-17. Reduction in yield of improved as well as local variety was quite high when planting was done in middle or late July (D2). At Mouda the variety IKMV-8201 was best among the varieties tested at both fertility levels and planting dates whereas CPM-17 was found best at Guetale when planted in late June (D1) but for late planting the IKMV-8201 is better compared to CPM-17 or local Mouri (Table 10). Low or no significant response of millet was observed to fertility level at Guetale as compared to Mouda. Soils at Guetale are alluvial and high in fertility level compared to the soils of Mouda.

b) Post Rainy Season Sorghum (Muskwari)

5.2.4.8 Effect of Dikes on Muskwari Sorghum

The objective was to find out the effect of dikes made in the rainy season on the performance of muskwari in the post rainy season.

5.2.4.8.1 Method: An experiment was set up at Salak to evaluate the effect of planting on a flat and diked area 7.5x15m size on muskwari sorghum. Large plots (30x15m) were used for realistic assessment of the effects of these land management treatments. The trials were conducted on Vertisols having high clay content and water holding capacity. The crop was transplanted at 1x1m spacing with 2 seedlings per hill.

5.2.4.8.2 Results: The crop establishment was good in both cases (about 94.5%). There was no significant difference between planting on flat and diked land in respect to grain yield and panicle weight. The area is nearly flat and water-logged with very poor drainage and as such the moisture status in the profile under these two situation was very similar. Making dikes could be beneficial in sloping land where rainwater runoff is high. (Table 11).

5.2.4.9 Response of Muskwari to Fertilizer and supplemental irrigation: The objective was to evaluate the response of muskwari sorghum to fertilizer and supplemental irrigation.

5.2.4.9.1 Methods: Five treatment combinations of irrigation and fertilizer were evaluated in randomized block design with 4 replications at Salak. Mukswari sorghum was transplanted in the first week of October 1989 at 1x1m spacing with two plants/hill. Fertilizer was applied in a deep hole adjacent to the planting hole at 30cm depth. The first irrigation of 5cm was applied at 30 days after transplanting and a second one (5cm) 60 days after transplanting. The yield and other data are presented in Table 12.

5.2.4.9.2 Results: Seedling establishment was very good. In the treatment where two irrigations along with 30 Kg each of N and P205/ha was applied, the crop establishment was 100%. Fertilizer without irrigation was not very effective in terms of improving grain yield. Application of one irrigation (5cm) after one month of transplanting increased the yield significantly. A 68% increase in yield over control was obtained by fertilizer application along with two irrigations (Table 12). Supplemental irrigation in dry season is possible only by collecting runoff during the rainy season.

5.2.4.10 Performance of Muskwari at different dates and depths of transplanting: The objective of the trial was to find out the interaction between depths and time of transplanting muskwari sorghum.

5.2.4.10.1 Method: An experiment was established using 3 dates and 3 depths of transplanting muskwari in 1989-90 crop season. The transplanting of muskwari was done at 1x1m spacing putting two seedlings at each hole. The depths of transplanting were 10, 20 and 30cm (correspond to D1,D2 and D3) deep on 20th September, and 20 October. The experimental design was split plot with date of transplanting as main plot and depths of transplanting as sub-plots with 3 replications.

5.2.4.10.2 Results: Results obtained on grain and stover yield as well as plant establishment are presented in Table 13. It can be noted from the data that there was no significant yield difference when transplanting was done in September or 1st October. However, lower grain yield was obtained when transplanting was done at shallow depths (10cm) in October as compared to deep transplanted. It is also interesting to note that transplanting can safely be done at a shallow depth (10-20cm deep) in the early transplanted crop (up to last week of September) without decreasing the yield. Delayed transplanting of muskwari definitely needs

deeper holes and will have the risk of low seedling establishment. If the farmers are careful and ready to transplant muskwari early (last week of September) then they can save labor cost of transplanting muskwari (making hole of 10-20cm deep which requires less labor as compared to making 30cm deep holes when upper soil layer is dry by delaying the transplanting).

5.2.4.11 Operational Scale Testing of Sequential Double Cropping on Vertisol at Mouda: The objectives are (1) to explore the potential of sequential double cropping in Vertisols by growing a rainy season crop preceding the traditional muskwari sorghum and (2) to explore the possibility and economics of using excess runoff collected in the rainy season as supplemental irrigation to the dry season crop.

5.2.4.11.1 Method: A water tank was constructed in December 1987 with a storage capacity of 1700 m^3 runoff water coming from 2.3 ha area. The area was graded to achieve an average land slope of about 0.2% so that the excess rain water collected in the reservoir through connecting drainage channels.

During the rainy season of 1989, seven treatments with two replications were tested. Immediately after harvesting or in the standing rainy season crop; muskwari sorghum was transplanted between the last week of September and first week of October. Later on three irrigation treatments to muskwari (5cm and 10cm) were superimposed by splitting the main plots used in rainy season. To muskwari, one irrigation of 5cm was given after one month of transplanting and two irrigations (5cm each) were given one and two months after transplanting. The plot size varied from 400 to 1100m^2. No other input was given to muskwari sorghum. The maize and cowpea in rainy season were fertilized at the recommended rate of fertilizers (maize 90:45:45 kg/ha of N, P205 and K20 respectively and cowpea with 100 Kg single super-phosphate/ha).

5.2.4.11.2 Results: There was no significant yield difference of maize and cowpea when planted either on ridge/furrow system or on flat. This was due to the fact that there was a gentle slope to facilitate the drainage of excess rainfall so as to avoid water logging and at the same time allow enough time for the rain water to infiltrate through the soil profile. All the systems tested including improved fallow (crotalaria and plowed fallow) produced significantly higher yields of muskwari as compared to a farmers traditional system at zero level of irrigation. A similar trend was obtained with one and two irrigation treatments (Table 14). The mean muskwari yield did not differ significantly where the preceding crop was either maize or cowpea or crotalaria (as green manure crop). Even the plowed fallow (one plowing was done in August) improved the muskwari yield by 28% over the farmers traditional method of muskwari cultivation.

Table 1: Mean Annual Rainfall (mm) during 1990 at different Locations

Month	Decade	Rainfall (mm)			
		Houda	Salak	Guetale	Ichatibali
April	1	-	-	-	-
	2	10.5	1.7	6.0	-
	3	24.5	25.5	2.0	33.0
Total		35.0	27.2	8.0	33.0
May	1	-	6.6	20.0	44.0
	2	6.5	-	36.0	61.0
	3	40.0	16.7	10.0	3
Total		46.5	23.3	66.0	108.0
June	1	60.0	42.9	33.0	16.0
	2	20.0	7.3	44.0	2.0
	3	203.0	103.3	29.0	11.0
Total		283.0	153.5	106.0	29.0
July	1	77.0	64.6	38.0	21.0
	2	88.0	115.1	127.0	98.0
	3	57.0	86.1	55.0	27.0
Total		222.0	265.8	220.0	146.0
August	1	51.0	30.1	49.0	72.5
	2	64.0	86.8	114.0	61.0
	3	63.0	39.1	72.0	30.0
Total		178.0	156.0	235.0	163.5
September	1	8.0	13.2	78.0	96.0
	2	35.0	29.4	16.0	37.0
	3	19.0	0.8	1.0	45.0
Total		62.0	43.4	95.0	178.0
October	1	9.0	21.0	36.0	-
	2	8.0	-	-	-
	3	21.0	2.2	-	23.0
Total		38.0	23.2	36.0	23.0
Grand Total		864.5	692.4	766.0	680.5

Table 2: Response of Sorghum to Fertilization in different Cropping Systems at Mouda, 1990

Fertility Level N: P205: K20 (Kg/ha	Grain Yield (Kg/ha) under different Cropping System				
	S-S-S-S	C-S-C-S	G-S-G-S	S/G - S/G	S-C-CP-S
0: 0: 0	767	1291	1580	948/247	1532
0:20:20	1810	2218	2422	1210/318	1998
20:20:20	2115	2677	3003	1570/391	2636
40:20:20	2593	2914	3061	1384/378	2789
60:20:20	2532	2869	2888	1384/313	2543
20: 0:20	1054	2021	2530	1237/299	1520
20:20: 0	1993	2332	2885	1520/378	2169
Mean	1838	2332	2624	1322/331	2169

SE± System 77; Fertility 90; System x Fertility 201
C.V. (%) 17

S-S-S-S - Continuous sorghum (From 1987 to 1990)
C-S-C-S - Cotton - Sorghum - Cotton - Sorghum
G-S-G-S - G'nut - Sorghum - G'nut - Sorghum
S/G...S/G - Sorghum and Groundnut association
S-C-CP-S - Sorghum - Cotton - Cowpea - Sorghum

Mean Yield of pure groundnut from adjacent plot = 750 Kg/ha

Table 3: Studies on Sorghum Based Crop Association, Mouda, 1990

Crops/Crop Association		Grain Yield (Kg/ha)	LER
Short Cycle Sorghum (Pure)		1467	1.00
Long Cycle Sorghum (Pure)		1328	1.00
Cowpea (Pure)		581	1.00
Millet (Pure)		750	1.00
Groundnut (Pure)		901	1.00
Short Cycle+Long Cycle sorghum	(1:1)	710 + 631	0.96
Short Cycle Sorghum + Cowpea	(1:1)	1332 + 254	1.34
Short Cycle Sorghum + Groundnut	(1:1)	1130 + 460	1.28
Short Cycle Sorghum + Millet	(1:1)	1095 + 685	1.65
Long Cycle Sorghum + Cowpea	(1:1)	1309 + 319	1.53
Long Cycle Sorghum + Groundnut	(1:1)	1150 + 383	1.28
Long Cycle Sorghum + Millet	(1:1)	1244 + 526	1.63

Table 4: Response of Sorghum Cultivars to Technology Component at Mouda, 1990

Level of Component Technology			Grain Yield (Kg/ha)		Stover Yield (Kg/ha)	
Fertility	Population	Tillage	Local (Damougari)	Improved (S-35)	Local (Damougari)	Improved (S-35)
Low	Low	Zero	808	1337	3277	2892
Low	Low	Conventional	951	1452	3054	2690
Low	High	Zero	740	1325	2771	3216
Low	High	Conventional	1225	1309	3256	2933
High	Low	Zero	1707	1371	2710	2923
High	Low	Conventional	1350	1761	3398	3054
High	High	Zero	1152	2017	3772	3641
High	High	Conventional	1408	2196	3924	3752
Mean			1105	1596	3270	3138
SE± For variety or fertility or population or tillage is (Variety, fertility, and tillage are significant) but other interactions are non significant.				48		N.S.
C.V.				18		23

1. Fertility — Low (20:10:10 Kg/ha each of N, P205 and K20)
   High (40:20:20 " " " " " " ")
2. Population — Low (41666 plants/ha by 80cmx60cm with two plants/hill)
   High (62500 " " " 80cmx40cm " " " ")
3. Tillage — Zero (No land preparation before planting)
   Conventional (Land preparation by animal traction or by tractor)

Table 5: Integrated Approach to Striga Management and Yield Performance of Sorghum at Mdonkole, 1990

Treatment Combination	Grain Yield (Kg/ha)			Striga count/M^2 at different stages			
				8 Week		Harvest	
	amougari (V1)	S-35 (V2)	Mean	V1	V2	V1	V2
Check (Striga not controlled)	3356	2675	3016	76	45	113	22
Check (Striga and other weeds controlled	3806	3628	3717	31	41	53	17
2,4-D Spray (2Kg a.i./ha)	3929	4282	4056	23	21	26	7
Garlon (1.5% spray)	3975	4087	4031	5	12	13	3
*FAO Approach	2923	3783	3353	63	25	66	54
Sorghum cowpea Asso.(1:1 rows)	2589/670	2887/848	2738/759	36	44	68	49
Sorghum/Soybean Asso.(1:1 rows)	2189/699	2563/833	2376/766	34	34	47	28
Sorghum/Millet Asso. (1:1 rows)	1558/1291	2216/1080	1887/1186	42	24	49	11
Sorghum and Cowpea (planted in the same	3502/155	4223/108	3862/132	48	19	55	4
Sorghum Cowpea planted in the same pocket	3416/87	4590/88	4003/88	32	21	19	14
Mean	3114	3493		39	28	51	21
SE± Variety	112			5		8	
Treatment 252	252			12		17	
V X T 356	356			17		24	
C.V. (%)	19			85		118	

* Chemical use is excluded from FAO package to evaluate the effect of package without chemical.

Table 6: Effect of Some Herbicides on Striga Control and Sorghum Yield at Mdonkole, 1990

Treatment	Grain Yield (Kg/ha)			Stover Yield (Kg/ha)		
	Djigari	S-35	Mean	Djigari	S-35	Mean
1. Check (Striga not control but other weeds are cont.)	876	1401	1138	4895	3200	4047
2. Hand removal of Striga and other weeds	1604	2080	1842	6495	5365	5930
3. 2,4-D (2 Kg a.i./ha)	2137	3326	2732	6965	5553	6259
4. Urea spray (20% solution)	2444	4066	3255	5742	5553	5648
5. Buctril (2 l/ha)	2142	3643	2893	6212	4706	5459
6. Paraquat (1 Kg a.i./ha)	2481	3567	3024	6401	5836	6118
Mean	1947	3014		6118	5036	
SE± Variety 106				338		
Treatment 184				586		
T X V 260				828		
C.V. (%)		21		30		

Table 7: Effect of some herbicides on Striga counts (No/m^2) in sorghum at Mdonkole, 1990

reatment	Striga counts/m^2 at different stages of crop growth					
	10th Week after planting			At Harvest		
	Djigari	S-35	Mean	Djigari	S-35	Mean
1. Check (Striga not controlled but other weeds are controlled)	134	27	80	158	20	89
2. Hand removal of Striga and other weeds	93	40	66	82	31	57
3. 2, 4-D (2 Kg a.i./ha)	22	6	14	39	5	22
4. Urea spray (20% solution)	139	14	77	117	60	88
5. Buctril (2 l/ha)	110	22	66	143	18	80
6. Paraquat (1 Kg a.i./ha)	47	17	32	67	23	45
Mean	91	21		101	26	
SE± Variety	12			14		
Treatment	20			25		
V X T	29			35		
C.V. (%)	103			112		

Table 8: Evaluation of Packages for Striga Control in Sorghum at Mdonkole, 1990.

	Grain Yield (Kg/ha)	Stover Yield (Kg/ha)	Striga Count (m^2 (at weeks)						
			6	7	8	9	10	Harvest	Mean
1. Striga tolerant variety (C) pre-emergence herbicides (PE)+2,4-D+ Garlon + 90 Kg N/ha	5298	6138	4	2	1	0	3	1	1.8
2. C+PE+N+Dimithametryne+Garlon	5377	7130	2	5	5	3	1	11	4.5
3. C+PE+N+2,4-D at 3 weeks	4035	6944	3	2	5	5	3	0	3.0
4. C+PE+N+Trichlopyr at 3 l/ha	6054	6634	2	1	1	0	8	0	2.0
5. Local sorghum variety+N+Farmers method of Striga control (hand Pull.)	4909	6138	8	26	37	28	7	4	18.3
SE±	127	212	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
C.V. (%)	26	15	153	163	145	174	224	222	

Table 9: Performance of Sorghum Cultivars Including Hybrids at different Fertility Levels and Location (1990).

FERTILITY LEVEL (N, KG/HA)		GRAIN YIELD (KG/HA) NDONKOLE 8319	8320	S-35	DAMOUGARI (LOCAL)	MEAN	HOUDA 8319	8320	S-35	DAMOUGARI (LOCAL)	MEAN
0		945	1386	2562	1798	1673	980	947	1177	631	909
30		3088	3013	4273	3152	3382	2134	1908	2466	1274	1968
60		3157	3147	4656	3378	3584	2704	2476	2779	2006	2491
90		3926	3113	5099	3584	3930	2522	2652	2587	2100	2465
MEAN		2779	2665	4147	2978	-	2060	2018	2252	1503	-
SE±	VARIETY	156						126			
	FERTILITY	193						91			
	V X F	386						162			
C.V. (%)				25				14			

Table 10: Performance of Millet Varieties Under Different Planting Dates and Fertility Levels at Mouda and Guetale, 1990.

TREATMENTS		GRAIN YIELD (KG/HA) HOUDA V1 (LOCAL) HOURI	V2 IKMV-8201	V3 CPM-17	GUETALE V1 (LOCAL) HOURI	V2 IKMV-8201	V3 CPM-17
D1 F1		557	1027	735	912	1453	1374
D1 F2		686	1327	887	899	1333	1635
MEAN		622	1177	811	906	1393	1504
D2 F1		267	534	483	472	1084	1131
D2 F2		359	690	536	509	1347	813
MEAN		313	612	510	490	1215	972
SE±	VARIETY		43			83	
	DATE OR FERTILITY		35			68	
	INTERACTION		N.S.			N.S.	
C.V. (%)			25			31	

D1 - NORMAL PLANTING DATE
D2 - LATE PLANTING
F1 - 20:10:10 (N, P205, K20, KG/ha)
F2 - 40:20:20 (" " " ")
N.S.- NON-SIGNIFICANT

Table 11: Effect of Transplanting on Flat or Dikes made in Rainy Season on Muskwari Sorghum at Salak, 1989-90

TREATMENT	PLANTS PER HA	HEAD WT. (G/HEAD)	GRAIN WT. (KG/HA)	STOVER WT. (KG/HA)	1000 GRAIN WT. (G)
DIKES	18896	79.8	1185	2140	46.87
FLAT	18895	79.1	1186	1823	47.61
SE±	144.3	5.1	77.4	119.5	0.60
C.V. (%)	2.2	18.0	18.5	17.1	3.6

Table 12: Effect of Supplemental Irrigation and Fertilizer Application on Muskwari Sorghum at Salak 1989-90

TREATMENTS	PLANTS PER HA	HEAD WT. (G/HEAD)	GRAIN WT. (KG/HA)	STOVER WT. (KG/HA)	1000 GRAIN WT. (G)
CONTROL	18819	95.5	1150	2375	45.23
30N + 30 P205 NO IRRIGATION	18125	104.1	1211	2243	47.33
NO FERTILIZER ONE IRRIGATION	19275	106.4	1326	2326	47.24
30N + 30 P205 ONE IRRIGATION	19166	119.3	1607	2375	46.77
30N + 30 P205 TWO IRRIGATIONS	20000	130.4	1937	2604	46.93
SE±	726	7.0	80.4	146.4	0.96
C.V. (%)	7.6	12.6	11.1	12.3	4.1

Table 13: Performance of Muskwari Under Different Dates and Depths of Transplanting, Mouda, 1989-90

DATE	GRAIN YIELD, KG/HA				PLANT ESTABLISHMENT (%)				STOVER YIELD, KG/HA			
	D1	D2	D3	MEAN	D1	D2	D3	MEAN	D1	D2	D3	MEAN
20 SEPTEMBER	864	869	947	893	94.2	92.5	93.3	93.3	2417	2521	2708	2549
1 OCTOBER	811	928	976	905	75.8	86.7	85.8	82.8	2375	2375	2625	2458
20 OCTOBER	565	726	804	698	41.7	65.8	62.5	56.7	1667	2125	2375	2056
MEAN	747	841	909	-	70.6	81.7	80.6	-	2153	2340	2569	-
SE± DATE (MEAN)		34				3				162		
DEPTH (MEAN)		23				3				94		
DATE X DEPTH		39				5				163		
C.V. (%)		10				10				14		

D1, D2, AND D3 ARE RESPECTIVELY 10, 20, AND 30 CM DEEP HOLES FOR TRANSPLANTING.

Table 14: Muskwari Based Double Cropping, Mouda, 1989-90

RAINY SEASON CROPS	- DRY SEASON CROPS	GRAIN YIELD, KG/HA				
		RAINY SEASON	MUSKWARI			
			I_0	I_1	I_2	MEAN
MAIZE (FLAT)	- MUSKWARI	3899	1073	1192	1376	1214
MAIZE (RIDGE)	- MUSKWARI	3853	1003	1226	1510	1246
COWPEA(FLAT)	- MUSKWARI	1190	1050	1265	1463	1259
COWPEA (FLAT	- MUSKWARI	1208	1029	1282	1506	1272
CROTALARIA (G.M.)	- MUSKWARI	-	1053	1329	1492	1291
PLOWED FALLOW	- MUSKWARI	-	886	1029	1115	1010
NATURAL FALLOW	- MUSKWARI	-	683	693	783	720
MEAN			968	1145	1321	-
SE± (MUSKWARI) CROPPING SYSTEMS				31		
IRRIGATION				13		
CROP.SYST.X IRRIG.				33		
C.V. (%)				4		

I_0, I_1, AND I_2 REPRESENT ZERO, ONE (5CM) AND TWO (10CM) IRRIGATION RESPECTIVELY.
G.M. - GREEN MANURE.

6. TESTING AND LIAISON UNIT (TLU)

6.1 BAMBUI-TLU

6.1.1 INTRODUCTION

The 1990 on-farm research program was more ambitious than in any previous year. The return of two researchers (Samatana and Meppe) from MSc training in the U.S. made this possible. The program included a survey of farmers' traditional maize stores, maize variety trials in the mid and high altitude zones, exploratory maize trials in 2 new research domains, a second year of maize NxP response trials in the Bui highlands, a 4th year of maize-rice cropping systems trials and 2nd year of second generation irrigated rice variety trials in Menchum Valley. Over 90 TLU-implemented maize and rice trials were set out in farmers' fields in 8 Divisions in the North West and West Provinces. An additional 50 farmer managed maize trials were carried out, and 300 maize minikits distributed to extension workers in the 2 Provinces.

6.1.2 OUTPUTS AND ACCOMPLISHMENTS

GOAL: To increase farmer incomes in the North West and West Provinces through the development of appropriate farming systems packages.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
A. RESEARCH		
1. To describe farmers' circumstances and identify farmers' constraints.	1.1 One completed survey of the selected zone. Report with estimated storage losses. Description of farmer' storage practices. Maize evaluation model reflecting farmers' use patterns & storage losses.	1.1 Sixty farm households (30 in mid-altitude zone and 30 in high-altitude zone) were surveyed with regards to maize storage practices and use patterns, beginning in January. Monthly samples were taken from each farmer's store for laboratory loss assessments. A Stored Maize Valuation Model was developed. Obtained preliminary estimates of losses.
	1.2 Time series data on food crop commodities.	1.2 The FAO-PTLR Project has been monitoring 11 village markets in the North West Province since August 1988. To avoid duplication of efforts, the TLU is assisting them with the tabulation and graphic analysis of the prices, and using these prices in the analysis of TLU research results.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
	1.3 Estimate the optimal levels of N and P for a maize+beans intercrop in the Bui highlands.	1.3 NxP response trials were repeated on 19 of the 20 farms on which the trial was carried out in 1989. All 19 sites were harvested, and the results are presented below.
	1.4 Identification of factors limiting productivity of a maize+beans intercrop in 2 new zones.	1.4 This trial was designed to estimate the potential responses of a maize+beans crop association to N, P, maize planting density and maize variety. It was planted on 10 farms in 2 new research domains (Donga-Mantung and Fundong highlands). The results are presented below.
	1.5 Identification of leguminous green manure species that will improve soil fertility for a maize+beans+potato intercrop.	1.5 Three leguminous green manure species were relay planted into a standing maize+beans+potato crop at the time of the potato harvest (July-August), on 10 farms in the Bui highlands. Results are presented below.
2. To test adapted technologies under farmers' conditions.	2.1 Identification of an adapted maize variety for the highland zone. Verification of 4 new maize varieties with specific desirable characteristics for the mid-altitude zone.	2.1 Three new maize varieties for the high altitude zone (>1500 m), were tested in 4 replication trials on 14 farms in 3 highland sub-zones. Four new mid-altitude varieties were tested in 2 replication trials on 27 farms in 3 mid-altitude sub-zones. The results are presented below.
	2.2 Estimates of performance of improved maize varieties on farmers' fields & under farmers' management. Estimates of yield contribution of improved variety and fertilizer.	2.2 Three hundred minikits, for testing 9 improved maize varieties, were distributed to village extension workers at 50 agricultural posts throughout the NWP and WP. The return rate for observation forms was similar to previous years (~40%). Results are presented below.
	2.3 Evaluation of a more intensive cropping systems for irrigated rice farmers who single-crop rice.	2.3 After 3 consecutive years on the same 4 farms, the trial (slightly modified) was extended to 6 additional farms in the Menchum Valley. Results are presented below.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
	2.4 Estimates of performance of new rice varieties with improved grain quality on farmers' fields.	2.4 For a second year running, 3 new rice varieties were tested against an earlier released NCRE variety plus the farmers local variety, on 10 farms in the Menchum Valley.
	2.5 Farmer assessments of new maize varieties and fertilizer rates, under real farmers' conditions.	2.5 Seed of KASAI maize variety and fertilizer were provided to farmers throughout the mid-altitude zones in the NWP & WP. The maize was planted and completely managed by the farmers. The TLU team harvested the KASAI plot and a sample plot of the farmer's local maize variety on 28 farms. The results are presented below.
B GENERAL 1. Institutional Development.	1. One junior researcher and three technicians trained in FSR/E skills.	1. The junior researcher and technicians participated actively in all aspects of the TLU on-farm research program. They gained experience in the following areas: research design (trials and survey), trial and survey implementation, data collection, data tabulation, and computer data entry and processing.
. Professional Improvement.	2. Presentation of Papers.	2. McHugh, Samatana and Meppe submitted papers for the AFSR-E Symposium at Michigan State University. McHugh and Meppe attended.

6.1.3 OTHER ACTIVITIES

Other activities of the TLU-Bambui during the year included the following.

- Participated in the "TLU Methodologies Workshop" in Yaounde (8-12 January).
- Participated in the "Food crop and Agro-forestry Research Planning Meeting" for the Western Highlands, held in Bamenda (29-31 January).
- Met and consulted with Ms. Mary Beth Wertime-Walker (Associate Peace Corps Director for Rural Development), re: collaboration of NCRE with a Peace Corps Agro-forestry Project in the North West Province.
- Two students from the Institute of Rural Development (IDR, ex: CUDS), Wirsiy Eric Fondzennyuy (3rd year Ingenieur des Travaux agricoles cycle) and Awondo Martin

(4th year Ingenieur Agronome cycle), did their practical training with the TLU-Bambui, and wrote "Stage" reports. Awondo Martin will return next year to do his memoire research with the TLU.

- Worked with Dr. Ajaga Nji (IDR-Dschang), other IRA researchers, MIDENO, PAFSAT and RTC-Mfonta, to prepare a Technical Maize Bulletin that is to be published at Dschang.
- Participated in a MINAGRI seminar entitled "Formation-Vulgarisation" at Mbouda (April).
- Samatana and Meppe presented seminars at IRA-Bambui on the subject of their MSc theses done at New Mexico State and Oklahoma State Universities, respectively.
- An American student (Kirk Lange) with the "Experience in International Living" program visited Bambui for 2 weeks (May), traveling out with the TLU team to villages in Ndop to carry out a survey of farmers for his research project.
- Ms. Sarah Jackson, a British agriculture/health-care volunteer in Akwaya (SWP), visited IRA-Bambui for 1 week of orientation (4-8 June), and spent much of her time with the TLU team.
- An IITA team (Drs. Fischer, Spencer, Mutsaers, Smith, Swift and Izak) visited IRA-Bambui (23-25 August), and made visits to TLU on-farm trial sites in Ndop Plain and the Bui highlands.
- The TLU team organized farmers meetings in 5 villages each in Ndop Plain and the Bui highlands, to discuss the on-farm research program.

6.1.4 RESEARCH FINDINGS

Farmers maize storage survey:

Both rapid rural appraisal and formal surveys have consistently shown maize storage losses to be of primary concern to farmers in the Western highlands of Cameroon. Storability ranks very high among the maize characteristics considered by farmers in their assessment of new varieties.

The introduction of new maize varieties (COCA, KASAI) boosted the yield potential of maize farmers by as much as 1 to 2 tons. The new varieties have been well received for their taste and cooking characteristics. However, farmers regularly complain that the large denty (soft) grains do not store as well, under traditional storage conditions, as the small flinty (hard) grained local varieties.

In the mid to high altitude zone of the North West Province, maize is harvested from late July until early November, depending upon planting date, variety and altitude, which ranges from 1000 to 2400 m. It is either 1) dried in a loft above the kitchen fire ("banda") and stored there in the husk; or 2) completely or partially dehusked and air dried on raised platforms ("wunchum" and "tapkwa") or hanging from the eaves of the house, and then stored in a rectangular bamboo silo ("nchang") in the ear. The first drying and storage method is practiced at the lower elevations where harvest occurs at the height of the single rainy season (March-October), and the second at higher altitudes, where it is harvested shortly before the onset of the dry season (November-February).

A minority of farmers use a chemical insecticide (actellic 2% powder) to control storage insects (principally, the maize weevil *Sitophilus zeamais*), which is the main source of storage losses. Others use local aromatic plant materials; while the majority use no control methods whatsoever.

The maize is stored from one harvest to the next; barring early depletion of the stock, as a result of insufficient production, unexpectedly large demands on the supply and/or excessive storage losses. The maize is removed piecemeal over the storage period at weekly to fortnightly intervals for consumption, sale or animal feed. During removal from the store, the maize ears are dehusked and graded into two categories: "good maize" (for consumption or sale) and "bad maize" (for animal feed or sale as feed, or rarely, outright disposal).

Because of farmers expressed and revealed preferences for maize with flinty grains, the TLU has been encouraging the highland maize breeder to select for this characteristic in the new varieties being developed. However, at this point we have neither reliable estimates of real storage losses (qualitative and quantitative) experienced by farmers, nor estimates of the effect of grain type on storage loss rates under farmers' storage conditions.

In January 1990, the TLU, in collaboration with the FAO Postharvest Food Loss Reduction Project (FAO-PFLRP)(Bamenda), the IRA grain storage entomologist (Dschang) and the IRA maize pathologist (Bambui), initiated a survey of farmers traditional maize stores in two zones in the North West Province. The objectives of the survey were: 1) to assess real maize storage losses; 2) to identify and characterize insect and fungal agents responsible for storage losses; and, 3) to estimate economic loss under varying assumptions about timing of farmer's removal of maize from the store and susceptibility of the maize variety (grain type) to weevil damage.

Thirty farmers were selected (non-random) from 5 villages (6 per village) in each of the zones (total=60): Ndop Plain (mid-altitude) and Bui highlands (high-altitude). The farmers were interviewed and 10-ear samples removed from their stores every month beginning in January and ending at harvest in August/ September. The samples were sent to the FAO PFLRP laboratory for loss assessment studies; and subsamples sent to the entomologist and pathologist for identification of the insects and fungi[1].

Loss assessment was hampered by the late start of the survey (4 months into the storage season, disallowing the base sampling necessary for the Thousand Grain Mass [TGM] method) and dependance on a single laboratory technician who gave priority to the processing of samples from the storage trial program of the FAO-PFLRP. As a result, samples were often processed 1 to 2 months after sampling, casting doubt on the loss estimates obtained. - A second lab technician began work with the FAO-FLRP in September. So the survey is being repeated with a smaller sample of farmers' stores (20 plus 20), beginning in October for the mid-altitude zone, and December for the high-altitude zone. A report of storage losses will only be available next year.

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[1] The entomology and pathology findings are reported in their respective annual reports.

The original interview, together with a short questionnaire filled out monthly during sampling from the store, provided information on the farm household, the initial quantity of maize in the store, rates of removal from the store, family consumption patterns and quantities sold during the year (**Table 1**). The survey farmers were 90% female; ranging in age from 21 to 82 (mean=40); with from 0 to 11 years of schooling, almost half being unschooled (mean=3); and, living in households averaging 9 members.

The survey households consume maize daily, and most often 2 to 3 times a day. By far, Fufu-corn is the most common form in which maize is consumed. Other forms consumed, in order of importance are pap (a thin cereal eaten in the morning), cornchaff (fried with beans), cornbeer and roasted ears.

The maize sampled in the stores in Ndop and Bui, respectively, was: 83% and 63% Local variety (the rest were IRA improved varieties); 100% and 63% in the husk: 63% and 100% white: and, 73% and 77% flinty or flinty-dent grained. Fifty-three percent (53%) of farmers in Ndop and 90% in Bui used no storage pest control measures.

The quantities of maize reported are farmer estimates, based on standard local measures (e.g., jute bag and 15-liter bucket). The estimated removal rate was cross-checked by comparing it with independently elicited estimates of quantities consumed and sold. As it turned out, the estimated quantities consumed and sold per week was only 10% above and 3% below the estimated totals removed from the store each week in Ndop and Bui, respectively (**Table 1**). At reported rates of removal, and assuming no storage losses, the initial quantities stored would last 44 weeks in Ndop and 32 weeks in Bui.

Table 1: Mean summary characteristics of households participating in the farmers maize storage survey and their maize stores (n = 30 + 30).

Item	Ndop Plain Mean (SD)	Median	Bui Highlands Mean (SD)	Median
Farmer*:				
% female	93.3		87.3	
Age	38.2 (13.2)	35.5	42.4 (9.7)	42.5
Education	2.1 (3.1)	0	3.7 (3.6)	4
# wives	2.9 (3.7)	2	1.2 (0.7)	1
# children	5.1 (3.8)	4	3.6 (2.1)	3
# other household	1.5 (1.8)	1	1.6 (2.2)	0.5
# times maize is is eaten per week	14.7 (4.9)	14	23.1 (5.9)	21
Quantity consumed per week (kg)	27.0 (16.5)	22.5	25.5 (10.5)	22.5
Quantity sold per week (kg)	11.0 (16.2)	0	8.0 (20.4)	0
Altitude of store (m)	1200 [100 m range]		1900 (167)	1970
Initial quantity in the store (kg)	1526 (758)	1300	1113 (802)	800
Quantity removed from store per week (kg)	34.5 (19.5)	30	34.5 (1.2)	30

* The farmer is the person responsible for managing the sampled store; most often a wife. Items 4, 5 & 6 indicate the total number of wives, children and other household members in the head of household's compound.

Stored maize valuation model[2]: In determining the value of the maize harvest to the farm family, farming systems economists typically evaluate net yield at a single price and deduct production costs to arrive at a net return to the residual factors (e.g., farmer's labor, management and land). However, this procedure does not adequately model the true relative benefits to the farmer, who, as described above, stores her maize from harvest to harvest, removing it piecemeal for food, feed or sale throughout the year.

A model was developed that values maize at the time of removal from the store, while adjusting for storage losses (quantitative and qualitative), rate of removal from the store, and changing qualities of food and feed maize over the storage season. The model can be used to estimate the true value of farmer's storage losses; to compare maize varieties with differing resistance to storage pests (e.g., flints vs dents); and, to evaluate new storage technologies (e.g., use of storage chemicals and hermetic storage).

The principal equations in the model are as follows:

$$R_i = C_i + F_i$$
$$= C_i (A_i - O_i) / (D_i - O_i) \qquad (1)$$

$$Q_i = (Q_{i-1} - R_i) (1 - M_i) \qquad (2)$$

$$V = (P^c_1 C_1 + P^F_1 F_1) + \ldots + (P^c_n C_n + P^F_n F_n) \qquad (3)$$

Where:

R_i is the total quantity (weight[3]) of maize removed from the store at the beginning of the ith storage period. [kg]

C_i is the quantity of food or market quality maize removed from the store at the beginning of the ith period. [kg]

F_i is the quantity of feed quality maize removed from the store at the beginning of the ith period. [kg]

A_i is the observed proportion of damaged grains in food and/or market quality maize at the beginning of the ith period. (This represents the acceptable levels of damaged grains in maize destined for human consumption in the ith period. It is assumed that quality standards will decrease over the course of the storage season, as supplies are drawn down and maize prices go up. Therefore, A_i should increase as one moves away from the harvest.) $0 \leq A_i \leq 1$

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[2] This was the subject of a paper presented at the AFSRE Symposium at MSU, 14-17 October 1990.

[3] Weights based on shelled maize at standard moisture content.

O_i is the observed proportion of damaged grains in feed quality maize at the beginning of the ith period. $0 \leq O_i \leq 1$

D_i is the proportion of damaged grains in the stored maize at the beginning of the ith period. $0 \leq D_i \leq 1$

Q_i is the (effective) quantity of maize remaining in the store at the end of the ith period. [kg]

M_i is the marginal weight loss for stored maize during the ith period, expressed as a proportion of the quantity of maize remaining in the store at the end of the previous period, Q_{i-1}.

V is the total value of maize in farmer's store to the farm family. [CFA]

P^c_i the price of food quality maize in the ith period. [CFA/kg]

P^f_i is the price of feed quality maize in the ith period. [CFA/kg]

This formulation of the model assumes that the farmer decides in advance the quantity of food quality maize to be removed in each period; and continues to remove, dehusk and sort the maize until she obtains this quantity (C_i). In this case the total amount of maize removed from the store (R_i) is a function of C_i, plus D_i, A_i and O_i. The surveyed farmers indicated in their monthly questionnaires that the quantity consumed per month was more or less constant, giving credence to the above formulation.

If, however, it is found that the farmer only pre determines the total quantity removed each period (R_i), and this is a function of the quantity remaining in store at the end of the previous period (Q_{i-1})[4]; then the quantity of food quality or consumption maize (C_i) will vary with this quantity (R_i), plus the same 3 variables listed in the paragraph above. In this case, the model can be simply reformulated by making R_i a function of Q_{i-1} [e.g., $R_i = Q_{i-1}/(13-i)$]; and solving equation (1) for C_i, to determine how much food maize is consumed or sold in each period.

<u>Mid-altitude maize (+groundnuts/soybeans) variety trial</u>:

This was a continuation of the "second generation" on-farm mid-altitude maize variety trial, initiated in 1989[5]. In it, new open pollinated maize varieties, with specific advantageous traits, were compared with selected varieties already released to farmers, plus the farmer's local variety. Two additional varieties were added this year.

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[4] A mechanism suggested by Dr. Susan Almy (TLU-Ekona).

[5] First generation on-farm maize variety trials were run from 1982 to 1985, and resulted in the release of COCA, BACOA and KASAI for extension to farmers in the 1000-1500 m zone in the North West Province.

The new varieties and their salient characteristics are: MSR (white, flinty-dent, long cycle, MSV-resistant), Synthetic 2 (white, flinty-dent, long cycle, MSV-resistant), ATP (yellow, flinty-dent, long cycle, acid tolerant) and Early White (white, flinty-dent, short cycle, short plant type). The released varieties used as checks include: COCA (white, dent, long cycle), KASAI (white, flinty-dent, medium cycle, short plant type) and BACOA (yellow, dent, short to medium cycle). The "Local variety" can differ from village to village, and even farm to farm.

The 8 maize varieties were planted on farms in three mid-altitude zones in the North West and West Provinces. The design used was RCBD, with 2 replications per farm. The experimental unit was 30 square meters (5 x 6 m); and the trial plot, 552 sq m (23 x 24 meters). The maize planting density was 40,000 plants per hectare (2 rows per 1.5 m ridge, 33 cm between plants). Compound (20-10-10) fertilizer was applied one month after planting, at a rate of 300 kg/ha. Maize was intercropped with groundnuts (local variety; 88,888 plants/ha) in one replication, and soybeans (seed obtained from the national soybean project; 177,777 plants/ha) in the other replication. A sample plot (5 meters by 5 ridges) was pegged out in each farmers field near the trial plot, at the time of fertilizer application, to provide an estimate of the farmer's yield.

The IITA team harvested 27 sites (farms): 9 in Ndop Plain, 7 in Bamenda Plain and 11 in the West Province. When the results are pooled for the 27 farms, it showed that all 7 improved varieties yielded more than the Local variety check (**Table 2**). The mean yield advantages over the Local variety ranged from 469 to 750 kg/ha. There were no discernible differences among the improved varieties. Only 281 kg separated the improved variety with the highest nominal yield (KASAI) from the lowest yielder (BACOA).

Within the subzones, however, the improved varieties could be separated on the basis of yield. In Ndop Plain (a fertile valley at the lower end of the mid-altitude zone), 5 varieties (KASAI, ATP, Synthetic 2, Early White and MSR) outyielded both BACOA and the Local variety. In Bamenda Plain (a higher altitude valley with problem soils), KASAI, COCA and BACOA outperformed ATP, Early White and the Local variety. On the West Province Plateau (high fertility zone), all the improved varieties, except MSR, yielded more than the Local variety.

Wind storms in July knocked down much of the maize at several of the trial sites, demonstrating clear varietal differences in resistance to lodging (**Table 2**). The lodging scores (% final stand lodged) for Early White (3.6%) and KASAI (4.3%) indicate good standability; whereas those for Local (14.1%) and COCA (12.6%) show an inability to stand up under heavy winds.

Farmers were asked to choose the one or two best varieties at each site. If one variety was selected, it was given a rank of 1 and the other varieties a rank of 2. Where 2 were selected, they were ranked 1 and 2, and all the rest given a rank of 3. The mean preference ranking is presented in Table 2.

Table 2: Mean grain yield (kg ha^{-1}), yield rank, lodging percentage (%) and farmers expressed preference ranking, for selected mid-altitude maize varieties (MWP & WP)

Maize Variety	YIELD Ndop	Banenda	W. Prov	All	Yield Rank	Lodging %	Pref Rank
KASAI	3858 a	1944 a	3804 a	3340 a	3.4	4.3 cd	2.0
COCA	3610 ab	1954 a	3975 a	3329 a	3.5	12.6 a	2.1
ATP	3902 a	1562 bc	3644 a	3190 a	4.2	5.7 c	1.9
Synth	23739 a	1626 abc	3724 a	3185 a	4.3	4.6 cd	2.0
Early W.	3833 a	1539 bc	3651 a	3164 a	4.3	3.6 d	2.3
HSR	3682 a	1744 ab	3445 ab	3083 a	4.7	5.0 cd	2.2
BACOA	3209 bc	1954 a	3639 a	3059 a	4.9	8.1 b	2.2
Local	3018 c	1301 c	3061 b	2590 b	6.6	14.1 a	2.4
SE	164.2	123.6	171.6	94.4	-	0.67	-
CV	19.3	27.2	22.2	22.2	-	65.4	-
Farmers yield	1735	1203	2452	1982			

Three variables (yield, lodging resistance and farmer expressed preference) are used in **Table 3** to rank the 8 varieties. A mean of these rankings is used to produce an overall ranking of the varieties. KASAI is ranked first; followed closely by ATP and Synthetic 2. Early White and COCA are not far behind. While BACOA is a distant 7th, having ranked 7th in yield, 6th in lodging resistance and tied for 4th in farmers expressed preference.

Table 3: Ranking of selected mid-altitude maize varieties by mean grain yield, lodging resistance and farmers expressed preference; and the overall mean of these three variable rankings.

Maize Variety	Ranking of Mean Values: Grain Yield	Lodging resistance	Farmers Preference	Overall Mean Rank
KASAI	1	2	2	1.7
ATP	3	5	1	3.0
Synthetic 2	4	3	2	3.0
Early White	5	1	5	3.7
COCA	2	7	3	4.0
HSR	6	4	4	4.7
BACOA	7	6	4	5.7
Local	8	8	6	7.3

Yields of the associated groundnut and soybean crops did not differ significantly under the different maize varieties. The mean dry shelled grain yields were 252 and 395 kg/ha, respectively.

Mid-altitude farmer managed KASAI maize variety trials:

Seed of KASAI maize variety was provided to more than 50 farmers throughout the mid-altitude zone in the North West and West Provinces. After the farmers had planted their maize, the TLU team passed around to stake out two 5-meter by 5-ridge subplots on each farm (mean area = 38 sq m); one for KASAI and the other for the farmer's LOCAL variety. A month later, fertilizer was applied to the KASAI plots at the rate of 250 kg/ha of 20-10-10 compound fertilizer. Some farmers applied fertilizer to the LOCAL variety plots. Others didn't.

Logistical constraints limited the number of farmer managed trials that could be harvested by the TLU team to 28. Mean yield gains for the KASAI plots over the LOCAL plots in Ndop Plain, Bamenda Plain and the West Province Plateau, respectively, were 105, 40 and 145% (Table 4). As in past years, Bamenda Plain showed the lowest yield gain. The overall gain across the mid altitude zone was 70.5%.

Practically all the participant farmers (27 out of 28) said that they preferred Kasai I to their own variety (Table 4). Of these, 56% cited superior yield as the deciding factor; 44% cited plant type (short, lodging resistant); 33%, ear aspect; 22%, grain type; and, 11%, taste.

Table 4: Mean grain yield (kg ha^{-1}), partial net benefit (CFA ha^{-1})* and farmers expressed varietal preferences (%) for farmer-managed KASAI maize variety trials, by subzone.

SUB ZONE	Grain Yield LOCAL	Grain Yield KASAI	Net Benefit LOCAL	Net Benefit KASAI	Preferring KASAI
Ndop	1,140	2,335	65,101	104,349	100%
Bamenda	1,620	2,274	67,085	78,549	93%
W. Prov	1,126	2,760	58,083	111,978	100%
Overall	1,395	2,378	65,449	89,785	96%

* Total revenue (maize plus groundnuts), assuming sale at harvest; net of seed and fertilizer costs.

High-altitude maize (+ bean) variety trial:

Since 1989, the TLU and the Highland Maize Breeding unit have been working in close collaboration, to accelerate the process of identifying and releasing a maize variety for the high altitude zone (1500-2400 m; especially above 1800 m). This goal has been given high priority because: 1) The high altitude zone is one of the most important maize growing areas in the Western highlands; and, 2) there is, as yet, no improved (IRA) maize variety for this zone.

In 1989, two maize varieties from highland populations (HAP and Pool 9) were tested against COCA and the farmers LOCAL variety on farms in the Bui Highlands. HAP was singled out as the most promising of the two.

In 1990, the same two varieties, plus an improved version of a Local variety (Improved Ndu Local), were tested against COCA and LOCAL in on-farm trials at high altitude sites in Bui, Donga-Mantung and Menchum Divisions in the North West Province. The trial (RCBD, 4 replications, 24 sq. m. experimental plots) was set out on 14 farms, with the maize planted at a density of 26,666 plants/ha and intercropped with phaseolus beans (177,777 plants/ha). Fertilizer (20-10-10 at 300 kg/ha) was side dressed to the maize 4 to 6 weeks after planting.

Two of the sites (farms) were found to be at altitudes below 1500 m, and were therefore excluded from the analysis. The 12 farms retained covered a range of altitudes (1760 to 2250 m) and farm productivity levels* (as indicated by farmers sample plot maize yields that varied from a low of 394 kg/ha to a high of 4671 kg/ha) **(Table 5)**.

Across locations, HAP was the highest yielder, significantly outyielding COCA and LOCAL **(Table 5)**. Even using median yields, the order of the varieties and the yield margin between HAP and LOCAL (> 600 kg/ha) are preserved. The ranking of the varieties by yield (1-5) differs considerably from farm to farm. But using the across location mean ranking once again confirms the order shown in Table 5 (mean ranks = 2.4, 2.8, 3.1, 3.3 and 3.4, respectively). HAP ranked 1st or 2nd in yield on 8 of the 12 farms.

Farmers expressed varietal preferences were influenced most by yield and grain quality (color and texture). Because HAP, at present, has a mixed grain color (approx. 10% yellow), it was sometimes passed over by farmers for the more "attractive" Improved Ndu Local or Pool 9. Therefore, the next goal of the NCRE Highland Maize Breeding Unit should be to convert HAP to a pure white variety. Flintiness, although appealing to many farmers, is of less importance at higher altitudes, where cooler storage temperatures mean lower insect related storage losses, than in the mid and low altitude zones.

Table 5: Mean grain yield (kg ha⁻¹) for selected high altitude maize varieties (NCRE)

Variety	F 1	2	3	4	5	A 6	7	8	R 9	10	M 11	12	Overall
HAP	5013	3677	3746	3445	3107	3616 ab	4025 ab	1449 b	1634	1402	5989 a	4412 ab	3476 a
Imp Ndu Loc	4564	3919	4351	2355	3725	2732 c	3335 bc	2431 a	1346	1301	5290 a	3901 b	3351 ab
Pool 9	4404	4027	3441	2542	3407	3523 a	3393 bc	2010 a	1448	1532	5957 a	4203 ab	3325 ab
COCA	4523	3336	3212	3344	2374	3016 bc	4335 a	1227 b	1612	1736	5337 a	4725 a	3179 b
LOCAL	3638	4102	3106	3262	3320	2632 c	2207 c	2068 a	1681	1814	2701 b	2304 c	2849 c
SE	325.3	319.5	339.2	335.2	561.0	211.9	320.1	171.3	178.8	233.3	524.6	228.2	95.5
CV	14.6	16.6	17.2	21.3	35.2	13.3	16.7	18.7	21.8	32.3	21.5	11.4	20.4
$LSD_{.05}$	NS	NS	NS	NS	NS	653.0	924.3	527.9	NS	NS	1616.6	703.2	264.6
Farmers													
Yield	4671	1931	1155	2252	2357	1075	2374	1530	3533	394	1672	1924	2071
Altitude (m)	2220	1960	-	2100	2160	1950	-	1760	-	2250	1840	1900	

*Farm productivity reflects a number of variables, including native soil fertility and farmer's management level.

Associated bean yields (mean = 334 kg/ha), although extremely variable across farms, were not affected by maize variety.

After reviewing these results, the Highland Maize Breeder, MIDENO Adaptive Research Agronomist and TLU researchers agreed that HAP should go into production at the MIDENO seed farm in 1991; so that, if next years on-station (TDC) and on-farm trial results confirm the findings of this and last year, seed will be available to be distributed to farmers for the 1992 cropping season.

Maize + beans N & P levels trial:

In 1989, the TLU planted maize+beans NxP response trials on 20 farms in the Bui highlands of the North West Province. Three levels each of N (30, 60 & 90 kg/ha) and P_2O_5 (0, 30 & 60 kg/ha) were arranged in all possible combinations (plus a zero fertilizer check), in a RCBD design with 2 replications per farm. No yield responses were detected. [See 1989 NCRE Annual Report.]

In 1990, the TLU returned to repeat the trial on 19 of the 20 farms. The original plots consisted of 4 1.5-meter wide ridges with 2 5-meter maize rows per ridge. After the harvest, the ridges were split, following the common practice, forming new ridges where the furrows had been. Therefore, the outside halves of the outer ridges of neighboring plots were combined constituting a single border ridge; and leaving only 3 ridges in each plot that were truly representative of the previous year's treatment. The same treatments were applied to these 3 ridges.

Once again, there was no discernible effect on maize yield from N or P; either on individual farms, or when the data was pooled for across location analysis (Table 6).

Table 6: Mean maize grain yield (kg ha^{-1}) from maize+beans N & P level trials, by treatment, and by N & P level (19 farms in Bui highlands)

			FACTORS			
Tmt	N - P	Yield	N	Yield	P	Yield
1	0 - 0	2620 (NS)	30	2962 (NS)	0	2999 (NS)
2	30 - 0	2948	60	3032	30	3016
3	30 - 30	2987	90	3005	60	2985
4	30 - 60	2952				
5	60 - 0	3157		SE 85.0		
6	60 - 30	3130		CV 27.8%		
7	60 - 60	2819				
8	90 - 0	2891				
9	90 - 30	2930				
10	90 - 60	3194				
	SE	144.3				
	CV	27.6%		Farmer's yield 2170		

Maize+beans exploratory NxPxDensity trial:

In 1989, the TLU carried out a Rapid Rural Appraisal (RRA) Survey in Donga-Mantung Division in the North West Province, in collaboration with the IRZ/GTZ Livestock Systems Research Project and MIDENO. For the TLU, this was a new, unexplored (with the exception of minikit trials) research domain(s). Although providing useful descriptive information and broadly defined constraints for farming systems in the Division; the RRA fell short in identifying specific technical constraints, such as soil nutrient deficiencies or maize varietal limitations. In 1990, the TLU followed up the survey with an exploratory maize trial in the high altitude region in Donga-Mantung Division, to look at the potential yield response of a maize+beans crop to nitrogen, phosphorus and plant population.

COCA maize variety was intercropped with beans, while three factors (N, P and Density) were applied at 2 levels each (low and high), in a full factorial arrangement (8 treatments). Two (2) additional Local maize variety checks completed the 10 treatments in the trial. The trial was replicated twice on each of 5 farms in Ndu Village in Donga-Mantung Division, ranging in altitude from 2000 to 2140 m.

Nitrogen and phosphorus fertilizer had no effect on maize yield. Doubling maize density, however, increased yield by 413 kg (22%) **(Table 7)**.

Table 7: Mean maize grain yield (kg ha^{-1}), by factor level, for exploratory NxPxDensity trial (Ndu, NWP)

Nitrogen level	Yield	Phosphorus level	Yield	Plant Density	Yield
(kg/ha)		(kg/ha)		(plts/ha)	
100	2140 (NS)	120	2140 (NS)	53,333	2262 a
0	1971	0	1971	26,666	1849 b
	SE 137.7		CV 42.4%		

Maize minikit trial:

Three hundred (300) maize minikits were distributed to extension staff in the North West and West Provinces in 1990, bringing the 8 year total to 2550. Nine maize varieties (4 mid-altitude and 5 low-altitude) were tested individually against a local variety check, with and without fertilizer. The TLU received 127 observation forms through the mail; a 42% return rate, comparable to previous years.

Most of the participating farmers planted on ridges (69%) and buried their crop and weed residues (70%). Production problems reported included: birds (42%), poor soil (28%), animals (20%), insects (20%), thieves (20%), stem borers (16%), lodging (15%) and disease (7%). Maize yield results and farmer varietal assessments are reported in **table 8**.

On average, the improved varieties yielded 33% higher than the local varieties, and fertilizer boosted yield by 37%. Overall, 90% of the farmers affirmed that they preferred the improved varieties. However, 69% claimed that the LOCAL variety stored better than the Improved varieties.

Table 8: Maize grain yield (kg ha^{-1}) and farmer appraisals of selected characteristics for nine maize varieties tested in minikit trials (NWP & WP)

Variety	n	MAIZE YIELD LOCAL -P	LOCAL +P	IMPROVED -P	IMPROVED +P	% yield increase for improved var. -P	+P	FARMERS ASSESSMENTS Prefer Imp var	Local variety stores better
		(kg / ha)				(%)	(%)	(%)	(%)
MSR	9	3139	4091	4233	5325	35	30	90	89
KASAI	15	3351	3689	3900	4939	16	34	94	62
BACOA	16	2548	3694	3400	4701	33	27	88	56
CMS8704	9	2615	3351	3687	4393	41	31	100	67
CMS8501	14	2352	3220	3550	4701	51	46	81	57
EK WHITE	11	1911	3209	2968	4983	55	55	83	83
CMS8507	8	2191	3251	3258	4208	49	29	88	62
COCA	14	2044	3147	2980	4616	46	47	93	92
EK YELLOW	15	2056	2416	1987	2971	(-3)	23	100	56
Mean		2489	3369	3276	4535	32	35	90	69

Maize-rice cropping systems trial:

From 1987 to 1989, the TLU double-cropped maize and rice on 4 farms in the Menchum Valley, in a bid to improve the land and labor use efficiency of the irrigated rice cropping system. Maize was to replace the normal grass fallow in the paddy, while substituting for (or supplementing) maize normally grown on upland plots, thereby reducing labor for land preparation.

Maize, in the place of grass fallow, had no effect on rice yield, and contributed an average of 3 tons of maize into the bargain. However, on some plots (paddies), the pathologist noted the incidence of banded-leaf spot on maize when planted on the flat. Therefore, a trial was designed to investigate the effects of land preparation (flat vs ridges) and maize variety on the disease incidence and maize yield.

A split plot design was employed, using land preparation (flat and ridged) as the main plot treatment and maize variety (CMS8704, CMS8507 and CMS8501) as the subplot treatment. The trial was planted on 11 farms; each farm serving as a replication.

Maize on ridged plots had significantly lower banded-leaf spot infestation rates than when planted on the flat, with no significant difference among varieties (see the Maize Pathology section). Ridging also increased maize yield by more than a ton; again, with no discernible difference among the three varieties **(table 9)**.

Table 9: Mean maize grain yield (kg ha^{-1}) for maize-rice cropping systems trial (Menchum Valley, NWP)

Main plot treatment	Yield	Subplot treatment	Yield
Land preparation		Maize variety	
Ridges	3386 a	CMS 8704	2946 (NS)
Flat	2207 b	CMS 8507	2733
		CMS 8501	2709
SE	126.7		120.0
CV		20.1	

6.2. EKONA TLU

6.2.1. INTRODUCTION

The Testing & Liaison Unit at Ekona works to improve food crop production of smallholders in South West Province through diagnosis of agricultural constraints and opportunities, testing of improved varieties and agronomic cultural practices, and liaison between the extension service and IRA. Constraints identified for action or further study in 1990 included: (1) low soil fertility due to shortened fallow periods; (2) insect (snail, borer and egusi beetle) and weed problems; (3) labor bottlenecks (high land preparation costs and late weeding); (4) disease-susceptible and low-yielding local varieties of maize and cassava; (5) food-crop marketing potentials; (6) pattern of diffusion of IRA technologies; and (7) inadequate maize storage facilities.

The key zones that are the focus of the Ekona TLU activity, are (1) the Lower Volcanic (LV), with recent volcanic soils, in Fako; (2) Kumba Corridor (KC), older volcanic soils, central Meme; (3) Sands (S), sedimentary sandy clay loam, S I with lower rainfall in Fako-Meme, and S II, high rainfall, in southern Ndian; and (4) Mamfe (M), with acidic, low-fertility soils, in Mamfe Central and Eyumojock, the more sandy Mamfe West (MW) around the town, and the heavy clay Mamfe Forest (MF) to the east and south.

The 1990 research activities included: (1) data collection for creation of field economic models (cost/benefit) by zone, including monitoring of labor costs of planting, land preparation and weeding, and measurement of typical farmers' intercrop yields; (2) market price recording and marketing analysis; (3) fertilizer risk analysis; (4) evaluation of farmer research priorities and response to existing IRA technology, including an impact (adoption) survey, minikit and village group discussion; (5) economic analysis of traditional and proposed storage methods, and continuing storage trials with entomologist C. Asanga; (6) on-farm trials including maize variety x N-P-K, N-P response on maize, cassava time of harvesting effects on cooking, rotting, quality and yield, maize and egusi insect pest control, and an introduction of alley cropping species to some farmers' fields; (7) on-station trials, including chemical/manual weed control, maize groundnut rotation, legume species selection, and effect of alley cropping species on maize yields, as well as collaboration with Drs. Thé and Balasubramanian in national maize variety and crop association/rotation trials; and (8) completion of soil profiles of the 4 key zones.

Activities planned for first season were completed successfully. Some second-season activities were scaled back to allow more time for reporting; the rest will be completed during January-February by the continuing national staff. Syntheses have been prepared of the soils, farming systems survey, marketing, maize variety and fertilizer results.

6.2.2 OUTPUTS AND ACCOMPLISHMENTS

Sub-Goal	Outputs	Accomplishments
1. Variety assessment	Maize variety x NPK trial, minikits: researcher and farmer agronomic, consumer assessment	Improved varieties CMS 8501, Suwan 1 SR Y, DMR ESR Y out yielded local maize. Suwan 1 SR Y most preferred for green consumption, CMS 8501 for fufu. Minikit and test kit results confirmed CMS 8501 and Suwan 1 well accepted by farmers. N-P-K applic. increased maize yield by 33% averaged across zones.
	Cassava var x Hz x NPK	IRA CSV 8017, 8034, 8061 out-yielded local csv across all zones. NPK applic. depressed csv. yield in Hfe. 8017 out-yielded 8034 by 9% across all zones; 8034 was better in the Sands only. Maize intercrop did not affect csv yield.
	Cassava time of harvest vs yield, cookability and rotting	On going research
2. Soil management improvement	Select legume species for intercrop and fallow trials	Local pigeon pea, Teophrosia, Desmodium, and Crotolaria selected for future use in fallow management due to excellent ground cover, high DM biomass and N-input to the soil. Trial repeated this season, should continue 1991 first season.
	Assess N contrib. from alley-cropping species on maize yields on-station, on-farm	Leucaena leucocephala gave maize yields comparable to 80kg/ha N; being introduced to farmers' fields along with cassia spectabilis.
	Assess N-P fertilizer needs by zone on-farm	In KC N and P did not affect maize yield significantly, whereas in the Sands N alone increased maize yield by 200%.
	Assess maize yield increase from groundnut rotation	N demand can be reduced 50% for maize planted after groundnut.

Sub-Goal	Outputs	Accomplishments
	Soil Profile characterization at KC, S, and Mamfe	Average surface soil depth was 18cm. Soil results have been used to interpret results.
3. Pest control	Assess profitability of herbicides vs. manual weed control	Round up & Armadas excellent control of spear grass 2nd season; 1st season land was properly plowed & herbicide effect was not significant.
	Assess toxicity, profit of hermetic storage of maize and of traditional methods	Hermetic storage 2-4 times more profitable than best traditional method, all storage profitable 6-7 months maximum; no equip. avail. for toxicity test
	Assess chemical, other methods of insect control for maize, egusi	No egusi infestation at trial sites so no insecticide effect.
	Assess stem borer incidence & control by furadan & time of planting	Not implemented, no time.
4. Evaluation of adoption potentials and impact.	Assess present & potential extent & impact of adoption of 6 IRA food-crop technol.	IRA cassava, maize, sweet potato preferred by most; cassava to reach near-total adoption by 1996; maize limited by seed multi-plication; potato little distributed; fertilizer, IRA plantain & rapid multiplic. low approval or use
	Chart food crop prices and influences on them in province	2-yr. charts for 19 crop forms prepared; most prices declined slightly second year; prices influenced by demand factors
	Determine farmers' labor costs by operation, zone, and typical yields	Most costly operation, land preparation, takes 60 person-days/ha; intercrop maize/egusi /groundnut yields much above sole maize (trial) yields even if omit late-harvest intercrops
	Meet in villages to evaluate research needs and results	Confirmed 1989 farmer research priorities (pest control, fer-tility) 2.90 mtgs.; results mtgs. scheduled 2.91

Sub-Goal	Outputs	Accomplishments
5. Communication of IRA results	Prov. training workshop, extension assessment of research needs, results	Workshop with 72 MINAGRI, IRA & devel. proj. staff 3.90, trained in 8 themes & evaluated variety & sustainab. res. plans
	Provincial farming systems synthesis and marketing reports for planners and IRA staff	Prepared for approval and distribution
6. Staff training (in house)	Computer courses in house-keeping, SYSTAT, MSTAT; typing and WP self-training	Basics of housekeeping, SYSTAT, MSTAT completed; self-training greatly limited by time avail.

6.2.3 OTHER ACTIVITIES

In 1990 the TLU was also involved in training, and presentation of results in diverse forums.

In training activities, the TLU carried out a 3-day provincial workshop for 72 participants, primarily agronomic extension agents of MINAGRI but including selected farmers, special-project and Community Development agents; topics were maize varieties, food-crop agronomy, sustainable agricultural systems, chemical use and pest control, marketing and cooking. Agents and farmers made group evaluations of the IRA maize varieties and of the potential for different sustainability options, and individuals made presentations of their work with the TLU. An apprenticeship was provided for a University of Dschang economics Ingenieur Agronome, and thesis orientation to economics and community development students interested in working on related problems. TLU researchers and secretary had local training in computer management, MSTAT, and SYSTAT, and three agronomic staff attended a Yaounde course in MSTAT. In-service training in on-farm trials continued for TLU staff and cooperating agents. Individual TLU researchers received training in extension (ICRA/Wageningen course) and maize production (IITA course). The economist received his PhD from the University of Nsukka.

Consultations on farming systems, trial and survey methodology were provided throughout the year to numerous farmers and extension agents, to the provincial planners for the new MINAGRI National Extension and Training Project, to the Korup Project in Nguti, to a Catholic Mission project in Akwaya, to USAID staff on Projet Semencier, to the Gatsby Foundation and IITA and ODI consultants on continuing cassava and plantain work, IITA Resource and Crop Management Program staff, and to IRA staff in Plantains, Soils, Root Crops and ROTREP.

Results were presented to farmers, extension and the general public, at the annual TLU workshop and associated Cameroon Tribune reports; to the Minister of Agriculture, at his visit to IRA-Ekona; and to researchers, in the American Society of Agronomy meetings, ICRA and IITA courses, and Association of Farming Systems Research & Extension Symposium (USA). Finally, the evaluation by farmers of IRA and other non-traditional agricultural technology was completed in the eight focus villages, and used to establish 1990 research priorities.

6.2.4. RESEARCH FINDINGS

6.2.4.1. Variety and Fertilizer Evaluation

6.2.4.1.1. Maize x NPK interaction

Objectives, material and methods

The objectives of this trial were to test the adaptability of the improved lowland maize varieties to the diversified environments, of the 4 key zones of South West Cameroon, their response to 300 kg/ha of 20-10-10, and their adoption potential by consumers.

The on-farm trials were researcher designed and farmer implemented with the assistance of extension agents. Land preparation, thinning, and timely weeding were done by farmers under the supervision of extension agents according to farmers' practices. The farmers were grouped in order to facilitate dissemination of information and ease of land preparation, planting, and weeding operations. Soil samples were collected from the sites at a depth of (0-20 cm) for chemical analysis. Similar trials were repeated in the second season in all sites but Mamfe and Sands (Ndian Division) due to bad roads and distance.

The trials were conducted in a randomized complete block design factorial experiment with 1 replication per farm. Maize was planted on flat land at LV, S, KC but on mounds at Mamfe West and on ridges at Mamfe forest. In LV, KC, and Sands the spacing between rows was 75 cm with 50 cm spacing between 2 plants within the row and a row length of 7 m whereas, in Mamfe West the spacing between mounds was 1.5 x 1.5m with 3 plants per hill spaced at 100 cm, and in Mamfe forest the spacing between ridges were 1 m with 50 cm spacing between rows/ridge and 75 cm between 2 plants within the row.

Thinning was done after seedling establishment followed by first weeding and fertilizer application at 3-4 weeks after planting (WAP), and second weeding at 6-7 WAP. NPK (20-10-10) was side dressed in band application at 0 and 300 kg/ha, respectively. The maize varieties included were CMS 8501, Suwan 1 SRY, DMR ESR Y and local. Maize ears were harvested from the central rows and yield (kg/ha) was computed at 15% moisture level.

Results and Discussions

Lower Volcanic

In the Lower Volcanic zone (Mutengene) unlike in the past the maize plant stands were relatively poor due to delayed or no weeding, low soil fertility (sites 3 & 4 with extremely low phosphorus) and animal damages. Consequently, a number of cobs were poorly filled with grain at sites 3 and 4 which could be attributed to low phosphorus level and

extremely heavy rainfall during the pollination period which might have washed off the pollen grain. In the other sites a high degree of ear rot was observed due to a combination of ear borer and heavy rainfall. The over all maize yield performance was not consistent with those of the past seasons.

The results showed significant maize yield increase due to fertilizer application and varieties used (Table 1). The highest mean yield of 4250 kg/ha was obtained from local maize fertilized compared to 1485 kg/ha DMR ESR Y without fertilizer. These yield differences could be attributed to the better ear cover of the local variety compared to poor ear cover of the improved ones which exposed them to ear rottening under the unusually heavy rainfall in July and August. Therefore the breeders need to improve the ear cover aspect of IRA maize in order to minimize ear rot and bird damage.

Table 1: Effect of N-P-K on yield (Kg/ha) of maize 1990, first season.

Treatments	Maize yields (Kg/ha)					
	LV	KC	S	H1	H2	All zones
CMS 8501 Fo	3003 AD	5610 A	4901 A	2011 CD	2750 AB	3632 BC
CMS 8501 F1	3058 AC	5874 A	4727 A	3602 A	3155 A	4213 AB
Suwan 1 SR Y Fo	1485 D	6292 A	4222 A	2123 BD	1969 B	3464 BC
Suwan 1 SR Y F1	3691 AB	6742 A	3877 AB	3361 AB	3412 A	4770 A
DMR ESR Y Fo	1993 CD	4681 AB	2345 AB	3305 AB	3412 A	3116 C
DMR ESR Y F1	2313 BD	6149 A	3126 AB	3079 AC	3226 A	4119 AB
Local Fo	3749 AB	3585 B	2372 B	1820 CD		2895 C
Local F1	4250 A	5875 A	2248 B	1659 D		4345 AB
Mean	2932	5601	3601	2620	3585	
cv(%)	27	22	32	28	28	30

Kumba Corridor

In Kumba Corridor the maize yield differences due to varieties was non significant due to the highly heterogeneous nature of the trial sites (CV 22%) and use of IRA maize in lieu of local variety by some farmers since they saved only IRA maize from the previous season. Nonetheless, the yield of the maize varieties was in the order of Suwan 1 SR Y > CMS 8501 > DMR ESR Y > local. The highest and lowest yields of 6742 and 3585 kg/ha were obtained from Suwan 1 SR Y fertilized and local variety without fertilizer, respectively (Table 1). N-P-K (60-30-30- kg/ha) application increased maize yield significantly with a mean yield of 6160 and 5042 kg/ha from the fertilized and unfertilized plots, respectively. Therefore, it is worthwhile to apply N-P-K (60-30-30 kg/ha) in order to maximize the maize yield potential in Kumba Corridor.

Sands

In the Sands there was no significant difference in yield among the maize varieties used due to the highly heterogeneous nature of the trial sites (CV 32%) and animal damages especially at Bongongo. However, N-P-K application increased maize yield significantly

confirming the need of N-P-K application in order to obtain reasonable maize yields (Table 1).

Mamfe (M1 with local)

In Mamfe West (Kembong) we had 5 sites. However, one set of trial was destroyed by termites while 2 sets of the trials were planted on a newly cleared forest area that has been fallowed for over 30 years. In the latter cases maize could hardly get established and eventually we could not get harvestable maize cobs. The Chief of Agricultural post and farmers indicated that this is a common phenomena of maize if planted on newly cleared land that has been left fallow for over 15 years. The cocoyams which were intercropped with maize in the same mounds were growing healthy and with high vigour. In Mamfe Forest (Fotabe) the farmers and the Chief of Agricultural post harvested and mixed the local maize from 4 trial sites. Therefore, we ended up with only 3 to compare local maize with IRA varieties.

In the 3 sites which included local maize (calabar) the results showed that the local yielded significantly lower than the improved varieties. NPK fertilizer increased maize yied significantly (Table 1). It is worthwhile to note that calabar is highly susceptible to maize streak virus. Nevertheless, the farmers still like to grow it because of its earliness in maturity (earlier than DMR ESR Y) and easy to chew when consumed dry. Therefore, we suggest that the breeders do some crossing of calabar with the improved IRA maize in order to improve its susceptibility to MSV and increase its yield potential.

Table 2: Effect of N-P-K on yield (Kg/ha) of maize across all zones, 1990, first season.

Variety	Maize yield (Kg/ha)		
	Fo*	F1*	Mean
CMS 8501	3632 BC	4213 AB	3922
Suwan1 SR Y	3464 AB	4770 A	4117
DMR ESR Y	3116 C	4119 AB	3617
Local	2895 C	4345 AB	3620
Mean	3277	4362	

Fo = without fertilizer
F1 = 60-30-30 kg/ha of N-P-K.

Mamfe (M2 without local)

In this set of trials the yield analysis from 7 sites showed that N-P-K application increased maize yield significantly, whereas there was no difference in yield among the improved varieties (Table 1). These results confirmed that it is worthwhile to apply N-P-K (60-30-30 kg/ha) in Mamfe in order to optimize maize yield. The maize yield performance of the improved varieties was in the order of DMR ESR Y > CMS 8501 > Suwan 1 SRY, indicating that DMR ESR Y is a prospective variety for Mamfe zone.

Effect of NPK on Maize yield across all zones

The results indicated that there were highly significant differences in maize yield due to locations with 33% increase in yield due to N-P-K applications. However, the yield differences due to varieties were not significant (Table 2). Nevertheless the yields were in the order of Suwan 1 SR > CMS 8501 > Local > DMR ESR Y with yields of 4117, 3923, 3620, and 3617 kg/ha, respectively. These results lead us to conclude that it is worthwhile to apply N-P-K (60-30-30 kg/ha) in order to optimize maize yield in the South West Province of Cameroon.

6.2.4.1.2. Effect of N and P rate of application on maize at Kumba Corridor and Sands

Materials and Methods

This trial was conducted in the Sands where N and P are deficient and in Kumba Corridor where P is usually below the critical level for maize production. The objective was to single out which of the nutrients most benefit maize production in the 2 zones. Land preparation methods and other field operations were the same as those in NPK effect on maize. The design used was a RCB 3 x 3 factorial experiment replicated by farm sites. The treatments were N and P applied at 0, 40, and 60 kg/ha, respectively. The maize variety used in the first season was CMS 8501 whereas in the second season DMR ESR Y and Suwan1 SRY were used in Kumba Corridor and Sands, respectively. Maize ears were harvested from the 3 central rows and grain yield (kg/ha) was computed at 15% moisture level.

Table 3: The Effect of N and P rates of application on yield (kg/ha) of maize, 1990 first season.

Treatments	Maize yield (kg/ha)	
N & P kg/ha	Sands	Kumba Corridor
0-0	1864 C	8432.5
40-0	3177 ABC	9993
60-0	4273 A	9116
0-40	3390 ABC	9797
40-40	3859 A	11477.5
60-40	4667 A	7224.5
0-60	2232 BC	9106.5
40-60	3695 AB	10036.5
60-60	4437 A	12688
Mean	3510	7541
CV(%)	23.8	36

Results and Discussions

In Kumba Corridor single application of Nitrogen and Phosphorus did not affect maize yield significantly due to the highly heterogeneous nature of the sites with CV of 36% (Table 3). However, in the Sands nitrogen alone increased maize yield by by 200%, whereas single application of phosphorus did not affect the maize yield (Tables 3). The highest maize grain yield (4667 Kg/ha) was obtained from the plots receiving 60-40 kg/ha of N-P even though it was not significantly different from single application of nitrogen at 40 kg/ha. Therefore, future research on the Sands should focus on nitrogen supplement from either chemical or combination of leguminous crops and chemicals at reduced levels.

6.2.4.1.3. Test kit results, first season 1990

The improved and the local varieties performed best in the Mamfe forest zone under farmer managed conditions. In all the zones, the improved varieties outyielded the local ones. The best variety across zones was CMS 8501 while within zones it varied. It is necessary to continue with the test kit testing for at least two more cropping seasons before drawing conclusions as to which variety is most suitable in each zone under farmer managed conditions. General minikit results for first season will only be available in February.

Table 4: Yield (Kg/ha) of Test Kits results 1st season 1990

	Yield (Kg/ha)						
Variety	Mamfe		Sands		Lower Vol.		
	Fot'e	Kebnq	Bonq'o	Mil.Eko	Mutq'ne	TOTAL	MEAN
Suwan 1 SR	6022	3911	1990	1315	918	14156	2831
CMS 8501	5206	3590	2940	1098	-	12914	3228
Local	4203	1072	833	937	629	3526	882
TOTAL	15511	8573	5813	3350	1547		
Mean	5170	2853	1939	1117	774		

6.2.4.1.4. Influence of N-P-K on cassava x maize intercropping

Materials and methods

In 1989/90, two sets of trials were conducted in order to evaluate the adaptability potential of the improved cassava varieties across the 4 key zones of South West Cameroon. In the first, cassava varieties 8017 and 8034 were planted as mono and intercropped with maize DMR ESR Y on farmers' fields in the four key zones in 19 sites. The key zones are Lower Volcanic (LV) with new rich volcanic soil, Kumba Corridor (KC) - medium fertility low in P, Sands (S) low in N,P, and K and Mamfe (M) granitic soil and slightly acidic. Half of the plots were fertilized with 400 kg/ha of N P K (20-10-10) at 3-4 WAP while the rest of the plots were not fertilized. Cassava and maize were planted on ridges in Mamfe and on

flat land in the other 3 zones. Weeding was done at 4 WAP followed by 7 WAP, with 1 additional weeding for cassava plots in October-November.

The row length was 9m with 1m spacing between rows and 1.5m between cassava stands within the row. Maize was planted between cassava rows at 1m x 1m spacing with 3 plants/hill, thus giving 10,000 and 6,667 plants/ha of maize and cassava, respectively. A RCB design factorial experiment with 1 replicate per farm was used. Maize yields (kg/ha) were computed at 15% moisture level and fresh tuber weight (t/ha) was harvested from the central rows.

In the second set of trials a cassava x maize intercropping trial was carried out following the same methodology. The varieties used were 8017, 8034, 8061, and local all grown without fertilizer.

Results and Discussion

The maize yield results are already included in the 1989 NCRE annual report. The effect of 80-40-40 kg/ha of NPK and maize on cassava yield per zone and across all zones (average) are shown in Tables 5 through 9.

In the LV zone cassava variety 8017 out yielded 8034 significantly with a yield advantage of 24% (Table 5). However, neither the fertilizer application nor maize intercropping had any significant effect on cassava yield. It is worthwhile to note there was a high incidence of root rotting in the Lower Volcanic and consequently the zone mean yield was unusually low.

In KC cassava yield was significantly increased due to 80-40-40 kg/ha of NPK where the mean yield from fertilized plots was 30 t/ha compared to 23.6 t/ha from the unfertilized check plots (Table 6). However, the yield differences due to varieties and intercropping with maize were not significant. These are clear indications that KC should be fertilized in order to optimize the cassava yield while either cassava variety can be beneficially intercropped with maize.

In the Sands zone, there was no significant difference in yields of cassava attributable to NPK application, variety, or intercropping with maize (Table 7). This could be due to the highly heterogeneous environments with a CV of 25% and location mean yields of 38 t/ha (Ekondo Titi) and as low as 13 t/ha at Yoke. In Mamfe variety 8017 (30 t/ha) gave significantly higher yield than 8034 (25 t/ha) regardless of cropping system on fertilizer application (Table 8). Thus 8017 proved to be a better variety for Mamfe. The lowest location mean yield of 21.4 t/ha was obtained at Kembong compared to a high of 32.4 t/ha at Nchang probably due to low P level and more acidic soils at Kembong. In Mamfe, unlike in the rest of the zones, N-P-K application depressed cassava yield. Cassava yield from fertilized plots was 26.1 t/ha compared to 29.7 t/ha from the unfertilized plots. Furthermore, cassava yields from the intercropped plots were higher than those from mono cassava plots. These results could perhaps be due to the maize shading effect on cassava thus promoting vigorous cassava establishment or it may also be due to maize removing excess N from the soil and thereby establishing an unbalanced balanced proportion of N-P-K for cassava tuberization.

Table 5: Effect of fertilizer and Maize on cassava yield (LV) 1990 first season.

Cassava Variety	Cassava tuber yield (T/ha)				
	F_0		F_1		Mean
	-Maize	+Maize	-Maize	+Maize	
8034	20.3 BC	21.5 BC	22.2 BC	16.6 C	20.2
8017	19.2 BC	25.7 AB	24.6 AB	30.5 A	25.0
Mean	19.8	23.6	23.4	23.6	
	Mean F_0=21.7		Mean F_1=23.5		

Table 6: Effect of fertilizer and maize on cassava yield (KC) 1990 first season.

Cassava Variety	Cassava tuber yield (T/ha)				
	F_0		F_1		Mean
	-Maize	+Maize	-Maize	+Maize	
8034	23.1 B	24.1 AB	25.2 AB	28.7 AB	25.3
8017	24.1 AB	23.1 B	31.9 AB	34.0 A	28.3
Mean	23.6	23.6	28.6	31.4	
	Mean F_0=23.6		Mean F_1=30		

Table 7: Effect of fertilizer and maize on cassava yield (Sands) 1990 first season.

Cassava Variety	Cassava tuber yield (T/ha)				
	F_0		F_1		Mean
	-Maize	+Maize	-Maize	+Maize	
8034	24.1 A	30.5 A	29.5 A	29.5 A	27.4
8017	24.6 A	24.8 A	26.3 A	30.5 A	26.6
Mean	24.4	27.6	25.9	30	
	Mean F_0=26		Mean F_1= 28		

Table 8: Effect of fertilizer and maize on cassava yield (Mamfe) 1990 first season.

Cassava Variety	Cassava tuber yield (T/ha)				
	F_0		F_1		Mean
	-Maize	+Maize	-Maize	+Maize	
8034	25.7 ABC	26.8 ABC	23.5 C	24.9 BC	25.2
8017	33.7 A	32.6 AB	25.6 ABC	30.4 ABC	30.6
Mean	29.7	29.7	24.6	27.6	
	Mean F_0= 29.7		Mean F_1= 26.1		

Table 9: Effect of fertilizer and maize on yield of cassava across all zones, 1990 first season.

Cassava Variety	Cassava tuber yield (T/ha)				
	F_0		F_1		Mean
	-Maize	+Maize	-Maize	+Maize	
8034	23.3 B	25.5 B	24.6 B	25.4 B	24.7
8017	26.1 B	23.7 B	26.5 B	31.7 A	27.0
Mean	24.7	24.6	25.6	28.6	
	Mean F_0= 24.6		Mean F_1= 27.1		

Table 10: Cassava tuber yield (t/ha) from cassava x maize intercropping trial, 1990.

	Cassava yield (t/ha)				
	LV	H	S	K	Mean
8034	38.85	24.17	57.04	19.99	35.01
8017	40.37	23.33	57.78	20.54	35.51
8061	31.07	29.17	48.89	10.56	29.92
Local	21.93	12.78	18.52	12.22	16.36
8034 + maize	39.11	27.78	52.52	18.15	34.41
8017 + maize	44.19	26.67	43.70	13.15	31.97
8061 + maize	28.15	16.67	45.93	7.41	24.54
Local + maize	16.44	9.99	23.70	7.51	14.43
Mean	32.51	21.32	21.19	43.52	
LSD.05			10		
CV(%)			21.8	13.7	

The modified yield stability analysis showed that 8017 was superior and more stable than 8034 in better cassava environments (KC, LV, Mfe) whereas 8034 did better under poorer cassava environments (Sands) when grown as sole crops with fertilizer application. Furthermore, 8017 showed constant superiority over 8034 when both varieties were grown in association with maize and fertilizer. The combined yield analysis across all zones showed that 8017 significantly out-yielded 8034 by 9% yield advantage and the fertilized plots gave higher yield than the checks (Table 9).

Cassava and maize intercropping

The results showed significant yield differences due to zones and varieties (Table 10). The lowest yield of 14.97 t/ha was obtained at Kumba Corridor due to high incidence of tuber rotting. The improved varieties outyielded local significantly both under mono and mixed cropping systems. There was no difference in yield among the improved cassava varieties. Maize intercropping did not have any significant effect on cassava yield. These results lead us to conclude that the farmer would be better off to grow the improved cassava varieties than local and would benefit more (biologic and economic yield) by intercropping as opposed to mono cropping cassava.

6.2.4.1.5. Fertilizer risk analysis

Farmers in SWP seldom use fertilizer. In the impact survey 15% of farmers had used it, but only 5% were still doing so, and most objected to spending money on it. Such expenditure, while much lower than for labour for land preparation, comes immediately after the latter in the agricultural calendar, when cash resources are at their lowest point. In order to evaluate the economic efficiency and risk of fertilizer use in the province, the TLU carried out economic analysis of the 80 on-farm maize variety and fertilizer trials harvested since 1987, using only the local variety and the IRA variety constant across all trials (CMS 8501).

Results showed that both variety and fertilizer made considerable contribution to farmers' income. CMS 8501 had an income advantage (MRR) over local of 20% and 30% with and without fertilizer, respectively. The advantage gained by fertilizer was 33% and 44% when applied to CMS 8501 and local variety, respectively.

These advantages varied by zone and season (Table 11). In KC, in first season, the improved variety and fertilizer gave rates of return of 58% and 28% respectively, but only 26% and 8% in the second season. In the LV zone, the improved variety and fertilizer gave 16% and 33% advantage, respectively, in first season, and 23% and 9% in second season. Due to the small number of trials per season (< 20) in the KC, Mamfe and Sands zones, only an elementary form of risk assessment (% of trial replications in which net benefits were negative) was used to evaluate the technologies within recommendation domains (Table 12).

Table 11: Advantages (ratios of net benefits) of variety and fertilizer by zone and season 1987-1990.

N	Zone	Season	Variety Advantage	Fert. Advantage
			8501 > local	$F_1$8501 > F_1local
12	KC	1	58%	28%
10	KC	2	26%	8%
20	LV	1	16%	33%
16	LV	2	24%	9%
5	Mfe	1	6%	60%
0	Mfe	2	-	-
14	Sds	1	34%	14%
3	Sds	2	53%	24%
80	SWP		30%	20%

Table 12: Risks of using CMS 8501 and fertilizer in 1987-90 on-farm trials by zone and season.

Zone	Season	Fo:8501> Local	F_1:8501> Local	8501:F_1>Fo	local:F1>Fo	N
KC	1	8%	25%	50%	58%	12
	2	30%	40%	30%	10%	10
LV	1	30%	25%	35%	50%	20
	2	38%	31%	38%	25%	16
Sds	1	21%	36%	14%	21%	14
	2	0%	0%	0%	33%	3
Mfe	1	60%	20%	40%	60%	5
	2	-	-	-	-	0

Using minimum returns analysis (MRA) for the 20 sites in the LV first season and for a total of 80 sites in the province, the following recommendations were made:-

1. Farmers in the LV zone should plant CMS 8501 without fertilizer, and if they have to plant the local maize they should consider applying fertilizer.
2. The same recommendation as in 1 applies to farmers in the four key zones combined. CMS 8501 without fertilizer has a higher average net benefit than local without fertilizer. The average of the lowest net benefits for local with fertilizer is higher than the average of the lowest net benefits for local without fertilizer. Overall, the averages of the lowest net benefits for the technologies recommended above are higher than the averages of the lowest net benefits for the farmers' practices.

6.2.4.2. Evaluations of Technology Impact and Demand

6.2.4.2.1. Impact Survey

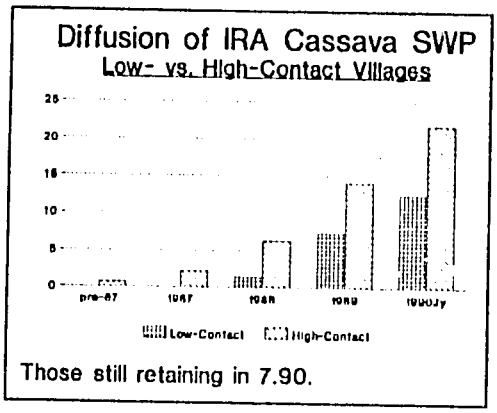
TLU impact on farmers to date is mostly limited to changing varieties in maize and cassava, since work on soil improvement, pest control and storage are not yet ready for diffusion. An adoption survey was carried out by TLU researchers and technicians in June-July 1990, using random samples of 16 villages in the four key zones, half in which we had worked extensively (high-contact, or HC) and half not (low-contact, or LC).

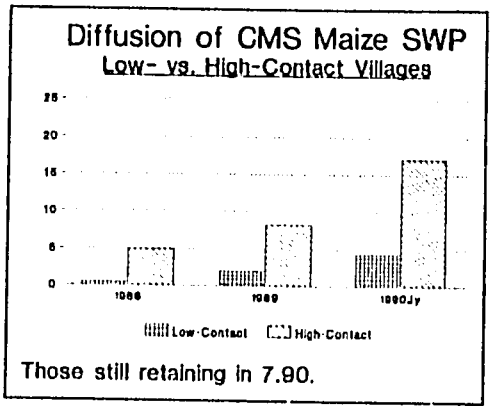
Interest in the IRA maize and cassava varieties is high. 72% of farmers (and 63% in the more representative LC villages) had heard of IRA maize, and 82% (80% LC) of IRA cassava. For both crops, two-thirds of those who had heard (62% LC) had tried to obtain planting materials. Half the farmers had learned of the varieties from other farmers, usually within the village, and a third from the extension service, usually the local agent. 60% who thought to get the material could find no one who had it, or came to the extension agent after it had all been given out; a fifth were denied material by other villagers.

After this common beginning, the diffusion of the two crops is quite different. Cassava planting material is difficult to transport and multiply in large quantity, but does not degenerate through admixture with local varieties and is easy to maintain in the field, where it is also very distinctive. The IRA Root and Tuber Program multiplied 40ha of cassava a year in 1988-90 and distributed it whenever they could get transport. Farmers claimed an annual multiplication rate on-farm of 15:1; with 10 short cuttings they could cover their farms in 2-3 years. After at least one harvest, loss rates were only 22% of recipients (38% LC), most of these from late receipt of cuttings or bush fire in the first planting.

A fifth of the farmers already had the IRA cassava by mid-1990, including 16% of low-contact farmers, and it is possible to project an adoption ceiling of 94% of farmers by 1996 from current trends. However, the loss of the Gatsby Project financing for IRA multiplication will curtail future direct distributions, which account for 46% of the increase to date. Most recipients have multiplied for themselves for one to two years and then let others take cuttings; those who have completed their own multiplication are planting on average 55% of their cassava fields to the IRA varieties, keeping their local for snack food and to have cassava during the months when the IRA cassava, which has shorter durability, has been harvested. The IRA cassava is highly valued at home and in the market for its white, tasty water fufu and good garri, high yields, and early maturity. Although it is very bushy for some cropping systems, farmers have adjusted by later planting or wider spacing.

Diffusion of improved maize is more complicated to achieve and to evaluate. With two parents, even composite maize rapidly degenerates by admixture with locals in the field, and improved seed must be replaced regularly from a pure source. IRA has no facilities for large-scale seed multiplication, and the Ministry of Agriculture has done no seed multiplication in the coastal lowlands. The sole source of CMS maize in the South West is the TLU-Ekona, and it has been given out only for trial, in 200-300g minikits or 1kg on-farm trials, each time to be planted next to a local maize for comparison, guaranteeing contamination. 2000 minikits and 174 researcher/farmer-managed trials have gone out since 1987, or, per season, 1 minikit for every 230 farmers in the province and 1 trial for every





1500 farmers in the key zones. The majority of recipients have been women, who are the principal maize farmers. Maize is also easy to lose: edible, so people and weevils eat it up, and less resistant to most insects and drought than cassava. The loss rates of 54% (69% in LC villages where farmers who lost it were not resupplied) should be no surprise.

What is surprising is that 18% of LC farmers receiving maize in 1988, and 43% of those in 1989, still had it to plant in 1990. The record for farmer seed preservation in the survey is 7 seasons for Ekona Yellow (an old IRA variety), 6 seasons for CMS 8501 and 5 for CMS 8602, both sent out first in 1987. 18% of HC farmers and 4% of LC farmers currently had CMS seed in mid-1990[1].

CMS maize from the minikits and trials is being sold at planting time at markets in all the key zones. In the survey 7% had obtained their seed this way, always at an inflated price over local material. Most farmers could not recall the variety names, and loss rates were not greater for white varieties than yellow. The white tends to be preferred for fufu-making and the yellow for the green-maize markets of Fako, Meme and Douala. The CMS maize meets some resistance in the Sands and Mamfe zones, where maize has been historically unproductive and unimportant. Many people are also ignorant of the fact that there are several good IRA varieties, one for fufu and one for green maize, one for early harvest and one normal; so that they tend to say they will keep a part of their farm for the local because the IRA one is white and they also need a yellow, or vice versa. The survey results made it plain that few of the extension agents have been passing on information, but only material inputs.

The National Extension and Training Program of the Ministry of Agriculture plans to multiply CMS 8501, and the other varieties as released, for general distribution across the province, and to improve the extension agents' training of farmers. If this is done, adoption rates should rise steadily, but it is difficult to predict now to what level. In the high-contact

[1] The numbers are probably higher; we have several cases of maize identified by the farmer as local which was recognizably CMS, and usually we could not inspect the maize s/he was using.

villages, about 70% of the farmers who heard of the maize tried to get it, and 30% of those who got it ate it up rather than keep it to plant again (some because of disapproval and some who were sure that weevils would eat it if they didn't). Farmers who have had the maize more than a season now put 67% of their maize field into IRA maize. It seems probable that the IRA maize will ultimately reach a smaller proportion of the farmers than the cassava, but be used on a much larger part of their fields. However, final ceilings and rate of adoption will depend more on the success of regional seed multiplication than on levels of farmer interest.

6.2.4.2.2. Farmers' labor costs and returns to farming

In dry season 1989-90, the TLU monitored land preparation activities on 165 fields in 11 villages in the four key zones, using local farmers or extension agents as recorders; 135 fields in 9 villages were correctly followed. A sub-sample of 5 fields per village was then taken from the 11 villages, in which we followed up with monitoring of labor for weeding, accurate field measurement, and taking yields of every crop grown in two sample plots per farm. In addition, less labor-intensive, less ecology-specific operations such as planting, harvesting and fertilization are being timed in a few fields only. Harvest data for the first-season crops is complete, while most tuber crops will be harvested only next year. It is intended to create enterprise budgets for each field type, and eventually whole-farm budgets.

The traditional methods of land preparation by farmers of South West Province are labour intensive, requiring on the average 60 man days per hectare. Activities such as cutting of grass, making of mounds and beds, tilling, raking and burning are particularly labour intensive. In 135 monitored fields, cutting of grass used 33% of labour input, making mounds 25%, tilling 17%, and raking, burning and making beds, 8% each. In the LV zone, cutting of grass and making mounds utilized 82% of all the labour input; while in the Mamfe zone, cutting of grass, making mounds, burning and tilling utilized 94%.

Women, men, paid labour, njanggi (labor exchange) and even children all do land preparation. There is no distinct gender specific activity, but the extent of labour input to each activity varies with gender. Men cut and prune most trees, and do slightly over half the cutting of grass. Women do almost all the building of mounds and beds, and more of the raking, burning and tilling. On the whole women provided about 35%, the men 32%, njanggi 24%, paid labour 23% and children 12%. In general, single-sex njanggi groups help the man or wife in his/her tasks; paid labour is usually male, and usually young men of the village, but sometimes it comes seasonally from Nigeria or Bamenda, and some Fako villages have resident workers. The LV and KC zones used more family labour, 59% and 73% respectively, than the other zones, while the Sands and Mamfe zones used more non-family labour, 61% and 58%.

Attention should be given by elementary tool manufacturers to better tools to reduce the drudgery of cutting grass and small shrubs (perhaps a kind of scythe could be tried), and to sturdy, lightweight implements that could turn the ground for beds or mounds more easily. Availability even of matchets and hoes is limited in most of the province, and small traders dealing in agricultural inputs need to be encouraged.

6.2.4.2.3. Food marketing

The food-price monitoring study began in August 1988 and records prices of 19 crops and crop forms every fortnight in 12 typical markets across the province. The data is intended for our own analyses, both micro and eventually macro, and for local Council and Ministry of Agriculture planners. It is processed into time series as well as averages, and a "market basket" of foods typically consumed in the province is constructed to represent general cost.

There was a general decrease in prices in the second year of the study (1989/90) at provincial and most divisional and market levels. Exceptions were Mundemba Market (24% increase), Afap (14%), Mamfe Town (8%), and insignificant increases for Konye and Ekondo Titi. The general decrease could be due to: (1) reduction in money supply (cash flow) caused by the economic crisis, (2) a shift from cash crops (cocoa and coffee) production to food crops as the world market prices for cash crops decrease annually and (3) the diffusion of new technological packages from IRA.

Despite variation in prices by season and location, markets that are more expensive for one food tend to be the same for most others. Manyu Division had the cheapest markets while Fako and Ndian had the most expensive, as reflected by their market baskets (Ndian's expense is mostly a reflection of Mundemba Market). This is explained by the greater weight of demand over supply in the provincial sitoation outside of Mundemba; because of the poor state of roads linking Manyu most of their food stuffs are sold within, while Fako Division has a large influx of buyers from other provinces, particularly Littoral, and countries such as Gabon. Mundemba has such poor farms that supply takes precedence there.

In regressions on crop price, variables that explained the most variance were, in order of strength: total weight of product sold, one of the market access variables (truckers or distance) and sometimes harvest availability (this variable could only be approximated). An interesting factor in these regressions was the opposite effect of demand-related variables in different crops. Number of external buyers was significantly related to price in 5 crop forms; in three (green maize, garri and Ibo taro) more buyers brought higher prices, while in two (plantains and white yams) it brought lower ones. Distance from the metropolis was also related to price in 5 forms, lower distance increasing price in garri and water yams, but greater distance, in dry maize, shelled groundnuts and cracked egusi.

Table 13: Mean Prices in the Twelve South-West Province Markets, by crop and division, 1988-90.

Crop	Mean Price (FCFA/kg)									
	South West		Fako		Meme		Manyu		Mdian	
	yr.1*	yr.2*	yr.1	yr.2	yr.1	yr.2	yr.1	yr.2	yr.1	yr.2
Maize green cob	86	88	108	105	70	65	79	95	88	88
Maize dry grain	120	150	90	72	113	140	127	219	170	203
Cassava garri	155	137	196	167	159	132	105	113	160	136
Cocoyam	101	95	119	114	79	77	86	88	118	102
Taro - Ibo	57	54	57	55	51	51	50	50	68	61
Taro - Country	52	43	51	47	43	39	63	48	51	39
Plantain	80	77	86	77	66	57	80	86	87	86
Banana	39	37	44	43	24	26	40	34	45	44
White Yam	132	153	148	141	125	150	123	163	131	156
Sweet Potato	72	65	79	75	52	55	68	58	87	70
G'nut unshelled	202	167	206	154	253	184	155	163	195	166
Egusi unshelled	383	356	423	428	492	377	306	259	311	354
Basket	157	155	165	152	168	149	121	122	170	182

* yr.1 = Sept.88 to Aug.89 yr.2 = Sept.89 to Aug.90

Intra-divisional integration was strongest in Manyu, with Mamfe correlating closely with either Afap or Mfaka or both for all crops but green maize, and in directions in accordance with their specialities. In Fako, plantain and dry maize prices were closely integrated, and plantains were also linked to Fiango prices. Green maize also showed a moderately strong tie between Muea and Fiango, the two chief consumer markets in Fako and Meme. Weak correlations backed up the Mudeka report that garri and cocoyams are brought over from Yoke area to Mudeka for sale. In Ndian there were moderate relationships between Ekondo Titi and Mundemba or Mbonge for most crops, and in Meme, integration was only strong for cocoyams, and for dry maize, between Fiango and Ebonji.

Crops showing price increases were dry maize (Manyu Division only) and white yams (D. rotundata, except in Fako Division). Manyu experienced poor maize harvests due to drought, and yam increases may be due to an increase in demand, Fako being the principal yam zone maintaining a slight decrease. Generally banana was the cheapest food crop per kilogram while unshelled egusi melon was the most expensive across the four divisions and in the province.

6.2.4.3. Pest control

6.2.4.3.1. Maize storage studies

In 1990 the TLU completed chemical and economic analysis of the hermetic storage trial, and supervised an economics thesis on existing farmers' storage methods and their profitability. Storage loss estimates gathered from several sources are internally consistent and indicate losses of about 43% by 6 months, most from weevils, and starting to be apparent

at 2-3 months after harvest. 85% of farmers store maize for more than a month. Some store only for seed, while others store for food and intermittent sales to satisfy small cash needs from one harvest to the next. The most common method is the "banda", a wide shelf or false ceiling above the kitchen fire with an average capacity of 1.9m³. A calculation from use patterns, seasonal price changes and loss rates indicates that it is extremely disadvantageous for the farmer to try to store beyond six months. (It is also more economical to sell the fresh maize as it is harvested from the field.)

The TLU, together with the Dschang entomologist, initiated a hermetic storage trial in 1989, which tested the efficacy and efficiency of containers small enough to fit most farmers' needs. The trial was to be completed with an aflatoxin test which it was not possible to run due to lack of suitable equipment in Cameroon. The storage consultant who came in October reviewed the results and recommended that it be repeated with different levels of moisture content, as he felt the seed germination problem reported in 1989 was due to inadequate drying. However, as food maize, the results were good, and economic analysis was done on this basis and using the norms of farmer behavior derived from the student thesis and farming systems surveys.

Results showed that farmers using the phased withdrawal strategy (equal amounts per month) would earn 24fr/kg above storage costs using 3-liter hermetic storage for 6 months, but only 4fr/kg using a banda: both methods would result in a loss over 12 months, due to price swings, but the banda losses were much greater. Using the single-withdrawal method, the farmer would make 44fr/kg in 6 months with the 3-liter hermetic method, and only 12fr/kg from the banda; and in 12 months, she would make 12fr/kg with the former, 28fr/kg with 11-liter hermetic cans, and lose 97fr/kg in the banda. The method is thus highly recommendable economically, but the germination problem needs to be resolved because farmers could store grain that they would later sell on the market as seed to unsuspecting others.

6.2.4.3.2. Chemical pest control for egusi beetle (Chrysomelidae)

Background and Objective:

Egusi is an important early cash crop to farmers in the Sands and Mamfe West zones of South West Province. Unfortunately, egusi beetles (Chrysomelidae) have been reported by farmers to be deterrents of egusi yield. Plant densities are reduced by an average of 25% after germination, and there are reports from farmer managed trials that the productivity of the remaining plants is lowered by early loss of leaves.

The objective of this trial was to evaluate the effectiveness of marshal methaldhyde, and furadan in controlling the egusi beetle.

Materials and Methods:

The trial was carried out at Malende, Fako, known to be a pest epicentre, to allow detailed observation. The design used was RCB with 4 treatments replicated in two farms. The treatments included 250 gm of egussi seeds treated with (i) 2.5 gm of marshal ST 25, (ii) 7.5gm of Furadan, and (iii) 7.5gm Methaldehyde and (iv) untreated egusi seeds (check).

Each treatment was planted in a plot of 9m x 4m and separated from each other by a plot of 9m x 4m planted with groundnut. A low density of maize was planted in the groundnut plot.

Results and Discussion

During the egusi growing season the incidence of the egusi beetle observed was low thus little or no damage was observed on the egusi plants. It is thus not possible to draw any conclusion from the trial. However, at the end of the season, the following results were obtained (Table 14). The number of melons obtained from the different treatments can possibly be explained by the degree of plant establishment. Pesticide control cannot be used as an explanation for the varying number of melons as the pest incidence was very low to have caused economic damage.

It is thus recommended that future work on egusi-beetle control be carried out in the Mamfe West zone where there is always a high incidence and severity of the insects. In addition, the trial should be replicated in at least four sites so as to allow for many more observations and thus have reliable information.

Table 14: Number of egusi melons harvested.

Treatments	Site 1	Site 2	Total	Average
Methaldehyde	127	54	181	91
Furadan	156	60	216	103
Marshal ST 25	161	117	278	139
Check	100	147	247	124

6.2.4.3.3. Weed control

Objectives, Materials and Methods.

In South West Cameroon land preparation in the first season is slash and burn. In the second season due to wet plant residues and continuous rainfall the residues are either mulched to supress weeds by shading in the LV or buried with soil to be decomposed inside beds/mounds at KC and M. During the 1989 rapid appraisal survey on land preparation and weed assessment we observed that in the LV weed recurrence in the first season after burning was very high and, thus, needed to be weeded out in order to optimize maize yield. In the second season mulching with plant residue controlled the weeds effectively. However, in the Sands and Mamfe once thorough burning was done weeds did not seem to cause serious competition on maize. The most commonly occurring weeds at Mamfe and Kumba Corridor were Acha cassara and on the Sands and Lower Volcanic were Mandola and Spear grass.

In 1990 first season a weed control trial on maize was conducted at Yoke station. The treatments included Roundup, Armada, Almazine (Pre and Post), 2,4-D at 1.68, 6.7, 2.0 and 1 kg/ha, respectively and hand weedings at 3 + 6 WAP, 4 + 7 WAP, 5 WAP and unweeded check. A RCB with 4 reps was used.

Results and Discussion

Since the field was properly plowed and disc harrowed the weed density was very low initially. Therefore the weed control treatments did not have any significant effect on maize yield (Table 15). However, the fresh weed weights varied significantly due to the treatments with the check plot having the highest weed weight of (19.37 ha).

In the second season the weed control trial was carried out on a fallow land highly infested with spear grass (Imperata cylinderica). The treatments were a repeat of the first season except the 4WAP + 7WAP was not included. The purpose was to select which treatment would effectively and economically control imperata.

Field plot ratings so far indicated that Roundup and Armada had 85-90% control of spear grass whereas, the rest of the chemicals hardly had any effect on spear grass. Furthermore, the Roundup and Armada treated plots have more vigorously growing maize compared even to the hand weeded plots because spear grass has already out competed maize due to the delayed hand weeding.

Table 15: Weed control trial, Yoke Station 1990 first season.

Treatments	Yield t/ha	
	Maize	Weed
Roundup	2.6	11.6
Armada	2.2	12.6
Almazine (Pre)	1.5	7.0
Almazine (Post)	2.6	9.3
2,4-D	2.5	7.9
3WAP + 6WAP (hand weed)	3.1	3.5
4WAP + 7WAP (hand weed)	3.3	4.0
5WAP (hand weed)	2.4	6.3
Unweeded check plot	1.7	19.3
Mean	2.4	9.0
CV(%)	34	39

6.2.4.4. Biological soil amendments

6.2.4.4.1. Alley cropping, 1990 first season

The materials, methods and objectives of this trial are already reported (NCRE Annual Report, 1988/89).

The results of 1990 first crop season showed significant increase in maize yield due to nitrogen application and mulching with leguminous hedge rows of Leucaena leucocephola and Gliricidia sp. The highest maize yields of 3422 and 3299 kg/ha were obtained from the plots mulched with leucaena and those fertilized with 80 kg/ha N, respectively (Table 16). It is worthwhile to note that the legumes had no effect on maize yield in the first 2 crop

seasons. The results of the 3rd crop cycle are clear indications that the leguminous hedgerows need time to get established but in the long run could be used as potential supplements of N in the sedimentary sandy loan soils of South West Cameroon.

The plant tissue analysis results showed nitrogen inputs of 176 and 77 kg/ha from 2 prunings of leucaena and gliricidia, respectively (Table 17). It is obvious that leucaena is a better species than gliricidia for the sedimentary sands of South West Cameroon. Consequently, it is now being tested on the farmers' field along with cassia spectabilis which also did well in Yoke station (Dr. Balasubramanian's collaborative research).

Table 16: Effect of nitrogen, leucaena, and gliricidia hedgerows on maize, Yoke Station 1989-1990.

Treatments	Maize yield (Kg/ha)		
	1989-1	1989-2	1990-1
0-0-0 (Kg/ha)	2272	815	1923 C
20-N (Kg/ha)	3292	356	2284 BC
40-N (Kg/ha)	4230	1647	2613 ABC
80-N (Kg/ha)	5197	2002	3299 AB
Leucaena	3044	810	3422 A
Gliricidia	3276	408	2962 ABC
CV(%)			23

Table 17: N input (kg/ha) from leuceana and gliricidia 1990 - first season.

	1st Pruning	2nd Pruning	Total
Leuceana	70.8	106	176.8
Gliricidia	38	39	77

6.2.4.4.2. Legumes screening trial
Background and objectives

The need of strengthening research on resource management and development of sustainable production systems in the humid tropical region with fragile soil characteristics is a timely call of the nineties. Sustainable agricultural production can be achieved through proper management of the existing cropping systems including systematic crop association and rotation, residue management, mulching/green manuring, and alley cropping.

Alley cropping maize with Leucaena leucocephola and Gliricidia sp have given maize yields comparable to those of 40 to 80 kg/ha N fertilized plots (Woldetatios et al, 1990). However, considering the problems of land availability and labour scarcity in the humid

tropical rainforest of South West Cameroon it became necessary to develop research on improved short fallow management and in situ green manure production using legume species. Therefore the objective of this trial was to assess the adaptability potential of legume species to the humid tropical rainforest of Cameroon and evaluate their N input capacity and soil cover so that they will be introduced into the farmers' fallow management practices.

Materials and Methods

14 legume species, and one maize plot (check) were planted at Yoke experimental farm on May 15, 1990. A RCB with 4 replications was used. The row length was 5m with 50cm spacing between rows and 25cm between plants within the row. The legume species included were groundnut, soybeans, mungbeans, sesbania, lima bean, mimosa (thornless), Teophrasia, Desmondium, Clotolaria anagyroides and Crotolaria caricia, pigeon pea (local), pigeon pea pop1, pigeon pea pop2, and pigeon pea BR4. Agronomic characteristics considered in assessing the trial were dry biomass (t/ha), nodule count/plant, plant tissue and soil analysis.

Results and Discussion

Four species including Crotoleria anagyroides, Teophrosia vogelii, Desmodium distortum, and local pigeon pea were selected for future use on the basis of plant vigour and ground cover. The total dry biomass, nodule counts per plant, and tissue analysis results are shown in Table 18. The dry biomass yields from local pigeon pea, Desmodium, Teophrosia, and crotolaria were 10.2, 9.7, 7.4, and 7.2 t/ha, respectively. Local pigeon pea again had the highest nodulation (9ml/plant). Crotolaria in spite of its high nodule formation and vigorous plant establishment was later on attacked by stem disease (Fusarum) and ended up giving lower biomass than expected. Therefore it should be deleted from future use in farmers' fields.

The plots are currently mulched with the respective legume species and planted with maize in order to determine their effects on maize yield. Considering all agronomic merits local pigeon pea and teophrasia vogelii seem to be the promising species for farmers' use in fallow management. The same trial is being repeated this season. Maize yield analysis will be done at the end of second season.

Table 18: Legume screening trial, 1990 first season.

Species	Total dry biomass t/ha	Nodules per plant (Ml)	N input Kg/ha
Crotolaria anagyroides	7.2	8	153
Desmodium	9.7	.7	172
Teophrosia	7.4	2	146
Local Pigeon Pea	10.2	9	390

6.2.4.4.3. Maize/groundnut rotation

Objectives, materials and methods

The objectives of this trial are (i) to evaluate the effect of groundnut on maize and (ii) quantify the amount of nitrogen gained.

The trial consists of 9 cropping systems: systems where during first and second cycles, maize with no fertilizer is followed by maize with 0 N and also followed by groundnut, maize with 40kg N/ha followed by maize with 40kg N/ha and also groundnut, maize with 80kg N/ha followed by maize with 80kg N/ha and groundnut and finally systems where groundnut during first season is followed by maize with 0 N and 80kg N/ha, respectively.

At the third cycle which is where the effect of groundnut in rotation is is evaluated, plots were planted to maize and sub-divided into 3 with 0, 40, and 80 kg N/ha respectively. Because the third cycle of this trial is not yet harvested, the data has not been analyzed. Therefore the results will be presented in subsequent reports.

6.3. MAROUA TLU

6.3.1. INTRODUCTION

In 1990-91 season, TLU research activities were reorganized following the reduction in the number of survey villages (6 in 1989-90) and the selection of 4 permanent research sites. Three main research operations (subgoals) were conducted in 1990: diagnosis of farming systems, on-farm test of improved technologies and practices, dissemination and extension. Training and collaboration with extension agencies received particular attention.

The agricultural practices survey moved into its second year with accent on environmental and managerial variables that were not studied in 1989. Collection of market prices of agricultural products continued but was restricted to the 4 TLU villages. Other studies included the evaluation of income/expenditures at farm level and a review of on-farm storage practices.

Two types of on-farm tests were conducted this season: (1) 20 regional tests (2 per sector, 10 sectors) in collaboration with SODECOTON (a peanut variety test and a sorghum/sorghum intercrop) and (2) 8 researcher/farmer managed tests in each of the 4 villages (a land preparation trial and a sorghum/cowpea association to combat striga infestation).

In September-October, a survey was completed in 36 villages in the cotton growing zone (TLU mandate) to assess the extent of adoption of foodcrop varieties and improved cultural practices. Preliminary results will be available in January 1991.

Rainfall was insufficient and poorly distributed both within and across sites in the Far North province. Useful rainfall did not start until late June across the province. In certain parts of Mayo-Danay, June was nearly a dry month. In August, several locations had less than 200 mm and in September, rainfall was very low for grain filling. Except for Mouda (30 km North of Maroua), IRA antennas and TLU/IRA research villages recorded rainfall ranging from 400-766 mm.

Another difficulty in 1990 has been the increasing cost of running available vehicles. Distances are long and spare parts difficult to acquire. The section still needs the service of one or two technicians.

With the end of the second phase of the NCRE project, the deadline for this year annual report was set at December 15, 1990. This has made it difficult to present all results as data analyses is still in progress.

6.3.2. OUTPUTS AND ACCOMPLISHMENTS

GOAL: To improve and stabilize food crop production in Extreme North Cameroon through farming systems diagnosis, testing of technologies under farmer conditions, and extension collaboration.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. Diagnosis	1.1.1.Completion of 2nd year agric. practices survey.	1.1.1.Description of practices, report to be available in May 1991.
	1.1.2.Income-expenditure study near completion.	1.1.2. Data collection to be completed by April 1991 report June 1991.
	1.1.3.Labor use in non agric. activities completed.	1.1.3.Draft paper available.
	1.1.4. Economics of dry season sorghum.	1.1.4. Draft paper available.
	1.2.1. Completed 2nd year.	1.2.1. Draft report available.
	1.3.1. Information on cost of structures by types, years of life and suggestions for improvements.	1.3.1. Informal survey initiated; operation postponed until June 1991; to be combined with formal on-farm loss survey.
	1.4.1.Area coverage of millet in E.N. to apportion research effort.	1.4.1.Operation cancelled to reduce time and resource allocation before end of 2nd phase of NCRE project.
2. Test promising varieties cultural and storage techniques under farmers' conditions.	2.1.1. Evaluation of yield and economic benefit to farmers from soil, water conservation and N fertilization.	2.1.1. Succesful results obtained from 15 sites. All data were collected and entered Preliminary results available. Plowing show high yield for both S35 and local. S35 yielded slightly more than local. No significant effect of N.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
	2.2.1. Evaluation and recommendation of cropping and fertilization methods beneficial under high striga infestations.	2.2.1. Succesful results from 16 sites. All data collected and entered. Preliminary analyses show that the best option may be djigari/vya. No effect from fertilizer application on striga. No effect from sorghum/cowpea assoc. on striga density.
	2.3.1. Evaluation of yield stability and economic returns to these varieties.	2.3.1. Successful results from 17 sites. All data collected and entered. Analyses begun, which show 5021, IB77 as high-yielding as 28206 and H416 much appreciated for grain quality.
	2.4.1. Evaluation of yield stability, benefits of sorghum intercrops compared to pure crops.	2.4.1. Test completed; all data collected and entered. Analyses begun.
	2.5.1. Evaluation of efficacy and farmer acceptance of double bagging and solar heater methods.	2.5.1. Experiment completed; currently monitoring eventual losses. Farmers' acceptance confirmed.
3. Dissemination and extension.	3.1.1. Extent of adoption of IRA/NCRE technologies; knowledge of characteristics of adopters and non adopters. Identification of constraints to adoption and feedback to research.	3.1.1. Survey completed data being processed; preliminary results expected in January.
	3.2.1. Feedback on adoption of technologies.	3.2.1. All minikit questionnaires returned to TLU/Maroua. Partial analysis performed.
4. Intitutional development.	4.1.1. IRA/TLU staff able to conduct farming systems research and extension program.	4.1.1. TLU counterpart additional experiment in on-farm test and village level survey.
		4.1.2. Counterpart economist received training in statistical analyses and survey design.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
	4.2.1. SODECOTON AVA and MINAGRI agents exposed to new technologies though participation.	4.2.1. Effective participation of SODECOTON and MINAGRI agents.
		4.2.2. PNFVA subject matter specialists received monthly training at IRA coordinated by TLU researchers.

6.3.3. OTHER ACTIVITIES

Both IITA staff and national counterparts participated in the NCRE TLU methodology workshop in January 1990 in Yaounde. The counterpart agricultural economist and agronomist attended CUDS/U. of Florida FSR/E training in Dschang from January 15-February 2, 1990.

The Counterpart agricultural economist completed a 6 week training course (USDA) on survey methodology and statistics (September 9-October 20) in Washington D.C.

The IITA agricultural economist was appointed member of the NCRE/IRA training selection committee that met in Yaounde on November 9 to screen candidates for long-term training.

Subject matter specialists of the MINAGRI National Extension and Training Project received monthly one-day training at IRA center on various subjects. These sessions were coordinated by TLU researchers.

J.M. Sangmonda of MINAGRI Tecnical College in Maroua completed a six week training participating in TLU field activities (on-farm tests and surveys) in August-September 1990. Grace Tima, extension agronomist completed a one week survey at Djoulgouf (TLU village) on women and extension in a muslem village.

In October the TLU received a consulting visit by Mr. R.A. Boxall of NRI/U.K. to advise on methodology of post harvest grain loss survey.

6.3.4 RESEARCH FINDINGS

6.3.4.1. On-Farm Test of Long and Short Cycle Sorghum Intercrops

The purpose of this test, conducted for the second consecutive year, was to investigate under farmer conditions to what extent mixtures of long and short cycle sorghum varieties can improve total grain yield production and yield stability across

environments. In 1990, the test was conducted on 22 sites: 20 in 0.125 ha farmers' fields in collaboration with SODECOTON, and 2 on MINAGRI's Test and Demonstration Centers in collaboration with the PNVFA. The results and discussion presented below are based only on the 18 SODECOTON sites that gave viable data.

Table 1: 35, Djigari, and Total Grain Yield, 1990 Sorghum/Sorghum Intercrop Test

Crop Pattern	Yield S35 (kg/ha)	Yield Djigari (kg/ha)	Total Yield (kg/ha)
S35 Pure	1644 a	0	1644 a
Djigari Pure	0	1203 a	1203 b
75% S35/25% Djigari	1090 b	468 c	1558 a
50% S35/50% Djigari	630 c	928 b	1559 a
25% S35/75% Djigari	245 d	1331 a	1577 a
C.V.	40%	37%	27%
LSD (0.05)	243	245	271

Table 2: Stability Parameters for 1990 Test of Sorghum/Sorghum Intercrops

Crop Patterns	b	MS Dev.
S35 Pure	0.79	289231
Djigari Pure	1.07	132622
75% S35/25% Djigari	1.00	47525
50% S35/50% Djigari	1.05	133450
25% S35/75% Djigari	1.09	58917

Table 1 indicates that in terms of grain yield, S35 in pure crop and all 3 associations were superior to Djigari pure. There was no significant difference in grain yields among the four patterns containing S35. The poorly distributed and scarce rainfall of 1990 evidently favored S35 throughout much of the test zone. One interesting result is that Djigari yield in the association dominated by Djigari yielded as well as Djigari in pure crop.

Table 2 clearly shows that at least in 1990 the stability of S35 in pure crop across environments was superior to Djigari pure, which confirms earlier research, and was also superior to any of the three associations. More detailed analyses of the data to identify the causes of this superior stability, contrary to the hypotheses upon which this theme was established, will be conducted.

6.3.4.2. On-Farm Test of Peanut Varieties

The peanut variety test of 1990 was meant to identify those of the promising short cycle high-yielding varieties coming out IRA Maroua's peanut breeding program capable of yielding well and consistently across the Far North and the department of Mayo Louti. Four of these new varieties were tested in comparison with the currently recommended improved variety 28-206. The test was conducted on 22 sites, 20 in 0.125 ha farmers' fields in collaboration with SODECOTON, and two on MINAGRI's Test and Demonstration Centers in collaboration with the PNVFA. The results and discussion below are based only on the 17 SODECOTON sites that gave useable data. Since the combined analysis of variance for grain yield indicated a significant SODECOTON region by variety interaction (p=0.0503), the yields are presented by region.

Table 3. Grain Yield, 1990 Peanut Variety Test, by Old SODECOTON Regions

Variety	Diamare	Kaele	Mayo Danay	Mayo Louti	Mora-Mokolo	Combined
5021	543	848 a	1101 a	990 ab	918 a	889 a
IB77	626	799 ab	801 ab	953 ab	974 a	846 a
ICGS-27	558	494 b	664 b	868 b	737 ab	681 b
M416	338	569 ab	717 b	868 b	718 ab	660 b
28-206	594 ns	527 ab	999 ab	1212 a	532 b	784 ab
C.V.	39%	29%	21%	19%	23%	24%
LSD (0.05)	392	351	337	282	269	128

Table 4: Stability Parameters of 1990 Peanut Test Varieties (From 17 sites)

Variety	b	MS Dev.
5021	0.97	36396
28-206	1.20	48587
M416	0.86	30228
ICGS-27	1.03	20549
IB77	0.94	35657

The interpretation of the results from this test are complicated by the high degree of unexplained error, which itself results in the high CVs shown in Table 3. This variability does not seem due so much to errors in experimental method (except for the sites already eliminated from the analysis) as to the truly variable yield response of these varieties from site to site. Table 4 shows IB77, 5021, and especially M416 to be more stable than 28-206 across environments.

As suspected, 28-206 is most productive under good, (i.e. high rainfall) conditions. The relatively high yield of 5021 and IB77 and the much appreciated grain quality of M416 argue for their inclusion in a second, wider test, perhaps on PNVFA's 10m x 10m parcelles d'adoption with emphasis on controlling experimental error and on gaging farmer acceptance.

The mean yield of 5021 in Diamare and overall would have been considerably higher but for a very serious and largely unexplained failure in Karagari (Bôgo sector). The extension agent claims it was attacked by aphids, while the other varieties were not; possible susceptibility of 5021 to major yield losses by aphids should be looked into. The chief reasons that M416 did not yield higher were poor germination and stand establishment and lack of availability of seed to assure adequate reseeding. If proper densities had been acheived, yields would probably have been much higher. Given the fact that farmers appreciate this variety, means of ensuring good stands should be investigated.

6.3.4.3. Minikit "Hungry Season Maize" 1990

The year 1990 was the 2nd year of minikit tests of two shorter cycle maize varieties grown as "green maize" in an operation called, variously, mais de case or mais de soudure. This minikit was distributed to each of the 44 farmers participating in SODECOTON regional trials, to 60 farmers in TLU research villages, and to 140 farmers collaborating with the PVNFA. Response to these two varieties, CMS-8704 and DMR-ESR-Y, was very favorable in 1989. Although results for the year 1990 which was very different from 1989 are not complete, early indications (Table 5) are that although the two varieties did less well than last year due to lower and more poorly distributed rainfall farmers still appreciate them enough to merit elaboration of a recommendation to extension for the dissemination of these varieties. Out of 137 farmers from whom TLU has received the responses, 100 say they will grown in 1991 the variety they tested this year.

Table 5: Farmer Opinions of "Hungry Season Maize" 1990.

Criterion	Number of farmers responding (from a sample of 137 farmers having grown either CMS-8704 or DMR-ESR-Y)		
	Good	Average	Poor
Plant Stand	84	35	1
Disease Resistance	65	47	8
Yield	44	39	25
Taste	86	8	3

Researcher/Farmer Managed Trials in TLU Villages

6.3.4.4 1990 On-farm Test of Sorghum/Cowpea Intercropping and fertilizer use for Striga Control.

In 1990, 16 sorghum and cowpea intercropping tests were conducted in four observation villages. The tests were designed to determine if the associations of sorghum with cowpea may increase yield, ensure better protection against striga (Striga hermonthica) damage in comparison to pure crops and, to observe the effect of urea application on the same parasite.

The design was a split plot. The villages were considered as replications. Main plot treatments were fertilizer rates 0 or 100 kg of urea/ha. Subplot were cropping patterns. Treatments were (1) 0 kg of urea and S35 pure (2) 0 kg and Djigari pure (3) 0 kg and vya

pure (4) 0 kg and S35/vya, (5) 0 kg and Djigari/vya, (6) 100 kg/ha of urea and S35 pure (7) 100 kg and Djigari pure, (8) 100 kg and vya pure, (9) 100 kg and S35/vya, (10) 100 kg and Djigari/vya.

Each field was 0.25 ha divided into two main plots separated by 2 m space. Each plot had 12 rows, 0.80 m apart, and measured 9.6 m by 24 m. The four central rows of each plot were harvested. Farmers were asked to choose a field with cotton as previous crop except in Djingliya where land is scare.

The sorghum plant density in pure stand was 62500 plants/ha and 41666 plants/ha in association. The cowpea plant density in pure stand was 50 000 plants/ha and 20 833 plants/ha for cowpea in association. Seed were treated with thioral before seeding.

Urea was applied in one side of the main plots at the rate of 100 kg of urea per hectare by hand application at 30 days after seeding. The farmers were asked to plant at the beginning of the rainy season and it was recommended to plant the cowpea variety after July 5th. Missing Sorghum or cowpea hills were reseeded 7 days after seeding.

Field observations included number of plants of sorghum and cowpea at 30 days after seeding, number of striga plants between the 2nd and 3rd central rows, number of plants and panicles of sorghum harvested, field weight of sorghum panicles and weight of cowpea pods were recorded. Samples from each plot were taken to Maroua and threshed. Threshing percentage and grain yield were calculated.

Successful results were obtained from 16 on-farm trials. In general, cowpea yields were very low as shown in Table 6. In association, cowpea yielded 82 kg/ha with Djigari and 83 kg/ha with S35. No significant difference was observed. In pure stand, cowpea yield was 645 kg/ha which was significantly superior to yield in association. However the yields of sorghum were slightly high. S35 in pure yielded 1361 kg/ha. The date of cowpea seeding was late. The yield of cowpea in association was zero because of plant canopy at Gatouguel.

Yield results shown in Table 6 indicate that Djigari/Vya may be the best intercrop option because it gives highest LER and provides some cowpea yield with no decrease in sorghum yields. In spite of the relatively low yield of both Djigari and vya, the land equivalent ratio is exactly the same as the LER for the same combination last year.

Results shown in Table 6 indicate that the association had no effect on Striga density. No significant differences among crop patterns were found. However S35 in pure stand had relatively low striga density, thus confirming its tolerance to striga.

Fertilizer use did not show any effect on striga population (Table 6). Indeed we found that where fertilizer was applied, striga density was high. So it may be difficult to appreciate the effect of striga damage this year.

In conclusion, fertilizer use at the rate of 100 kg/ha of urea has no effect on striga population. The rate must be increased in order to obtain an effect. Crop association should be repeated to find the expected effect of vya on sorghum yield.

Table 6: Means of Yield and Yield components over 16 sites in 1990

Cropping Patterns	Sorghum grain yield (kg/ha)	Cowpea grain yield (kg/ha)	LER	Striga density (plants/ha)
S35 Pure	1361 a	-	1.00	139127 b
S35 Vya	1161 a	83 b	0.98	152392 a
Djigari/Vya	830 b	82 b	1.13	183854 a
Djigari Pure	827 b	-	1.00	260628 a
Vya pure	-	645 a	1.00	-
LSD (0.05)	213	182		117810
C.V.	41%	134%		128%

Table 7: Means of Yield and Yield Components over 16 sites in 1990

Fertilizer rates urea (kg/ha)	Sorghum grain yield (kg/ha)	Cowpea grain yield (kg/ha)	Striga density (plants/ha)
0	897 b	289 a	168115 a
100	1192 a	247 a	199886 a
LSD (0.05)	151	149	83304
C.V.	41%	134%	128%

Table 8. Means of Yield and Yield Components over 16 sites in 1990

Cropping Patterns	Sorghum density 30 d.a.s	Cowpea density 30 d.a.s.	Sorghum density at maturity	Sorghum panicles density
S35 pure	50944 a	-	46378 b	38936 a
S35/vya	38989 b	14642 b	36255 c	30436 b
Djigari/vya	42448 b	14347 b	38651 c	24345 c
Djigari pure	53641 a	-	50427 a	29647 b
Vya pure	-	38247 a	-	-
LSD (0.05)	3754	4270	3805	4947
C.V.	16%	38%	18%	32%

Table 9: Analysis of Variance over 16 Sites

SOV	df.	Sorghum grain yield	Cowpea grain yield	Sorghum plts density 30 d.a.s.	Cowpea plts dens. 30 d.a.s.
Vill	15	**	**	**	**
Rate	1	**	NS	NS	NS
Vill * rate	15	NS	NS	NS	NS
Par	3	**	**	**	**
Par * rate	3	*	NS	NS	NS
C.V.		41%	134%	16%	38%

Table 10: Analysis of Variance over 16 sites.

SOV	df.	Striga plts density	Sorghum plts at harvest	Panicles of sorghum density
Vill	15	**	**	**
Rate	1	NS	NS	*
Vill * rate	15	NS	NS	NS
Par	3	NS	**	**
Par * rate	3	NS	NS	NS
C.V.		129%	18%	32%

6.3.4.5. 1990 On-farm Test of Fertilizer and Land Preparation on Sorghum

Four tests were distributed in each of the four observation villages and 15 exploitable results out of 16 were obtained. The test was designed to determine and compare the effects of nitrogen fertilizer and the different methods of soil preparation on yield of two sorghum varieties, and also economically compare the farmers practices to improved technologies.

The design was a split plot. Main plots treatments were soil preparation (1) direct seeding without soil preparation followed by ridging; (2) normal animal or hand plowing as soon as soil moisture permits and seeding as soon as possible, on the same date as direct seeding followed by tied ridging.

Subplot treatments were fertilizer rates and varieties. Fertilizer rates were 0kg of urea/ha and 50 kg of urea/ha. Varieties were S35 and farmer selected local variety of sorghum.

The Test area was 1/4 hectare divided into two main plots by a 2 meters space. Each main plot was divided into four subplots. Each subplot consisted of 15 rows, 0.80 m apart and measured 12 m by 24 m. The five central rows of each subplot were harvested.

The previous crop recommended was cotton, except in Djingliya because of lack of land. The plant density was 62500 plants/ha. Seeds were treated with thioral before seeding. Nitrogen fertilizer was applied in the corresponding subplot, at the rates of 0 and 50 kg of urea/ha at 30 days after seeding.

Field observations included number of hills reseeded, number of plants at 30 and 45 days after seeding, number of plant and panicles harvested, number of striga (striga hermonthica) plants between the 2nd and the 3rd central rows, and field weight of panicles.

Successful results were obtained from 15 sites. One of the tests failed because of lack of rain at the end of the season. The grain yield and other yield components are presented in the tables below (Table 11 to 13). No significant difference was found between 0 and 50 kg of urea/ha as presented in Table 13. The grain yields were 1276 and 1328 kg/ha for 0 and 50 kg of urea/ha, respectively (Table 11). The levels of response to 50 kg of urea/ha are similar to all other TLU results in farmers' fields.

Across all 15 sites, S35 outyielded the local variety by an average of 128 kg/ha of grain, all treatments combined.

There was a highly significant difference between different methods of soil preparation (Table 13). The effect of plowing followed by tied ridging increases sorghum grain yield for both varieties by 389 kg/ha on average. This represents an increase of 35% in comparison to direct seeding followed by ridging. The sorghum grain yields were 1494 kg/ha and 1109 kg/ha for plowing followed by tied ridging and direct seeding plus ridging, respectively.

In general, plowing followed by ridging before planting was one of the most difficult operations reported by many farmers. Some farmers refused to make ridges before planting, arguing that lack of rain at sowing time created a labor conflict between seeding and soil preparation. The date of seeding and reseeding were sometimes delayed. It was recommended to reseed 7 days after seeding. But many farmers had reseeded 15 days after seeding. Some farmers preferred to transplant but there was not enough rain. The main plots direct seeded suffered because of drought at the germination period. Although density was good at harvest, the number of panicles with grain was low.

Many farmers appreciated the benefit of plowing plus tied ridges, but they regret the fact that they are not ready to adopt this new technology because of the irregularity of rain and multiple occupations at the beginning of rainy season.

Table 11: Means of yield and yield components over 15 sites

Fertilizer rates kg/ha of urea	Sorghum grain (kg/ha)	Pockets reseedods (plts/ha)	Sorghum density at 30 d.a.s.	Sorghum density at 45 d.a.s.	Sorghum plants at maturity	Striga plants density/ha	Grain mold (0-3)
0	1275 a	9220 a	49019 a	51457 a	47218 a	79566 a	1.10 a
50	1328 a	8789 a	47859 a	50097 a	46470 a	129384 a	1.14 a
LSD (0.05)	114	1026	1308	1353	1589	64220	0.21
C.V.	21%	30%	7%	7%	9%	161%	50%

Table 12: Means of yield and yield components over 15 sites

Varieties	Sorghum grain yield (kg/ha)	Pockets Reseededs per ha	Sorghum density at 30 d.a.s. (14 sites)	Sorghum density at 45 d.a.s.	Sorghum plants at maturity	Striga plants density/ha	Grain mold (0-3)
S35	1366 a	8995 a	47219 b	49748 b	45637 b	107248 a	1.07a
Local	1238 a	7016 a	49659 a	51805 a	48052 a	101701 a	1.18 a
LSD (0.05)	114	1026	1308	1353	1025	64220	0.21
C.V.	23%	30%	7%	7%	9%	164%	50%

Table 13. Means of yield and yield components over 15 sites 1990

Method of land preparation	Sorghum grain yield kg/ha	Pockets reseeded plts/ha	Sorghum plts density 30 d.a.s. (14 sites)	Sorghum plts density 45 d.a.s.	Sorghum plts at maturity	Striga plants density / ha	Grain mold (0-3)
Without plowing + ridging	1109 b	13126 a	44546 b	46993 b	42196 b	87682 a	1.05 a
Plowing + tied ridging	1494 a	4884 b	52332 a	54560 a	51493 a	121267 a	1.18 a
LSD (0.05)	114	1026	1308	1353	1308	64220	0.21
C.V.	23%	30%	7%	7%	9%	164%	50%

Means with the same letter are not significantly different (p = 0.05).

Detailed economic analyses of 1990 on-farm tests will be presented when the full version of this report is completed (Febr. 1991).

6.3.4.6 Socio-Economic Studies

The study of non agricultural labor utilization was completed in April 1990 in the 6 villages where ILU conducted surveys in 1989-90 season. Across all villages, the data indicate that an average farm family allocates 1592 hours in non-agricultural activities. Major activities include search for water (21.5%), gathering of wood and wild fruit (19.2%), animal care and nutrition (21.1%), farm house repairs (21.0%), commerce (21%) and social meetings (5.7%).

The gender distribution of these activities (table 13) shows that women are particularly involved in gathering activities (fetching water and collecting wood) as well as in petty commerce. Men repair farm structures, and attend diverse social meetings. They also practice commerce activities and tend compound animals.

Total use of family labor in agricultural and non-agricultural activities is shown in table 14. Peak periods in agricultural activities (July, August and November) are associated with slack periods in non-agricultural activities and vice-versa. We estimated total labor demand and checked it against the stock of labor available for all activities. The results corroborate the fact that availability of labor still is scare during the peak period despite low demand in non-agricultural activities. The average farmer in the E.N. province allocates 25% more time to non agricultural activities compared to agricultural activities.

Nearly half the farmers (46%) monitored in 1989-90 planted dry season sorghum (muskwari) on an average of 1.4 ha per farm. The economics of Muskwari cultivation has not been fully documented. In this respect, TLU/IRA collected data on labor use and input expenses during the 1989-90 off-season (October 1989 to March 1990). Detailed results of this study will be presented in a working paper. Only salient features are reviewed here.

The largest share of the cost of producing muskwari (table 15) is represented by the valuation of the opportunity cost of family labor (72%). While the production of rainy season sorghum requires more than twice the labor for muskwari, only a small fraction is hired (13 to 15%) compared to 26% for muskwari production. Income indicators shown in table 16 reveal a higher profit for muskwari than rainy season sorghum mostly due to low amount of labor required. Muskwari is considered a catch crop particularly when rainy season sorghum has failed.

Monitoring of grain prices continued through 1990 in order to collect reliable data to be used in economic analysis of on-farm tests and to learn more about the determinants of commodity prices in rural markets. Table 17 is a summary of avarage monthly prices across 6 rural markets in 1989 and 1990. Detailed analysis of these prices will be done in March-April 1991.

The study of income/expenditures in the TLU research villages is continuing to complete a year cycle by April 1991. The objective is to determine cash flows, consumption patterns, sources of cash and types of household expenditures. Critical periods in cash flows will be also identified together with the capacity for farmers to hire outside labor at peak period.

Table 14: Monthly Stock of Labor (man-days) Available for Farm Work in E.N. Province

Activities	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1/ Jan	1/ Feb	March	Total
Agricult.	18.9	23.3	21.4	33	33.7	14.3	20.6	39.9	17.8	8.4	12.4	8.4	252.1
Non-agric.	29.7	13.3	20.8	23.9	26.1	21.3	21.7	22.4	29.4	30.7	29.3	35.4	333.7
Total available 2/	85	85	85	85	85	85	85	85	85	85	85	85	1020
Balance	36.4	48.4	42.8	28.1	25.2	19.4	42.7	22.7	37.8	45.9	43.3	41.2	434.2

1/ estimates of time involvement in dry season sorghum activities
2/ 3.4 man-equivalent * 25 day/month.

Table 15: Labor Required by Task and Cost of Producing Muskwari

Field Operation	Labor			Cost (CFA/ha)
	Total (man/days/ha)	Family %	Hired %	
Nursery care	4	100	0	1 147
Land preparation	16	44	56	11 093
Digging	13.6	77.7	22.3	7 079
Transplanting	5.7	89.4	10.6	4 895
Weeding	11.6	66.2	33.8	5 434
Harvesting	11.1	66.5	33.5	5 183
Total average	62	74	26	34 831

1/ including opportunity cost of family labor at 550 F CFA/hour.

Table 16: Net Benefit (CFA/ha) in Muskwari and Rainy Season Sorghum

	Muskwari	Rainy Season Sorghum
1. Value of Prod.	59 780	71 500
2. - Variable cost 2/	44 951	89 900
3. Gross margin	14 829	- 18 400
4. - Fixed cost 3/	-	-
5. Net cash income/ha	49 660	48 700
6. Net cash income/man-day 4/	801	348
7. Operating ratio 5/	0.75	1.25

1/ 854 kg/ha at 70 F/kg and 1100 kg/ha at 65 F/kg, respectively
2/ include opportunity cost of family labor
3/ data not available, value assumed negligeable
4/ with 62 and 140 main-days/ha, respectively
5/ ratio of variable cost to value of production.

Table 17: Evolution of Grain Prices in Rural Markets of E.N. Province (FCFA/kg)

	Jan	Fev	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	All year average
Sorghum	60	55	59	62	59	58	77	99	76	60	56	51	64
Muskwari	56	63	58	62	57	73	74	92	79	61	57	52	65
Millet	53	56	75	69	55	78	71	82	85	97	63	53	69
Peanut	200	174	183	201	205	239	247	261	252	198	227	194	215
Cowpea	121	105	113	118	117	171	156	196	175	149	138	101	138

6.4 NKOLBISSON TLU

6.4.1 INTRODUCTION

During 1990, Nkolbisson TLU activities continued to focus on two research domains in the Center Province, the sub-humid forest and the forest-savanna transition zones. Adaptive trials and surveys were concentrated in three research villages;Nkol Fep, Nkometou II and Kiki.

The TLU's top priority during 1990 was to get closure on several research sub-goals. Consequently, most TLU tests were follow-ups on earlier TLU research, including trials covering maize, cassava and sweet potato varieties, improved maize-cassava-groundnut cropping patterns, weed control methods for sole maize and groundnut-based cropping patterns, and maize fertilization. The primary new initiative for 1990 was a series of attempts to establish alley cropping, border hedge, and improved fallow sites.

Several uncontrollable events substantially constrained TLU progress during the year. The most severe blow was collapse of the TLU's collaborative regional testing program with SODECAO. Added to this were (a) a substantial reduction of the first season program in Kiki due to late rains, (b) loss of data from the first season and abandonment of the second season program in Nkometou II due resignation of the TLU's farmer representative, (c) cancellation of second season maize variety tests due to lack of seed, and (d) near collapse of the agroforestry initiatives due to seed shortages for appropriate species.

Despite problems encountered, the TLU was able to implement joint and farmer managed trials at more than 150 sites. Based on results from these tests, the TLU has drawn the following tentative conclusions about technology options for Center Province farmers:

a) Variety introduction is the most promising avenue to productivity enhancement due to demonstrated yield impact and ease of diffusion. The TLU therefore needs to expand variety testing to encompass other important crops such as groundnut and plantain.

b) Aside from the TLU's proposed 60 kg N/ha recommendation for maize, chemical components are not likely to be sufficiently beneficial to stimulate widespread, rapid adoption. Future work on chemical components will need to be targeted to particular field and/or farmer circumstances,thereby increasing expectation of a profitable return.

c) The TLU probably can identify modified groundnut-maize-cassava cropping patterns which are more productive than traditional patterns, but problems can be expected in gaining farmer acceptability and training for farmer management. A combination of testing under controlled conditions to document potential benefits when implemented as part of a complete rotational system,and a series of farm level demonstrations will probably be needed in place of farmer managed tests as are used when introducing and assessing varieties.

d) The critical constraints on introduction and acceptance of biological technologies for improving soil fertility appear to be species establishment and demonstration of short run farmer gain. Several species and strategies will have to be explored before the TLU can reasonably invest in large scale testing of any particular strategy or species.

The above conclusions will form the basis of TLU strategic planning for NCRE III, covering 1991-1994. As in previous years, research activities were complemented with extension agent training and demonstrations. The IITA technical assistants were regularly called upon for NCRE Project and IRA supplemental duties.

6.4.2 OUTPUTS AND ACCOMPLISHMENTS

Goal: To enhance rural incomes and food security of family farmers in the Center and South provinces through more productive and sustainable crop production systems.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
1. Feedback information on farmers' circumstances and practices.	1.1 Data on pest incidence and losses due to pests. 1.2 Household and crop enterprise diagnoses for Nkol Fep and Kiki. 1.3 Analysis of IRA maize seed use and diffusion following participation in TLU test.	1.1 Measured stem borer infestation and analyzed stem borer impact. Were able to relate maize yield losses to stem borer infestation. 1.2 Characterized crop enterprises, practices, sales and purchases, resource constraints, and non-crop income in Nkol Fep and Kiki. Found several significant differences between villages. 1.3 Showed there has been substantial maize variety retention following participation in TLU tests. Analyzed determinants of variety retention.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
2. Identify improved and well-adapted varieties.	2.1 Analysis of performance of CMS 8704, CMS 8501, CMS 8806, DMR ESR-W, BSR Syn-1 and TZEE-Y relative to local maize. 2.2 Analysis of performance of 8034 versus local cassava. 2.3 Analysis of performance of TIb-1 sweet potato. 2.4 Analysis of farmers' varietal preferences and utilization patterns.	2.1 Showed that: (a) CMS 8806, BSR Syn-1 and DMR ESR-W out-yielded local varieties under farmer conditions; (b) CMS 8806 is well liked by farmers; (c) BSR Syn-1 and DMR ESR-W fill farmer preference and utilization niches but are not liked as much as CMS 8806; (d) TZEE-Y did not do better than local varieties in yield or taste assessment. 2.2 Showed that 8034 out-yielded local cassava planted in Kiki in 1989 by an average of 2.7 t/ha. 2.3 Collaborated in cassava multiplication to prepare for 1991 regional testing. 2.4 Showed that TIb-1 out-yielded local sweet potato and is well liked by farmers.
3. Identify acceptable and more productive cropping patterns.	3.1 Analysis of cassava yields for 1989 trials. 3.2 Analysis of maize and groundnut yields for 1990 trials.	3.1 Verified that 8034 does not have adverse effect on intercropped groundnut yields. 3.2 Showed that angle planting does not increase cassava yields relative to flat planting. 3.3 Measured two season gross benefits for five cropping patterns in Kiki, but were unable to show financial benefit with new systems. 3.4 Verified that improved systems produce significantly higher one season gross benefits in Nkol Fep, but still must demonstrate acceptability.
4. Identify improved weed control methods.	4.1 Analysis of no weeding versus hand and/or chemical weed control in groundnut-based pattern. 4.2 Analysis of biological versus hand and/or chemical weed control in sole maize.	4.1 Showed that pre-emergence herbicide (a) reduces early season weed competition and (b) results in substantial labor savings without significant reduction in yield or profit. 4.2 Showed that benefits of pre-emergence herbicide relative to hand weeding are greater in the forest zone and for sole maize.

SUB-GOAL	OUTPUTS	ACCOMPLISHMENTS
5. Identify appropriate, low risk maize fertilization rates.	5.1 Analysis of maize response to 60 kg P/ha in transition zone for sole maize and maize-groundnut mixture. 5.2 Analysis of relative maize response to urea and equivalent valûe of NPK.	5.1 Distributed regional maize-urea test kits, but abandoned test due to laying off of SODECAO field agents. 5.2 Showed that 60 kg P/ha: (a) produced a significant sole maize yield response during first season in Kiki but not during second season; (b) did not increase either maize or groundnut yields when broadcasted pre-plant in a maize-groundnut crop pattern; (c) did not give a significant financial gain regardless of season or pattern. 5.3 Showed that transition zone farmers might be able to invest the same amount in 20-10-10 as would be required to buy urea without obtaining significantly lower maize yields or profit.
6. Identify biological technologies that improve and sustain soil fertility.	6. Trials planted and field observations on improved fallow and hedge row establishment.	6.1 Planted and made field observations on 13 agroforestry sites. 6.2 Planted and made field observations on 17 managed fallow sites.
7. Increase knowledge of improved crop production materials and methods.	7.1 SODECAO extension agent training courses in every department of Centre Province. 7.2 Three demonstration plots for agro-pastoral show. 7.3 Finalized three research monographs. 7.4 Prepared two TLU research briefs for agro-pastoral show. 7.5 Hundreds of farmers provided with IRA maize and cassava varieties.	7.1 SODECAO agents well prepared to carry out regional tests. 7.2 Secured agreement to begin collaborative regional testing with MINAGRI field agents. 7.3 Organized a training course for MINAGRI agents from four provinces, to be held in 1991. 7.4 Demonstrated improved maize-groundnut-cassava cropping patterns developed by TLU. 7.5 Practical advice leaflets available for maize and cassava. 7.6 More than 500 farmers throughout Center Province provided with IRA maize seed.

6.4.3 OTHER ACTIVITIES

Dr. Poku on several occasions served as Acting Deputy Chief of Party and regularly participated in NCRE Project administrative meetings. He also had duties as Head of IRA's Farming Systems Program, including preparation of the program's annual report. In June, he attended a meeting in Ghana of the Collaborative Group on Maize Based Systems (COMBS), at which he presented a paper "On-Farm Research in the Centre Province, Cameroon." In September, he carried out a brief in-country consultancy, on the basis of which he prepared "Consultancy Report on Weed Management in Cropping Systems Research Conducted by the NCRE Cereals Agronomy Unit in Garoua, Cameroon."

Dr. Baker attended the AFSRE Symposium in Michigan, at which he made three presentations: a panel presentation on "Reorientation, Not Reversal: African Farmer-Based Experimentation" and "Risk Assessment Methods for Technology Screening," and a poster on "Farmers and Sustainability in Southern Cameroon." He participated in several meetings of IRA's Task Force (for implementation of the Performance Contract), as a member of its technical secretariat. An important accomplishment of the technical secretariat during the year was design of a management information system, called IRAMIS.

TLU coordination duties were relatively restricted during most of the year. The primary activities were preparation of proceedings for the 1990 TLU Workshop, which took a great deal of time, and a series of site visits carried out in November and December for which analytical mission reports were prepared and circulated. In addition, repeated discussions were held with representatives of the following organizations regarding future TLU collaboration: (a) Netherlands Development Assistance Organization for training and backstopping of the proposed Bertoua TLU, (b) Dschang University Center for training in farming systems research, (c) and U.S. Peace Corps for agroforestry testing and demonstration.

Six national counterparts from the TLU participated in an MSTAT training course organized by the NCRE Deputy Chief of Party. As part of the course, Dr. Baker gave a session on economic analysis with MSTAT.

6.4.4 RESEARCH FINDINGS

6.4.4.1 Household Characteristics Survey (Sub Goal 1)

The purpose of this survey was to generate data on household circumstances and cropping practices in Nkol Fep and Kiki. These data are needed (a) as a baseline for evaluating TLU impact, (b) for analyzing and documenting differences between TLU research villages, (c) for assessing village representativeness (through comparison with results from the 1989 regional household survey), and (d) for identifying household income sources and constraints.

Methods

Household census lists were compiled for Nkol Fep and Kiki. For each list, five random numbers were chosen between one and N/5, where N represents the total number of households on the list. In addition to each chosen household, every N/5th following household was selected giving a total of 25 households in each village to be interviewed.[1] For qualitative data, statistical differences between Nkol Fep and Kiki households were assessed at a $P(<0.05)$ level using a Chi-Square test.

Results

Findings summarized in Tables 1 through 6 make it abundantly clear that Nkol Fep and Kiki represent two distinct research domains, the differences going well beyond a simple distinction of groundnut-based versus maize-based.[2] Table 1, for example, shows substantially different patterns for crop product transactions. The table suggests that Nkol Fep farmers are sales oriented, with many households selling several different food crops. At the same time, Nkol Fep households do not depend on market purchases for food security, reflected in the fact than only four of 22 commodities were bought by more than one-third of the Nkol Fep households. Furthermore, there were only seven commodities for which more households were buying than were selling.

Crop transaction results for Kiki stand in stark contrast. In comparison to Nkol Fep, fewer Kiki households sold crop commodities, while in nearly every case more Kiki households bought commodities. In essence, Kiki households produce for home consumption but failing to obtain self sufficiency, often turn to the market to supplement food availability. Differences between Kiki and Nkol Fep are particularly evident for maize. Maize is one of the most frequently sold crops in Nkol Fep but with few households buying, while exactly the reverse pattern occurs in Kiki.

While the TLU has not measured total farm production or household consumption, the patterns in Table 1 conform with field observations that Nkol Fep farmers are surplus producers, while Kiki farmers have lower productivity and struggle to produce sufficient food.[3]

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[1] Pooled results from multiple systematic sampling have the statistical properties of a random sample, but are less likely to under-represent certain parts of a village in cases where there is non-random ordering on a census listing.

[2] In this report, selected findings are given on household incomes sources, cropping practices and farmers' perceptions of constraints. In 1991, this data set will be analyzed together with data from the 1989 regional household survey in order to evaluate representativeness of the TLU's research villages.

[3] Differences in productivity can be seen repeatedly in tables below where zonal results are given for TLU trials.

Table 1: Percentage of households selling and buying various crop products

Crop Product	Nkol Fep Sell	Nkol Fep Buy		Kiki Sell	Kiki Buy	Crop Product	Nkol Fep Sell	Nkol Fep Buy		Kiki Sell	Kiki Buy
Cocoa	56	0		44	0	Palm oil	24	40	b	12	92
Plantain	83	0		60	12	Okra	36	24	a	12	48
Cassava tubers	60	0	a	16	20	Hot pepper	56	0	ab	4	28
Cocoyam	48	0	ab	16	28	Palm nut	40	32	a	0	44
Groundnut	8	36	b	4	64	Sugar cane	8	40		4	20
Banana	36	8		28	20	Sweet potato	36	8	a	8	16
Tomato	28	60	a	4	88	Soy bean	4	0		0	0
Palm wine	36	28		16	36	Cassava leaves	12	0		4	0
Maize	72	4	ab	4	88	Processed maize	0	8		4	4
Processed cassava	56	0	b	48	44	Processed groundnut	0	8		0	20
Yam	24	8	b	4	44	Green beans	0	4	b	4	76

a. Differences in village percentages for selling significant at P(<0.05).
b. Differences in village percentages for buying significant at P(<0.05).

Village differences are no less striking when one moves to non-crop income sources, shown in Table 2. Not only do more Nkol Fep household get income from crop sales than do Kiki households, more Nkol Fep households generate income through non-crop production sources. Over half the Nkol Fep households in fact had at least one member with wage employment. Crop buying and selling, crop processing and fruit gathering and selling were also common income sources in Nkol Fep but not in Kiki. To overcome cash shortages, three out of four Kiki households received money from relatives many of whom have moved to Yaounde for wage employment. This level of remittances can generally be considered a sign that farmers do not have much of a margin for trying new technologies.

Table 2: Percentage of farms having various sources of non-crop production income

Source	Nkol Fep		Kiki	Source	Nkol Fep		Kiki
Sell palm wine	36		20	Sell non-agr. products	8	a	40
Hunting or fishing	0		4	Buy & sell processed crop products	40	a	16
Selling livestock	36	a	12	Collect & sell wood	4		4
Crop buy & sell	40	a	8	Money from relatives	12	a	76
Wage employment	52		32	Make & sell charcoal	0		0
Collect & sell fruit	52		32				

a. Difference in village percentages significant at P(<0.05).

With respect to technology development, different field characteristics, farming practices and cropping patterns must be taken into account (Tables 3 and 4). Table 3 shows that major differences can be attributed to land resources and resulting land management practices. Nkol Fep farmers, as is typical of farmers in the forest zone, have sloping fields which they prepare by burning. Plowing is done for groundnut-based mixtures but rarely for maize fields. Kiki farmers work in a savanna ecology with sandy soils. Many fields are in

low lying areas and are built up into elevated plots through an arduous labor investment. Nkol Fep farmers generally use a groundnut field for one season and let it go into a cassava fallow. They harvest cassava and perhaps cocoyam during the second year, and then plantain until it is time to use the field again,maybe after three to five years. Kiki farmers, though, invest so much in their fields that they often used them season after season. If the fields are rested it is generally for a short time, often only a season. Consequently, soils are depleted, in large part accounting for the low productivity.

Table 3: Percentage of fields having various characteristics

Characteristic	Nkol Fep		Kiki	Characteristic	Nkol Fep		Kiki
Sloping terrain	64		40	Only local maize used	25	a	59
Sandy soil	13	a	74	Color of maize: white	37		41
Cleared by burning	95	a	4	yellow	92		100
Plowed before planting	67	a	100	Only local cassava used	54	a	81
Plants put on hills/ridges	0	a	96	Weeded less than two times	33	a	87
Fertilizer used	4		13	Insecticide used	0		0

a. Difference in village percentages significant at P(<0.05).

There is some room to manoeuver in both villages. As Tables 3 and 4 show, many farmers still use only local varieties of maize and cassava. This undoubtedly holds for other important crops such as groundnut, plantain and cocoyam. Few households use fertilizer but the TLU has a substantial body of evidence showing the profitability of fertilizer on maize. Finally, the TLU has not yet initiated work on plantain or cocoyam but surveys have consistently revealed the importance of these crops, particularly in the forest zone.

Table 4: Percentage of fields having various crops as the primary or added component in a crop mixture[a]

	Nkol Fep		Kiki			Nkol Fep		Kiki	
Crop Product	Main	Added	Main	Added	Crop Product	Main	Added	Main	Added
Maize	13	25	58	33	Plantain	30	32	0	26
Groundnut	32	2	10	26	Cocoyam	8	23	0	29
Cassava	8	28	31	32	Tomato	6	2	1	0

a. Based on 53 field descriptions in Nkol Fep (39 second and 13 first season), and 72 in Kiki (49 and 22). Only four most important crops in crop mixtures, based on farmer assessment, were analyzed.

Reflecting their different circumstances, respondents from Nkol Fep and Kiki stressed different resource (Table 5) and agronomic constraints (Table 6). In general, more Kiki respondents said various potential constraints were actually a problem for their household. By contrast with Nkol Fep, Kiki respondents also consistently gave greater emphasis to money and labor shortages. Nkol Fep respondents instead identified a land constraint, for access to new land and for adequately fallowed land.

Table 5: Rating of resource constraints based on farmer assessment

Overall Rank	Constraint	Rating[a] Nkol Fep	Rating[a] Kiki	Overall Rank	Constraint	Rating Nkol Fep	Rating Kiki
1.	Adequately fallowed land	104	84	8.	Labor for harvesting	16	40
2.	Maize seed	76	72	9.	Labor for weeding	12	36
3.	Money to hire labor	20	108	10.	Labor for clearing	0	44
4.	Money to buy seed	40	84	10.	Laborers to be hired	0	44
5.	Groundnut seed	60	60	12.	Cassava cuttings	28	8
6.	Access to new land	80	8	13.	Labor for selling	0	12
7.	Labor for planting	16	44	13.	Labor for processing	0	12

a. Based on inverse weighting of the percentage of farmers reporting that each constraint was "not a problem" (weight=0), a "minor problem" (weight=1), or a "major problem" (weight=2). Thus, the potential rating range is 0-200.

With respect to agronomic constraints, farmers in both villages emphasized weeds and maize stem borers. Not unexpectedly given cropping patterns and ecologies, birds, rodents and termites were more often viewed as a problem by Kiki respondents than by Nkol Fep respondents.

Table 6: Percentage of farmers saying that various field circumstances were an agronomic problem for them, 1990

Circumstance	Nkol Fep		Kiki	Circumstance	Nkol Fep		Kiki
Grassy weeds	84		72	Maize stem borers	100		78
Broadleaf weeds	96		74	Termites	32	a	65
Birds	0	a	100	Other insects	0	a	44
Rodents/hedgehogs	36	a	100	Shading	30		17
Poor soil	40		47	Lodging	8	a	30

a. Difference in village percentages significant at P(<0.05).

In summary, the TLU now has a data set which documents dramatic differences between its primary research villages and reinforces findings about zonal differences identified in earlier TLU reports. In addition to identifying appropriate interventions for farmer circumstances such as are described above, a major challenge for the TLU is to determine whether comparable significant differences exist in other parts of the Central Province;both justifying and necessitating work in additional research villages.

6.4.4.2 Stem Borer Monitoring (Sub-Goal 1)

Maize stem borers are a pest in both the forest and transition zones. Field monitoring was carried out to assess stem borer incidence and losses due to infestation.

Methods

Six sampling units per field, each four square meters, were pegged in different parts of 38 sole maize fields. Selected field characteristics, hypothesized to potentially affect stem borer incidence, were recorded during pegging. Mid-season observations were made on plant vigor and signs of stem borer infestation. Harvest measurements were taken for each sampling unit, distinguishing yield and prolificacy for plants showing signs of infestation from those not seemingly infested. Quantitative measurements on pest incidence and length of stem borer tunnels were made on a per plant basis within sampling units.

Results

Visual signs of stem borer infestation were similar for Nkol Fep and Kiki sites at mid-season but infestation levels at harvest were significantly higher in Nkol Fep (Table 7).[4] Despite lower infestation levels, stem borer impact on yield was more severe in Kiki, affecting both prolificacy and yield per plant. Anomalous results from Nkol Fep showing higher yield from affected plants perhaps are due to sampling error (since there were few observations for plants not showing signs of attack).

Table 7: Stem borer infestation and plot outcomes, second season, 1990

Characteristic		Nkol Fep	Kiki
Infestation:			
Percentage plants showing signs at mid-season		39	32
Percentage plants showing signs at harvest		88	32
Percentage of stem length bored		17	4
Average number of borers per plant		1.43	0.14
Outcomes:			
Plant density at harvest ('000/ha)		52.3	19.8
Prolificacy (pct.):	attacked plants	68	52
	non-attacked plants	79	83
Weight/plant (grams):[a]	attacked plants	115	35
	non-attacked plants	131	51
Yield (kg/ha)[a]		5503	1023

a. Fresh ear without husk for Nkol Fep, grain for Kiki.

Regression analysis was used in an attempt to determine whether stem borer infestation significantly reduced maize yield. Regression coefficients for four stem borer infestation measures were negative, as expected, but only the coefficients for "average number of borers per plant" were significantly different from zero (Table 8). This would appear to be the most crucial measure for future stem borer monitoring and tests.

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[4] Findings presented in this report are based on 19 sites from which complete yield and stem borer count data were collected.

Table 8: Relationship between measures of stem borer infestation and yield, second season, 1990[a]

Stem Borer Measure	Nkol Fep	Kiki
Average number of borers per plant	-3720.5 (894)	-5054.3 (1928)
Percentage of stem length bored	-9.7 (97)	-76.5 (155)
Percentage plants showing signs at harvest	-1.8 (10)	-14.1 (16)
Percentage plants showing signs at mid-season	-4.6 (16)	-11.7 (25)

a. Regression coefficients from series of regression of form: y=constant+density+x, where: y is fresh ear weight for Nkol Fep and grain for Kiki, and x is the stem borer measure. Coefficient standard errors are in parentheses. Harvest densities were used for the first three measures while mid-season density was used for the mid-season measure. Regression R^2s for the end-of-season measures all ranged from .83 to .96. The R^2s for the mid-season regressions were .18 for Nkol Fep and .30 for Kiki.

An attempt was made to identify field management factors significantly associated with infestation levels. The number of independent variables which could be considered was constrained due to lack of variation in practices within zones (thus confounding practices and zonal effects). In Kiki, for example, beds were formed prior to planting by incorporating residues and weed biomass, while in Nkol Fep all farmers burned their fields and planted without plowing. Substantial intra-zone variability was observed for only four variables; planting dates, use of chemical control, use of IRA maize variety, and use of chemical fertilizer. Planting date did not have a significant relationship with infestation levels (Table 9). Infestation levels were, however, significantly lower on fields planted with IRA maize and where some form of chemical control was used.

Table 9: Relationship between farmer practices and average number of borers per plant, second season, 1990 [a]

Farmer Practice	Nkol Fep	Kiki
Planting date (numbered sequentially from 1 August	-.018 (.033)	.002 (.003)
Used some chemical control against borers	-.76 (.54)	-.19 (.05)
Use an improved (IRA) maize variety	b	-.17 (.05)
Used chemical fertilizer	-.51 (.52)	.10 (.05)

a. Regression coefficients with standard errors in parentheses. R^2 for Kiki = 0.857. R^2 for Nkol Fep = 0.571.

b. All farmers in Nkol Fep used an improved maize variety.

Results given in Table 9 must be interpreted with caution due to the small number of observations for each regression equation. Delayed planting has in many studies been shown to have a significant, positive relationship to stem borer infestation. Moreover, IRA maize germ plasm is not stem borer resistant and not all chemical control methods were equally effective. Specifically, infestation levels were higher than average at sites where furadan was used mid-season, but were quite low at sites where treated seed was planted. Thus, various field management factors, including alternative control measures, need to be assessed in TLU tests before even tentative conclusions can be drawn.

6.4.4.3 Maize Variety Adoption Study (Sub-Goals 1 and 2)

One objective of the TLU's testing program is to increase farmer access to improved varieties, thereby hopefully stimulating farmer adoption. An important question is whether test participants do indeed retain IRA seed and use it or diffuse it to other farmers. The objectives of this study were: (a) to find out whether participants in TLU maize variety tests during first season 1989 used IRA seed during following seasons or made the seed available to other farmers, and (b) to identify determinants of continued use and diffusion.[5]

Methods

Following the maize variety test in first season 1989, all participants were asked to rank IRA varieties relative to their local variety for five production and four taste characteristics. They were also asked whether they had retained any seed for future use. During first season 1990 as many test participants as possible were reinterviewed. Data were collected on selected household and individual characteristics and on whether IRA seed had been (a) planted second season 1989, (b) planted first season 1990, (c) given or sold to other farmers. Respondents were also asked whether they had sold any IRA cobs or grain in a local market.

Determinants of five bivariate (0,1) dependent variables were evaluated using linear probability regressions. Selected farmer and household characteristics were used as independent variables in all regressions to enable comparability across regressions. The regressions were estimated using two-stage weighted least squares to correct for heteroscedasticity caused by bivariate dependent variables. The weights used for second stage estimation were inverses of the variance of predicted values derived from first stage equations. This weighting improves precision in estimating standard errors of the coefficients but does bias expected values of regression coefficients. A remaining problem with linear probability models is that predicted values are not constrained to fall between zero and one. When predicted values less than one were encountered following first stage estimation, predicted values for stage two were changed to .001.

Results

Fifty-three test participants were interviewed in both 1989 and 1990, 33 in the forest zone villages and 20 in Kiki. Of these respondents, 62 percent were female and 38 percent had not received any formal education. Approximately half of the households enumerated sold maize in 1989, 38 percent sold cocoa, and 50 percent had a member with salaried employment.

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[5] The study was designed by the TLU and implemented by Amadou Nchare, a fourth year student at Dschang University Center. Mr. Nchare gave descriptive findings in his memoir "Utilisation des variétés améliorées de maïs par les paysans après participation a un essai en milieu réel." Additional analyses for this report focus on determinants of future seed use and diffusion.

All but one of the first season test participants planted at least one IRA variety during second season 1989 or first season 1990. Sixty percent planted IRA maize during both seasons following participation in the TLU test. There was also substantial diffusion of IRA maize through market sales (47 percent of households) or provision of grain directly to other farmers (41 percent). The main means of diffusion in the forest zone was market sales, while direct provision to other farmers was the main means for diffusion in Kiki.

Linear probability regression coefficients, shown in Table 10, suggest that initial taste assessment is a poor indicator of future seed use and diffusion at least in situations where most test participants find the new varieties to be as good as or better than local varieties. To the extent any relationship exists, initial production assessment may be positively related to future seed use but negatively related to diffusion. Household size and cocoa sales appear to be positively related to future seed use but negatively related to diffusion.

Table 10: Coefficients from linear probability equations for IRA seed use and diffusion, 1990[a]

Variable	Planted 1989	Planted 1990	Sold in Market	Supplied to Farmers	Sold or Supplied
Constant	.295	.693	.543	.478	.975
Retained IRA maize for seed (0,1)	.086	.550**	.223*	.623**	.413**
Production assessment [b]	.021**	-.009	-.001	-.037**	-.028**
Taste assessment [c]	.007	-.027**	.017	.009	.002
Household size	.048**	.035**	-.038**	-.031**	-.034*
Household sold cocoa (0,1)	-.382**	.237**	.175	-.551**	-.338*
Household sold any type maize (0,1)	.236**	-.129	.669**	.016	.419**
Participant was male (0,1)	.186	-.279**	-.356*	.562**	.197
Participant had some eduction (0,1)	-.424**	.287**	.156	.264**	-.279**
R^2	.925	.980	.859	.882	.874

a. Coefficients significantly different from zero: ** = P(<0.05); * = P(<0.1).
b. Production assessment scores ranged from -20 to 20, going from negative to positive the more times participants said one or both IRA varieties were better than local varieties.
c. Taste assessment ranged from -16 to 16, also going from negative to positive as IRA varieties were ranked as being better than local varieties.

Most remaining coefficients, shown in Table 10, cannot be interpreted with any confidence due to confounding of IRA maize planting and diffusion with locational maize planting and diffusion patterns. For example, second season planting is more common in Kiki while fewer Kiki households sold cocoa, fewer Kiki participants had any schooling, and more Kiki participants were female.

Regardless of limitations, the adoption study served as a pilot for future TLU adoption and impact studies. Interpretation problems encountered in the study should not be a problem in a large sample, region-wide study such as would be carried out following regional testing. Statistical properties of regression results can be further improved by using a probit model.

6.4.4.4 Maize Variety Test (Sub-Goal 2)

The objectives of this test were (a) to compare yields of four varieties identified by the lowland maize breeder with farmers' current varieties when grown by farmers using normal practices and (b) to obtain farmer assessment of the new varieties.

Materials and Methods

The four new varieties were: (a) CMS 8806, a quick maturing yellow maize variety; (b) DMR ESR-W, developed as white version of CMS 8806; (c) TZEF-Y, a extra early yellow variety with flinty grain similar to Bafia, the dominant local; and (d) BSR Syn-1, a soft endosperm white variety which is a slightly improved version of a widely accepted variety in East Province.

Participating farmers were given 100 grams of seed for each of two IRA maize varieties. They were asked to plant the IRA varieties and a local variety in adjacent plots, using whatever cropping pattern and practices they wanted--as long as all plots were treated the same. Pockets, plants and ears were counted at harvest, and a sample of 15 ears was weighed from each plot.

Results

CMS 8806, DMR ESR-W and BSR Syn-1 significantly out-yielded farmers' varieties due to a combination of greater prolificacy and bigger fresh cobs (Table 11). CMS 8806 was consistently rated as being better than local varieties for both production and taste characteristics (Table 12). The other three varieties generally were rated as good as or better than local varieties for taste characteristics although the relatively small percentages of farmers saying that BSR and TZEF-Y are better than locals is a sign of potential acceptance problems.

Table 11: Maize variety yield results relative to local varieties in farmer tests, first season, 1990

Variety	Number of Comparisons	Ear Weight		Prolificacy		Fresh Ear Yield	
		Percent Increase	Prob. of Increase	Percent Increase	Prob. of Increase	Percent Increase	Prob. of Increase
CMS 8806	13	8	67	17 a	86	41 a	75
DMR ESR-Y	15	19	67	9 a	68	30 a	71
BSR Syn-1	11	39 a	72	12	67	54 a	75
TZEF-Y	9	-3	46	12 a	75	11	60

a. Percentage increase significantly greater than zero at P(<0.05).

Overall, these test results conform with prior TLU tests showing that IRA's new maize varieties outyield local varieties and have acceptable taste characteristics. CMS 8806, DMR ESR-W and BSR Syn-1 fulfill farmer's needs for varieties with specific characteristics. CMS 8806 certainly is ready for regional testing, while DMR ESR-W and BSR Syn-1 could also

be forwarded for regional testing unless the lowland maize breeder can identify suitable alternatives for their particular niches. TZEF-Y did not perform well in this particular test, and seemingly needs further modification to improve yield potential, tip cover and taste.

Table 12: Farmer evaluation of IRA versus local maize varieties following participation in farmer test, first season, 1990

	Production Characteristics:				Taste Acceptability:		
	Germ-ination	Lodging	Ears/ Plant	Size of Ears	Roasted Ears	Boiled Ears	Sanga
	(Percentage of respondents[a])						
CMS 8806:							
Better	87	20	97	87	86	86	79
Worse	0	0	7	13	7	7	0
BSR Syn-1:							
Better	71	12	88	94	44	38	20
Worse	0	0	0	0	25	6	7
DMR ESR-W:							
Better	45	9	80	73	60	50	40
Worse	0	0	10	27	10	0	0
TZEF-Y:							
Better	64	0	80	80	27	36	18
Worse	0	0	10	10	18	0	0

a. Remaining respondents said their was no difference between varieties or, in the case of taste assessments, did not consume maize in the indicated form.

6.4.4.5 Sweet Potato Variety Tests (Sub-Goal 2)

In 1989, farmers in Nkol Fep were given Tlb-1 sweet potato sets so the yield performance of Tlb-1 sweet potato could be tested against farmers' current varieties. The test was repeated in 1990 in order to obtain farmer assessment of Tlb-1 yield performance and acceptability.

Materials and Methods

In both years, participating farmers were asked to plant Tlb-1 and a local variety in adjacent plots following their normal practices. In 1989 harvest measurements were made on the number of tubers and tuber weight. In 1990 a farmer evaluation survey was administered following harvest.

Results

In limited scale testing, Tlb-1 clearly showed superiority over local varieties. In 1989 it significantly out-yielded local varieties (Table 13). In 1990 nearly all participating farmers said it was better than local varieties for both yield and taste (Table 14). The superiority of Tlb-1 will now be verified through regional testing as a prelude to multiplication and extension.

Table 13: Sweet potato varieties yield comparison based on farmer test, Nkol Fep, 1989

Variety	Tubers/ Pocket	Tuber Weight (grams)	Tuber Wt. /Pocket (grams)	Tuber Yield (kg/ha)[a]
TIb-1	4.4	204	884	11,056
Local	3.7	170	627	7,833
$LSD_{(0.05)}$	0.3	22	49	669

a. Population standardized to 12,500 pockets/ha, 2 plants/pocket.

Table 14: Farmer evaluation of whether TIb-1 or local sweet potato varieties are better following participation in farmer managed test, Nkol Fep, 1990

	Production Characteristics				Taste
	Germin-ation	Resist Disease	Tubers/ Plant	Size of Tubers	of Tubers
	(Respondents saying better)				
TIb-1	10	9	4	11	11
Local	0	2	7	0	0

6.4.4.6 Cropping Patterns Trial (Sub-Goal 3)

This was the second year for a trial designed to (a) assess the possibility of increasing the value of production through modified plant spatial arrangements and populations, and (b) determine the production mix generated through various groundnut-cassava-maize cropping patterns.

Materials and Methods

In 1989, five cropping patterns were tested in an RCB design. The patterns are described in the *1989 NCRE Annual Report*. For the 1990 trial, a new pattern was substituted for the traditional pattern. Sole maize was dropped, and cassava density was increased in the maize-cassava pattern.[6] The resulting cropping patterns were as follows:

[6] The sole maize pattern was dropped because it requires second season cultivation to give a competitive return and does not include either cassava or groundnut. Therefore, it is not viewed by farmers as a substitute pattern for their basic food crop field. Sole maize is a specialized cash crop enterprise undertaken primarily by men.

a. Transition. Randomly planted groundnut (farmers' population) and maize (3,000 pockets/ha, 2 plants/pocket); cassava planted around edge of plot (3,333 pockets/ha, 2 cuttings/pocket).

b. R 2,3. Randomly planted groundnut (farmers' population); maize and cassava row planted, with two rows cassava (1 m between cassava pockets within rows, 1 m between rows, single cutting/pocket) alternating with three maize rows (0.5 m between pockets within rows, 0.75 between rows and from cassava rows, 2 seeds/-pocket).

c. Maize-cassava. Cassava rows (1 m between pockets within rows, 1 cutting/pocket) alternating with maize rows (0.5 m between pockets within rows, 2 seeds/pocket), with rows spaced 0.5 m.

d. L 1,2. Randomly planted groundnut (farmers' population); mixed maize-cassava rows with two maize pockets for each cassava pocket (0.5 m between pockets within rows, 1.5 m between rows, 2 seeds/pocket, 2 cuttings/pocket).

Results

In the 1989 test, farmers in Kiki were the only ones who tried to take advantage of the second season planting opportunity afforded by the sole maize, transition and R 2,3 patterns.[7] Despite farmer attempts at second season replanting, poor results were obtained with the modified patterns (Table 15). This was due to the increased proportion of maize in the new patterns coupled with low maize yields during both seasons of 1989. Low first season yields were attributable to drought while second season populations were extremely low.

[7] Farmers in the forest zone were unable to do so because the cassava variety used (8034) left little area unshaded during second season.

Table 15: Evaluation of maize-cassava-groundnut cropping patterns, Transition Zone, 1989-90

	Traditional	Transition	R 2,3	Maize-Cassava	Sole Maize
Yield (kg/ha):					
Fresh maize ears:					
First season	178	82	204	2,073	1,997
Second season	373	355	317	164	1,882
Groundnut	962	1,029	648	0	0
Cassava tubers	9,357	8,808	10,652	11,188	0
Gross Benefit (FCFA/ha):					
Regular [a]	849,020	840,900	761,836	738,219	523,581
Low [b]	820,871	818,251	735,425	632,109	330,008

$LSD_{(0.05)}$ regular: ns $LSD_{(0.05)}$ low: 267,401

a. Prices: maize without husk--135 FCFA/kg, equivalent price with husk--89 FCFA/kg; groundnut--426 FCFA/kg, equivalent price in shell--230 FCFA/kg; cassava tubers--39 FCFA/kg.

b. Substitutes low price for maize without husk--82 FCFA/kg.

Despite relatively poor results during the first year of testing, modified cropping patterns which increase maize and cassava populations relative to groundnut and enable second season replanting are consistent with farmer practices and priorities in the transition zone. Therefore, the patterns tested in the forest zone in 1990 will receive further testing in the transition zone.

In the forest zone, the modified patterns gave significantly higher gross benefits during the first growing season in both 1989 and 1990 (*1989 NCRE Annual Report* and Table 16). This one season benefit is critical since forest zone farmers generally leave their groundnut-based fields to cassava fallow during second season, sometimes gap filling with additional cassava. Eventual cassava yield is also important to forest zone farmers but two of the three modified patterns have greater cassava populations than either the traditional or transition pattern. The third modified pattern (R 2,3) has sufficient space to allow a substantial increase in cassava density during second season gap filling.

Table 16: One season evaluation of maize-cassava-groundnut cropping patterns, Forest Zone, 1990

	Transition	L 1,2	Maize-Cassava	R 2,3
Density (plant/ha):				
Maize	6,667	13,827	30,718	21,334
Groundnut	208,000	207,833	0	216,167
Cassava (planted)	6,667	8,889	10,000	5,000
Yield (kg/ha):				
Fresh Ears	1,588	3,233	6,056	3,868
Groundnut	497	441	0	432
Gross Benefit (FCFA/ha):				
Regular [a]	426,189	624,329	817,569	706,221
Low	342,018	452,964	496,598	501,201

$LSD_{(0.05)}$ regular: 139,625 $LSD_{(0.05)}$ low: 98,102

a. See notes Table 15 for valuation.

Overall, the modified patterns should result in increased productivity in the forest zone and perhaps in the transition zone. The main constraints on adoption are likely to be: (a) increased management input necessary to take full advantage of the modified patterns, (b) possible reductions in groundnut production (although not observed in 1990 for L 1,2 or R 2,3), and (c) overcoming farmer's lack of interest in using second season replanting opportunities.

6.4.4.7 Cassava Planting Methods Trials (Sub-Goal 3)

This was the second year for a trial designed to assess angle versus flat planting of cassava cuttings for both local and improved material. Angle planting is recommended by IRA cassava breeders while flat planting is the farmer's normal practice. The assessment has taken into account impact on groundnut yield as well as cassava yield due to the importance of groundnut in farmers' diets and the spreading architecture of available improved cassava varieties.

Materials and Methods

In 1989, two cassava varieties (local and cv. 8034) and three planting methods (1 cutting buried; 1 cutting planted on a angle; 2 cuttings buried) were arranged in an RCB design. Cassava hills were 1.5 x 1 meter. Participating farmers' planted local groundnut varieties at their desired population.

In 1990, the trial was repeated in the forest zone villages with the same varieties. Only two planting methods were included, flat versus angle, both planted with two cutting per hills. Spacing for cassava hills was reduced to 1 x 1 meter. Participating farmers again planted local groundnut varieties at their desired population. Farmers wanting to include maize were allowed to do so at low populations (around 6,000 plant/ha).

Results

Cassava yield data for the trial planted in 1989 were obtained from eight farms in Kiki (transition zone). Neither variety nor planting method had a significant effect on cassava yield (Table 17). Although the yield difference is not statistically significant due to high variability in plot outcomes, the improved variety, 8034, tended outyield the local control by 34 percent.

Table 17: Effect of cassava variety and planting method on cassava yield (kg/ha), 1989

Variety	Flat; 1 Cut.	Flat; 2 Cut.	Angle; 1 Cut.	Mean
Local	6398	7155	8011	7817
8034	10865	10718	7656	10510
Mean	9327	9750	9938	9179

$LSD_{(0.05)}$ for variety; planting method: ns

Groundnut yield data for the 1990 trial were obtained from eight farms in Nkol Fep and Nkometou II. As in 1989, neither variety nor planting method had a significant effect on groundnut yield (Table 18).[8]

Table 18: Effect of cassava variety and planting method on groundnut yield (kg/ha), first season, 1990

Variety	Flat	Angle	Mean
Local	544	525	535
8034	560	507	533
Mean	552	516	

$LSD_{(0.05)}$ for variety; planting method: ns

Pending cassava yield results from the 1990 trial, there appears to be no reason for recommending a change away from the traditional planting method. Coupled with earlier on-farm tests showing the yield advantage and acceptability of 8034 and 8061, the lack of impact on intercropped groundnut yields found in two years of this test provides further support for moving IRA's improved, but spreading architecture, cassava varieties (8061 as well as 8034) into pre-extension regional testing and demonstration.

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[8] Groundnut density and inclusion of maize were used as covariates but this did not affect the outcome of the ANOVA.

6.4.4.8 Groundnut Weed Control Trial (Sub-Goal 4)

This was the second year for a trial designed to evaluate the possibility of substituting a pre-emergence herbicide application for hand weeding in groundnut-based cropping patterns.

Materials and Methods

Three weed control treatments and an unweeded control were arranged in an RCB design. The weed control treatments were (a) hand weeding at four weeks after planting, (b) 1.5 kg ai/ha Alachlor applied pre-emergence, and (c) 1.0 kg ai/ha Alachlor plus hand weeding at six weeks after planting. The same groundnut-based cropping pattern was used in all plots. Farmers provided local varieties of groundnut and planted at their desired population. Groundnut was intercropped with cassava (farmers' local) at 6,000 plants/ha and maize (cv. CMS 8704) at 6,667 plants/ha. The trial was implemented first season at eight farms in the forest zone villages with one replication per farm.

Results

Alachlor applied at the rate of 1.5 kg ai/ha gave significantly better early season weed control than did the lower rate of Alachlor (Table 19). The benefits of early season weed control carried over to harvest resulting in lower weed biomass. Improved weed control did not, however, translate into significantly higher maize yields, groundnut yields, or financial benefits. In fact, yields and financial benefits of the unweeded plots were not significantly lower than the plots having weed control.

Based on two years of testing, it appears that farmers facing a labor constraint can obtain comparable, if not higher, yields and profits while substantially reducing labor requirements by using Alachlor as a pre emergence herbicide. However, benefits have not been sufficient to justify an Alachlor weed control recommendation on the basis of increased profitability alone. In fact, there has been a lack of benefit for any weed control method relative to no weeding due to thorough land preparation and high groundnut populations.[9] Thus, the best option for many farmers might be to do no weeding at all. It should be noted, however, that prevailing weed species were not particularly aggressive and weed populations were not heavy. With different weed densities and species, such as might be found at other sites, benefits from weed control could increase substantially. Due to the equivocal nature of these findings the TLU does not anticipate forwarding proposals for weed control in groundnut-based patterns to regional testing.

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[9] Thorough land preparation reduces early season weed growth and development of a groundnut canopy shades weeds later in the season.

Table 19: Evaluation of weed control methods in groundnut-based cropping pattern, Forest Zone, first season, 1990

Weed Control Method	Fresh Ears (kg/ha)	Ground-nut (kg/ha)	Weeds 21 DAP[a] (no./m^2)[b]	Weed Dry Wt at Harvest (g/m^2)[b]	(hr/ha)	Labor Partial Time Benefit (FCFA/ha)[c]
Alachlor (1.5 kg/ha)	1719	782	49 (5.7)	16 (3.6)	5	555,756
Alachlor (1.0 kg/ha) + Hand weed at 6 WAP	1494	741	115 (9.6)	25 (4.3)	78	499,301
Hand weed at 6 WAP[d]	1547	767	118 (9.7)	27 (4.9)	83	522,571
Unweeded control	1499	689	168 (11.5)	48 (6.5)	0	495,296
$LSD_{(0.05)}$ treatment	ns	ns	- (2.2)	- (1.7)	-	ns

a. DAP - days after planting.
b. Numbers in parentheses are means of square root transformations, used to normalize data for the ANOVA.
c. Valuation: fresh ears (without husk)--135/kg; groundnut--426/kg; Alachlor--2550/l with concentration of 480 g/l; labor--150/hr.
d. WAP - weeks after planting.

6.4.4.9 Sole Maize Weed Control Trials (Sub-Goal 4)

This was the second year for a trial designed to evaluate the possibility of substituting a pre-emergence herbicide application for hand weeding in sole maize.

Materials and Methods

During first season, three weed control treatments were arranged in an RCB design (a) hand weeding at four weeks after planting, (b) 2.75 kg ai/ha Alachlor GD applied pre-emergence, and (c) 1.5 kg ai/ha Alachlor GD plus hand weeding at six weeks after planting.[10] The trial was implemented at 26 farms with one replication per farm.

The test was repeated during the second season at 21 different sites. At all but five sites, the lower Alachlor GD treatment level was not complemented by hand weeding due to minimal weed development. To assess fertilizer-weed control method interaction, weed control plots were split with maize in one sub plot receiving a side dressing of urea at a rate of 60 kg N/ha. Sites having different treatments were analyzed as separate tests, as were sites in the forest zone versus the transition zone (due to differences in weed species, farming practices, and maize yields).

[10] Alachlor GD is a formulated mixture of alachlor plus atrazine.

Results

First season 1990 results were substantially different from second season 1989. In 1989, Alachlor GD gave a significant yield and financial benefit relative to both hand weeding and Alachlor GD (at a lower rate) plus hand weeding. In 1990, there was no rain for over two weeks after Alachlor application, resulting in relatively poor performance of the herbicide and no yield advantage in either the forest or transition zone (Table 20). In circumstances such as faced in 1990, supplementing Alachlor with hand weeding was necessary to obtain higher yields and profits than were obtained through the farmer's practice of a single hand weeding.

Table 20: Evaluation of weed control methods in sole maize, first season, 1990

Weed Control Method	Maize Yield (kg/ha)	Weeds 21 DAP[a] (no./m^2)[c]	Weed Dry Weight[b] (g/m^2)[c]	Labor Time (hr/ha)	Partial Benefit (FCFA/ha)[d]
Forest Zone:					
Alachlor GD (2.75 kg/ha)	5815[e]	270 (14.4)	74 (7.1)	5	799,497
Alachlor GD (1.5) + hw	6388	347 (15.9)	52 (5.7)	67	892,510
Hand weed	5835	753 (24.7)	76 (7.4)	158	872,846
$LSD_{(0.05)}$ treatment	ns	(4.1)	- ns	-	ns
Transition Zone:					
Alachlor GD (2.75 kg/ha)	917[f]	17 (3.5)	178 (11.9)	5	100,842
Alachlor GD (1.5) + hw	1179	37 (2.9)	66 (7.2)	86	128,036
Hand weed	1007	358 (18.1)	149 (11.8)	127	107,842
$LSD_{(0.05)}$ treatment	ns	(4.1)	- ns	-	ns

a. DAP - days after planting.
b. Dry weight per square meter at harvest.
c. Numbers in parentheses are means and LSD following square root transformation, used to normalize data for the ANOVA.
d. Valuation: fresh ears (without husk)--135/kg; maize grain--126/kg/ha; Alachlor GD--2790/l with concentration of 550 g/l; labor--150/hr.
e. Fresh ears without husk
f. Maize grain at 15% moisture.

During second season 1990 different results were obtained in the forest and transition zones (Table 21). In the forest zone differences between weed control methods were not significant for yield, weed biomass or profit. Nevertheless, in both tests, plots treated with Alachlor GD at 2.75 kg/ha out-yielded manually weeded plots and had an average financial gain (in unfertilized plots) of more than 75,000 FCFA/ha. A comparison of results across tests suggests that Alachlor GD at the rate of 1.5 kg/ha requires a supplemental hand weeding. In the transition zone, Alachlor GD was ineffective due to a different configuration of weed species. As a result chemical weed control resulted in lower yields and profits relative to manually weeded plots.

Table 21: Evaluation of weed control methods in sole maize, second season, 1990 [a]

Weed Control Method	Maize Yield No Fert. (kg/ha)	Maize Yield With Fert. (kg/ha)	Weeds 21 Days After Plant (no./m²)	Weed Dry Wt. No. Fert. (g/m²)	Weed Dry Wt. With Fert. (g/m²)	Labor Time (hr/ha)	Partial Benefit No Fert. (FCFA/ha)	Partial Benefit With Fert. (FCFA/ha)
Forest Zone:								
Alachlor GD (2.75 kg/ha)	5392	7181	46 (6.3)[b]	16	24	5	710,041	925,215
Alachlor GD (1.5) + hw	5405	7629	256 (14.1)	20	40	134	698,809	972,708
Hand weed	4955	7402	674 (24.1)	23	23	232	634,203	938,251
$LSD_{(0.05)}$ control	ns			-	(6.7)	ns	-	ns
$LSD_{(0.05)}$ fer. in control	1015		-	-		ns	-	137,026
Forest Zone:								
Alachlor GD (2.75 kg/ha)	4817	6330	103 (9.0)	42	23	5	632,411	810,401
Alachlor GD (1.5 kg/ha)	3722	6077	363 (17.2)	39	44	5	490,921	782,516
Hand weed	4367	5899	806 (27.2)	49	67	241	553,370	733,908
$LSD_{(0.05)}$ control	ns			-	(9.3)	ns	-	ns
$LSD_{(0.05)}$ fer. in control	1146		-	-		ns	-	154,737
Transition Zone:								
Alachlor GD (2.75 kg/ha)	820	1231	22 (4.2)	50	40	5	87,593	113,194
Alachlor GD (1.5 kg/ha)	831	1084	28 (4.8)	43	57	5	95,409	101,037
Hand weed	1168	1193	175 (12.4)	36	44	88	133,945	110,807
$LSD_{(0.05)}$ control	ns			-	(2.3)	ns	-	ns
$LSD_{(0.05)}$ fer. in control	308		-		ns	-	ns	

a. See notes on Table 20 for treatment levels, definitions and valuations.
b. Means and LSD following square root transformation.

As in many other TLU trials, there were substantial yield and financial benefits from fertilization. In the forest zone gains from fertilization were significant regardless of weed control treatment. In the transition zone, yield and financial gains were obtained only in the chemical weed control plots. Nevertheless, fertilizer by weed control method interactions were not significant in any of the three tests.

Combined results over three seasons of testing show that use of Alachlor GD consistently increases yields and profits relative to the farmer's standard practice, while substantially reducing labor requirements. During the shorter, but more intense second rainy season, the higher rate of Alachlor GD gives good early season weed control and this benefit carries over to yield even in the face of heavy late season weed biomass development. During the longer first rainy season Alachlor GD seemingly requires a supplemental hand weeding in order to outperform the farmer's hand weeding practice. Overall, Alachlor GD continues to show promise as an improved weed control method for forest zone farmers. Due to differences in results depending on season and application rate, more research village testing is required before regional testing can begin.

Due to the ineffectiveness of Alachlor GD in controlling weeds in the transition zone, further testing would appear to be unnecessary. The TLU will try to identify an alternative pre-emergence herbicide for use by transition zone farmers.

6.4.4.10 Phosphorus Fertilization Trials (Sub-Goal 5)

Nkolbisson TLU has concluded that 60 kg N/ha nitrogen is profitable and should be promoted as a recommendation for sole maize. This rate can be adjusted downward on a plant equivalent basis for maize intercropped in groundnut-based cropping patterns. TLU fertilization work now is directed at identifying potential supplements or substitutes for the standing 60 kg N/ha recommendation.

During both seasons, phosphorus fertilization trials were carried out in Kiki as a follow up to earlier trials showing occasional but erratic maize response to phosphorus. During first season, 60 kg P/ha was assessed as a supplement to 60 kg N/ha for sole maize and for a groundnut-maize cropping pattern. In addition to generating additional observations on sole maize yield response to 60 kg P/ha, the purpose of the trial was to determine whether the combined response of groundnut and maize to 60 kg P/ha in a groundnut-maize mixture might be profitable even if the response of maize alone was not.

During second season, sole maize response to a supplement of 60 kg P/ha was again assessed in Kiki. As part of the trial, an attempt was made to determine whether equivalent values of 20-10-10 and urea (0.46 N) would result in significantly different maize yields and profits.

Materials and Methods

The first season trial had a split plot design, with cropping pattern main plots and fertilizer sub-plots. The cropping pattern treatments were sole maize at 53,330 plants/ha and a groundnut-maize mixture with maize at 26,667 plants/ha and groundnut planted by farmers at their desired populations. The maize variety used was CMS 8704 while farmers provided their own groundnut. A uniform application of urea was side dressed to all maize at a rate of 60 kg N/ha for sole maize and 30 kg N/ha for the maize groundnut mixture (an equivalent per plant rate). The sub-plots were 0 and 60 kg P/ha delivered through triple superphosphate (TSP; 0.46 P). For the sole maize pattern, TSP was side dressed along with the urea. For the groundnut-maize pattern, TSP was broadcasted immediately before planting.

During second season, sole maize was planted by farmers following their normal practices. Three fertilizer treatments were randomly superimposed in equal sized plots. The treatments were (a) urea at a rate of 60 kg N/ha, (b) urea at 60 kg N/ha plus TSP at 60 kg P/ha, and (c) 20-10-10 at a rate of 168 kg/ha (equivalent in cost to the quantity of urea applied in the other plots).

Results

During first season, maize yield response to P was significant in sole maize but there was not a significant financial gain after netting out fertilizer costs (Table 22). In the mixed

groundnut-maize pattern, neither maize nor groundnut responded to the P supplement. There was a large financial gain from the intercropping pattern relative to sole maize due to low maize yields and the high value of groundnut relative to maize.

Table 22: Effect of triple superphosphate on sole maize and maize-groundnut yields and partial benefit, Kiki, first season, 1990

Cropping Pattern	N & P Rate (kg/ha)	Maize Grain (kg/ha)	Groundnut (kg/ha)	Partial Benefit (FCFA/ha)
Maize	60, 0	466	0	30,803
	60,60	629	0	37,290
Groundnut	60, 0	167	681	297,956
+ maize	60,60	175	707	283,945
$LSD_{(0.05)}$ pattern:		129	-	128,356
$LSD_{(0.05)}$ fert. in pattern:		122	ns	ns

a. Valuation: maize grain--126/kg; groundnut--426/kg; labor--150/hr for 60 hr/ha; urea (.46 N)--6750/50kg; triple superphosphate (.46 P)--6750/50kg; transport from Yaounde--1000/50kg.

In the second season test, there were no significant differences among fertilizer treatments for yield or financial gain (Table 23). Coupled with results from prior TLU tests, there would appear to be no reason to pursue development of a 60 kg P/ha recommendation even for the transition zone. If there is to be further work on phosphorus fertilization, the focus should be on identification of collateral data for targeting fields where larger than average P responses can be expected.

The lack of significant differences in yields and financial gain between urea and an equivalent value of 20-10-10 suggests that farmers can use 20-10-10 instead of urea in cases where the latter urea is unavailable. This proposition needs at least another year of testing in Kiki before it can be forwarded for regional testing in the transition zone.

Table 23: Effect of urea, triple superphosphate and 20-10-10 on maize grain and partial benefit, Kiki, second season, 1990

Fertilizer	Quantity (kg/ha)	Nutrients (N,P,K/ha)	Grain Yield (kg/ha)	Partial Benefit 1988 Prices	Partial Benefit 1990 Prices
Urea	130	60, 0, 0	1,102	109,664	112,602
Urea + TSP	130 + 130	60,60, 0	1,184	99,702	105,577
20-10-10	168	34,17,17	1,131	112,493	111,225
	$LSD_{(0.05)}$		ns	ns	ns

a. Valuation: maize grain--126/kg; labor--150/hr for 60 hr/ha; urea (.46 N)--6750/50kg; triple superphosphate (.46 P)--6750/50kg; 20-10-10--5250/50kg; transport from Yaounde--1000/50kg.
b. Valuation changes: urea, TSP and 20-10-10--5628/50kg.

6.4.4.11 Agroforestry Site Establishment (Sub-Goal 6)

The goal of the TLU during 1990 with respect to agroforestry in the forest zone was to establish alley cropping sites for future on-farm testing of three crop-fallow rotation patterns. This strategic approach was adopted in the view that alley cropping will only be accepted by farmers if it can be demonstrated that they can increase cropping intensity (ratio of cropping to fallow) without seriously depleting soil fertility.

The goal of the TLU in the transition zone was to establish border hedge sites for future on-farm testing of benefits from incorporation of biomass from leguminous tree cuttings.[11] Soil nutrients are already depleted in Kiki due to more or less continuous cropping, and farmers can be expected to readily adopt border hedges if yield benefit can be demonstrated. Border hedges have the added advantage of preventing collapse of the edges of elevated plots prevalent in the low lying swampy areas (*bas fonds*) of Kiki.

Materials and Methods

Alley hedges were direct seeded at four meter intervals in seven fields. Different plot shapes were used depending on field size, but a minimum of five hedge rows were planted on each field. Plantain suckers were planted each five meters of every third row, to increase short run economic benefit of the agroforestry system. In another effort to increase short run benefit, farmers were encouraged to plant food crops during the initial seasons of hedge row establishment. It was anticipated that at least one full year would be needed before the TLU could begin comparing three cropping intensity patterns: (a) first and second season cultivation,[12] (b) first season cultivation followed by second season natural fallow, (b) first season cultivation followed by second season improved fallow.

In Kiki, one border hedge site was planted during first season with seedlings in order to demonstrate the border hedge concept. During second season, four farmers attempted to establish additional sites by direct seeding.

At all locations, the species used was *Leucaena leucocephala*. The TLU had hoped to use *Calliandra calothyrsus* but could not obtain sufficient seed.

Results

Of the seven alley cropping sites, good establishment was achieved at only two sites. At other sites, there were gaps which required replanting. Post-establishment

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[11] Alley cropping is not likely to be accepted in the transition zone research village due to the small size of plots, few of which have sloping terrain.

[12] Both season cultivation is quite common in Kiki but is still relatively rare in Nkol Fep. This option would only be possible with substantial biomass supplementation from the alley hedges.

biomass development was poor at all but one site, and that one site was threatened by termites at the end of 1990. Relatively speaking, the best growth was at fields cultivated both first and second season, at which cassava was not planted or was planted only during second season. Four of seven fields were planted during second season. Hedge development was better on these fields than in remaining fields where there was heavy shading due to first season cassava (2 sites) or weeds.

In Kiki, biomass development was poor at the site planted with seedlings and two weedings were required to reduce shading. Establishment was quite poor at the four direct seeded sites, leading to no possibility of testing biomass response in 1991.

Tentative conclusions based on 1990 field observations are: (a) farmers must be willing to repeatedly reseed hedges or will need a low cost method for seedling nurseries since direct seeding results in poor establishment; (b) farmers should cultivate during the first two seasons of hedge row establishment but no cassava should be planted during the first season, (b) *Leucaena* is unlikely to produce reasonable biomass for a least two years, (c) plantain intercropping does not influence farmer interest or willingness to maintain sites but is useful for finding hedges in unmaintained fields, and (d) there are no apparent advantages to an alley planting format, and perhaps some substantial disadvantages, except for sites having sloping terrain.

6.4.4.12 Managed Fallow Establishment (Sub-Goal 6)

Two primary constraints on introduction of managed fallow in the forest zone are fallow species establishment and the additional labor required for establishing, managing and utilizing the planted fallow species. The primary goal of the TLU during 1990 was to try to establish a second season planted fallow without specialized investments in land preparation.

Materials and Methods

Three strategies were tried by the TLU. The first was to relay plant a first season field immediately following groundnut harvest. This strategy was proposed by the lowland maize agronomist. Relay planting was done at eight sites in Nkol Fep using *Desmodium distortum* and *Crotalaria cariccа*. The second strategy was to simultaneously establish maize and pigeon pea (*Cajanus cajan*) in alternate rows at the beginning of the first season.[11] Maize pigeon pea intercrops were planted at eight sites in Nkol Fep. The last strategy was tried at a single site in Kiki. This was to plant second season in seeding holes created by uprooting first season maize stalks, without traditional bed preparation and with only minimal removal of emerged weeds. Planting was done in separate plots with *Desmodium* and *Crotalaria*.

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[11] This strategy emerged as a by-product of an attempt to use pigeon pea as a biological means of weed control.

Results

At maize-pigeon pea intercrop sites, there was only moderate establishment but excellent growth of established plants. Some farmers cut pigeon pea after the first season while others did not. Cut plants had good regrowth and farmers managed the cutting and mulching operation without TLU input. Uncut pigeon pea grew to more three meters and produced seed before the end of the second season.

Based on 1990 observations, maize pigeon pea intercropping appears to be a promising option for introducing planted fallow. Due to erratic establishment, planting should be tried at higher maize and pigeon pea densities. Pocket planting in groundnut or maize fields might be explored as an alternative to inter-row planting. Farmers probably should cut after the first season, enabling almost immediate benefit and reducing management problems for second season cutting and mulching. Cassava shading should not be a problem for biomass development since pigeon pea will likely grow faster than cassava.

It was not possible to establish either *Desmodium* or *Crotalaria* through relay planting at the end of the first season. This was due to poor emergence as opposed to drought stress during the short dry season. Only at one site was there reasonable establishment of *Desmodium*. Biomass development during second season was quite satisfactory at that site. There was poor emergence and failure to establish an improved fallow at the site planted second season as well.

Further efforts will be needed to determine causes of poor emergence and establishment. One option for improving emergence rates is to pocket or row plant, rather than broadcast, but this will require attention to relative labor requirements and farmer acceptability.

7.1 CEREAL PATHOLOGY

7.5.1 INTRODUCTION

This unit has the mandate to conduct research on Maize, Sorghum and Millet diseases. During the 1990 growing season, activities were limited to maize pathology, the reasons being not only limited funds that could not allow the unit conduct research on these crops from Bambui, but mainly the lack of collaboration with sorghum team based in Maroua. The Sorghum Agronomy Unit was contacted to set up an experiment on the effect of nitrogen levels on the incidence and severity of head smut on sorghum, as a follow up of 1989 results, but no positive reaction was made. Likewise Breeding did not respond on our request to continue the West Africa Sorghum Leaf Disease Nursery as well as screening elite NCRE entries to dead heart caused by Colletotrichum graminicola of which incidence was very high in 1989. Thus the work presented in this report is limited to maize pathology. Nine experiments were conducted to investigate various aspects of maize diseases in Cameroon. In addition, highland breeding trials were evaluated for disease resistance.

7.5.2 RESEARCH FINDINGS

7.5.2.1 Effect of inbreeding depression on the resistance to rusts and blights

This experiment started in 1989, the objective being the assessment of early generation selection on resistance to rusts and blights. Cycles of selfing (S1, S2, ... S5) are formed each season without selection and remnant seed kept for generation testing. S3 was formed in 1990 and will be advanced to S4 next growing season.

7.5.2.2 Incidence of *Excerohilum* and *Bipolaris spp.* in maize leaves in Cameroon

This experiment started in 1989 during which Excerohilum turcicum was found to be widespread in the maize growing areas of the country, with an incidence of about 80%, while Bipolaris maydis had 22% incidence, and occurring mostly in the lowlands and mid altitude zones. The virulence of 13 isolates of E. turcicum from maize and one isolate of Helminthosporium turcicum isolated on sorghum at Ndonkole, was tested on four genotypes of the inbred line H4460 with specific genes of resistance Ht1, Ht2, or Ht3. These lines were obtained from Dr. Paul Christensen of **Dekalb pfizer Genetics 3100 Sycamore Road, Dekalb IL. 60115 U.S.A.**

Five weeks old seedlings were inoculated by putting drops of spore suspension in the whorl of the plant. Disease assessment was made two weeks after inoculation. Table 1 presents the phenotypic response of the four genotypes when inoculated with the 14 isolates.

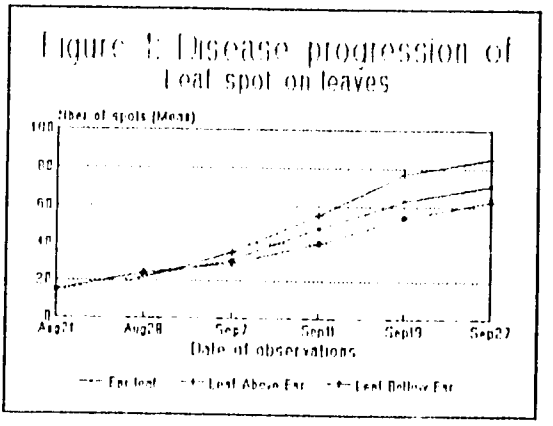
A chlorotic lesion is a resistance reaction whereas the necrotic lesion indicates susceptibility. From the phenotypic response above the virulence formula of each isolate is determined, followed by its race (table 2). Three isolates are designated H. turcicum race 1 (UPPER-FARM, MFONTA, and NDONKOLE), three of race 3 (BATHE, NGONGZEN, and NDONKOLE). The others are of race 2. All the four genotypes exhibited resistance to H. turcicum isolated from sorghum, indicating a possible host specificity.

7.5.2.3 Epidemiology and etiology of *Pheosphaeria* leaf spot and *Diplodia* leaf stripe

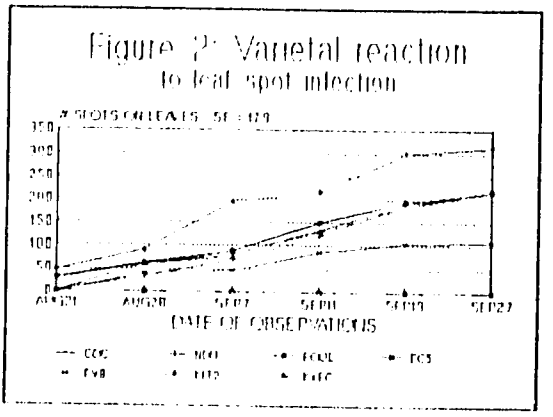
7.5.2.3.1 Phaeosphaeria leaf spot

The 1989 results showed that this was a wind born disease, caused by Phaeosphaeria maydis. The objective of this study was to determine the time of establishment of the disease and its development on plants, and also to evaluate high altitude varieties for their resistance to the disease.

Seven entries were planted at Upper-Farm (1900 m) and disease was monitored on the ear leaf, and leaves above and below ear leaf. The first symptoms appeared in mid-august, when plants were in the soft dough stage. Disease severity was assessed by counting the number of spots on the three leaves, while incidence was measured as the number of infected leaves/plant. As indicated on figure 1, disease severity increased continuously during the first three weeks of September, then slowed down towards maturity (senescence of leaves).



The reaction of entries to the disease differed significantly at the probability level 5% (table 1 and fig 2). While EC573 showed no symptoms on leaves, Kitale 2, COCA and POOL 9 had 60% or more of their leaves infected.



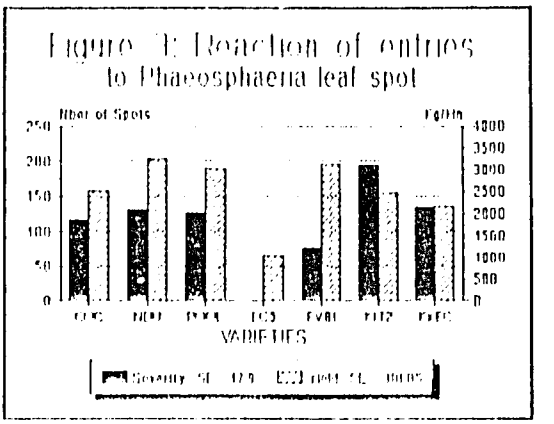
The direct effect of Phaeosphaeria leaf spot on the plant is the reduction of photosynthetic activities and premature death of leaves, leading to yield reduction.

As indicated in figure 3, EC573 seemed to have immunity against the disease; EV8119 presented good resistance to the disease, and NDU local, POOL 9, and KITALE 2 showed very high tolerance to Phaeosphaeria maydis.

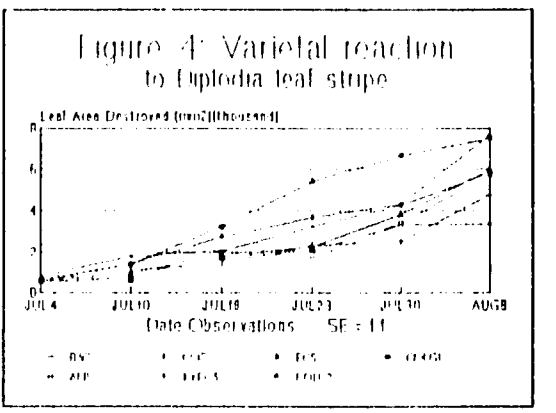
7.5.2.3.2 Diplodia leaf stripe

The objectives of this study were similar to those of Phaeosphaeria leaf spot. Seven entries (BACOA, COCA, EC573, COCA LIGULESS 1, ATP, KITALE2 X EC573, and COCA LIGULESS 2) were planted at Bambui Plain (Mfonta).

Conspicuous symptoms were observed early July. Lesions were counted and lesion areas calculated weekly until senescence of leaves (early August). Figure 4 shows that leaf area destroyed by Diplodia macrospora increased continuously, with a high rate of increase towards the end of the season.



It seemed not to follow the typical disease progress curve, except on ATP and EC573 (fig. 4). Entries did not differ significantly (P > 0.05) in their reaction to the disease. We noticed a very high incidence and severity of the disease on PACOA in isolation plot, as compared to varietal trial. So it seems that epidemics can easily occurr in large scale farms where only one susceptible genotype is planted.



7.5.2.4 Comparative reaction of lowland and highland entries to blights and rusts.

The objectives of this study were:

- to evaluate level of resistance of lowland materials to highland diseases which are prevalent in intermediate zones where these materials are likely to be used,
- to identify a suitable site to be used as disease nursery site for lowland materials.

The experiment was carried out at Nkolbisson, actually used as lowland nursery, and where H. turcicum is very common and even severe on susceptible entries, and at Foumbot (mid-altitude), actually used as highland nursery and where selection for lowland diseases such as maydis blights and polysora rust are prevalent. A line susceptible to both blights and rusts was planted around the plot as spreader.

7.5.2.4.1 Highland and lowland inbreds

Five lowland and four highland inbreds were planted at Foumbot on April 27 and at Nkolbisson on May 17, in a randomized complete block design, with 4 replications, and 3 row plots. Data on diseases were collected on the central rows.

The analysis of variance of the transformation of the infection index into Arcsin showed highly significant differences among entries, for their reaction to H. turcicum and Puccinia polysora at both locations, as indicated in table 3. Disease was higher at Foumbot than at Nkolbisson. We also noticed that lowland entries were very susceptible to rust at

Foumbot, but not at Nkolbisson. Highland materials demonstrated high tolerance to diseases and yielded more than 2t/ha while lowland entries yielded at most 1.9t/ha. Lowland inbreds 52-1 and 20-1 had complete crop failure due to polysora rust.

7.5.2.4.2 Highland and lowland composites

Likewise for inbreds, disease pressure was higher at Foumbot than at Nkolbisson. Highly significant differences (P=0.05) were observed among entries for their reaction to rust, but not to blights. At Nkolbisson, Yaounde 8701, COCA were the most susceptible to polysora rust, followed by BSR Synthetic 2, SHABA, Foumbot5-MSR-87 and Foumbot3-MSR-85, while CMS 8503, POOL 16 SR, and CMS 8704 were fairly resistant. At Foumbot, DMR-ESR-Y, POOL 16 SR, BSR Synthetic 2 and BACOA were the most susceptible.

Diseases were greater at Foumbot than at Nkolbisson, both in number and quantity, and lowland materials had more disease at Foumbot than at Nkolbisson. Thus Foumbot can be recommended as a site for disease nursery of lowland materials, as it is for highland materials.

7.5.2.5 Effect of land preparation on the incidence and severity of Rhizoctonia blights

In a farming system experiment conducted by IITA to investigate the possibilities of cropping maize in rice plots before rice, we noticed that Rhizoctonia solani infection was a limitation to this practice, causing up to 20% stalk and ear rot in some plots. Disease patterns in the field indicated that disease severity was very high with water logged plots.

The objective of this study was to determine the beneficial effect of land preparation in suppressing the disease. Three varieties were used in a split plot design where the main plot was land preparation and varieties being the sub-plot. Five farmer's rice plots were used as complete blocks. Disease assessment was done one to two weeks before harvesting, by counting the number of infected plants over the total number of plants in the plot.

The analysis of variance showed significant differences in disease severity in the main plots at P=0.05, and no significant differences among varieties. Table 6 indicates that planting on ridges saved about 4% of total plant stands thus 4% of the yield. The experiment will be repeated again in 1991.

7.5.2.6 Assessment of yield loss due to Blights and Rusts.

This study was conducted to determine the actual percentage of yield loss due to blight. Dyrene 75, containing 75% anilazine, reported to be effective against blights on maize, was used to control *H. turcicum*.

Nine varieties, both highland and lowland were planted in a randomized block design, with three replications. The plot was surrounded by two rows of susceptible lines, to serve as spreader rows. All the entries, including the spreaders were inoculated at knee high with a powder of infected leaves from previous cropping season. This set up was duplicated, without spreader rows, and was not inoculated, but was sprayed weekly with Dyrene 75, starting 6 weeks after planting.

Table 1. Phenotypic response of four maize genotypes inoculated with 14 isolates of *E. turcicum* 15 days after inoculation.

Isolates	GENOTYPES			
	H4460	H4460Ht1Ht1	H4460Ht2Ht2	H4460Ht3Ht3
BATIE	N	C	N	N
FOUMBOT	N	N	N	C
MBANG-MBIRNI	N	N	C	N
BEFANG	N	N	C	C
UPPER-FARM	N	C	C	C
NKOLBISSON	N	N	C	N
MFONTA	N	C	C	N
SANTA	N	C	N	C
BANSOA	N	N	C	C
BABUNGO	N	N	C	C
MBIAME	N	N	C	C
BAFOU	N	N	N	C
NGOMDZEN	C	C	N	C
NDONKOLE	C	C	C	C

C = Chlorotic lesions
N = Necrotic lesions

Table 2. Virulence formula and designated races of the isolates.

Isolates	Virulence formula	Races
BATIE	Ht1Ht2/Ht3	3
FOUMBOT	Ht3/Ht1Ht2	2
MBANG-MBIRMI	Ht2/Ht1Ht3	2
BEFANG	Ht2Ht3/Ht1	2
UPPER-FARM	Ht1Ht2Ht3	1
NKOLBISSON	Ht2/Ht1Ht3	2
MFONTA	Ht1Ht2/Ht3	1
BAMSOA	Ht2Ht3/Ht1	2
BABUNGO	Ht2Ht3/Ht1	2
MBIAME	Ht2Ht3/Ht1	2
BAFOU	Ht3/Ht1Ht2	2
NGOMDZEN	Ht1Ht3/Ht2	3
SANTA	Ht1Ht3/Ht2	3
NDOMKOLE	Ht1Ht2Ht3	1

Table 3: Reaction of highland and lowland inbreds to blights and rust

Entries	Turcicum		Maydis		Polysora	
	FBT	NKOL	FBT	NKOL	FBT	NKOL
89311	3.8	2.2	4.4	6.7	4.4	6.7
13-1	2.8	2.8	2.2	3.3	11.1	3.9
89286	3.9	2.2	3.2	2.2	6.1	9.4
M 131	5.6	3.3	4.4	3.3	8.3	10.0
89299	3.3	2.2	2.8	2.8	3.3	7.8
22-1	3.3	2.2	2.2	2.8	11.1	5.0
GP1-37	6.7	2.8	3.3	2.2	7.8	2.2
52-1	2.2	11.0	2.2	2.2	11.1	3.3
20-1	2.2	2.8	2.2	2.2	11.1	4.4
MEANS	3.8	3.5	3.0	3.1	8.07	5.8
CV	14.3	11.9	16.4	22.6	8.07	13.5
LDS (0.05)	2.6	2.1	2.7	3.8	2.2	3.1

* in tons/ha
FBT = Foumbot
NKOL = Nkolbisson

Table 4: Reaction of lowland inbreds to diseases as compared to highland inbreds.

	Turcicum		Maydis		Polysora	
	FBT	NKOL	FBT	NKOL	FBT	NKOL
Lowland	3.4	4.3	2.4	2.5	10.4	3.3
Highland	4.5	2.5	3.7	3.8	5.5	6.2
SE	0.78	0.61	0.79	1.11	0.66	0.92

Table 5: Reaction of highland and lowland composites to blights and rusts.

Entries	Polysora rust Fbt.	Nkol.	Yield at Fbt (t/ha)
Synthetic 1	4.3	3.0	8.7
CMS 8704	5.7	3.0	8.3
FBT3-MSR-85	4.7	4.7	8.1
SHABA	5.0	4.3	7.9
KASAI	4.7	3.3	7.6
CMS 8503	5.3	2.3	7.6
FBT5-MSR-87	4.3	4.0	7.4
BACOA	6.0	3.7	7.0
YAOUNDE 8701	4.0	6.3	6.7
CMS 8710	4.7	3.7	6.3
COCA	4.0	6.3	6.3
DMR-ESR-W	5.3	3.0	5.8
POOL 16 SR	6.7	2.7	5.6
BSR SYN 2	6.7	4.0	5.4
DMR-ESR-Y	6.3	3.0	5.2
MEANS	5.1	3.8	6.9
CV (%)	7.9	16.2	11.1
$LDS_{(0.05)}$	1.77	3.08	1.3

Table 6: % infected plants as influenced by land preparation.

Varieties	% infected plants		
	Flat	Ridges	Means
CMS 8704	22.73	24.37	23.55
CMS 8507	25.59	19.27	22.33
CMS 8501	23.87	17.89	20.88
MEANS	24.06	20.51	

SE (Land Preparation) = 1.51
SE (Varieties) = 2.13

Table 7: Incidence and Severity of Blights and rusts at Foumbot in 1991.

Varieties	Blights		Yield (T/Ha)	
	Inoc.	Non Inoc.	Inoc.	Non Inoc.
SHABA	5.92	3.7	6.9	7.4
766	6.66	3.7	4.0	2.8
BSR SYN 2	6.66	2.22	4.2	5.2
KASAI	5.18	2.96	7.9	6.8
126	8.14	6.66	4.2	4.4
YAOUNDE 8701	8.14	5.92	3.8	3.8
751	5.92	2.96	3.3	3.6
CHS 8704	5.18	4.44	7.7	8.8
FBT HSR 87	4.44	2.22	8.4	8.6
MEANS	6.25	3.86	5.6	5.7
CV(%)	11.9	16.1	21.4	22.3
$LSD_{(0.05)}$	2.5	3.5	2.4	2.5

7.2. RICE PATHOLOGY

7.2.1. INTRODUCTION

Studies conducted by the rice pathology program in 1990 have been oriented around the influence of cultural conditions on the incidence of Pyricularia oryzea on rice in the Mbo plain. Within the framework of this theme, several operations were developed, programmed and realized.

- Effect of nitrogen nutrition on the incidence of pyricularia.
- Effect of planting dates on the incidence of pyricularia.
- Effect of soil preparation on the incidence of pyricularia.

Also, within the framework of a multi-disciplinary approach, the rice pathology program has done observations on trials based in Dschang and on the Mbo Plain of the varietal improvement program and noted among other things:

- Germplasm characterization.
- The populations in segregation (crossing in F2, F3 and F4).
- Trial research of varieties resistant or tolerant to cold.

These studies have given place to research on varieties resistant or tolerant to cold and to the principal diseases:Pyricularia oryzea, Rhynchosporium oryzea and Aerocylindrium oryzea.

The principal objective was to make varietal selection of viable parents. The evaluation of yield losses due to pyricularia in natural conditions in the Mbo plain was not ready for this report. However the results of the trial on soil preparation effect on incidence of Pyricularia done in the 2nd season of the 1989 agricultural year was not reported last year but is reported here.

7.2.2 OBJECTIVES

a) Effect of nitrogen nutrition on the incidence of pyricularia on 5 varieties of rice in the Mbo plain.
The objective of the study was to evaluate the effect of different levels of nitrogen on the incidence of this disease on 5 varieties of rice extended in the Mbo plain.

b) Effect of planting dates on the incidence of pyricularia on 5 varieties of rice in the Mbo plain.
We studied the best date of seeding: a period without pyricularia or a period with less disease pressure.

c) Effect of soil tillage on the incidence of pyricularia on 5 varieties of rice extended in the Mbo plain.

The average farmer uses a variety of cultural practices. These different practices should have an influence on our varieties.

d) Research on varieties resistant or tolerant to the principal diseases: Pyricularia, Rhynchosporium, Sheath rot.

7.2.3. CONSTRAINTS

The funds granted to our unit of research have been insufficient to execute our action plan. In view of the preceding we have been forced to reduce our volume of work and to limit our work to only one location: the Mbo plain. Four researchers, four technicians and observers utilize the same vehicle. This involves constant modifications of the travel calendar detrimental to the trials and the work of the pathologist.

Also some difficulties were due to SODERIM:

a) Delay in plot preparation for the experiments.
b) Delay in furnishing water to the experimental plots.

7.2.4. RESULTS

7.2.4.1. Effect of nitrogen nutrition on the incidence of pyricularia

This study included six levels of nitrogen and was realized in irrigated conditions at Santchou. The trial has indicated:

a) For all these varieties, the level of attack of pyricularia increases with rates of nitrogen. (Table 1)

b) Only in function of the degree of attack, the treatments No, N20 and N40 of nitrogen are similar as well as the rates of N60, N80 and N100. (Table 1) The test of Friedman revealed that these differences are not significant.

c) Concerning varietal resistance, the ranking of the varieties from most resistant to least resistant is similar across levels of nitrogen. V4 (Cisadane) appears in the trial as the most resistant while V5 (CICA 8) as the most sensitive to foliar pyricularia.

The results obtained for stem rot are not analogous to those of the leaf. The influence of the different rates of nitrogen are not clearly demonstrated on the stem. (Table 2) This we believe is due to differences of varietal sensitivity, variability of pathogenicity of Pyricularia oryzea in the field or to unfavorable cultural or season for the fungus. The second season is not favorable to the disease. Looking at the results obtained, there does not seem to be a close relation among yields and levels of nitrogen nor among the indices of attack and yield losses. (Table 3) Analysis of variance confirms that there were not significant differences among the yields and the different treatments.

We know that nitrogen is the most determining factor of yield. We know also that strong attacks of pyricularia on the stem lead to low yields. These realities have not been obvious in the trial. This trial has suffered certain negative factors such as abundant panicle abortion at heading, iron toxicity established by a very pronounced yellowing of the plants during their vegetative phase. These factors should have biased the results.

Table 1 : Effect of nitrogen nutrition on incidence of pyricularia. Foliar pyricularia average of 3 observations.

	N0	N20	N40	N60	N80	N100
V1	2,5	3,25	4,0	3,75	3,50	4,25
V2	2,5	3,0	3,25	4,0	4,0	4,0
V3	2,75	3,0	2,75	3,75	3,50	4,0
V4	2,50	2,25	2,75	3,25	3,0	3,75
V5	3,25	3,50	4,25	4,75	4,75	4,75

Table 2 : Effect of nitrogen Nutrition on incidence of pyricularia. Stem pyricularia average of 3 observations.

	N0	N20	N40	N60	N80	N100
V1	6,47	4,15	6,66	7,51	7,05	4,94
V2	5,69	5,22	6,69	7,04	5,19	8,06
V3	5,84	4,81	6,63	5,01	5,17	4,60
V4	3,54	3,43	5,21	2,94	2,96	4,30
V5	6,17	6,03	4,20	4,92	4,84	3,70

Table 3 : Effect of nitrogen Nutrition on incidence of pyricularia. Mean Yield t/ha.

	N0	N20	N40	N60	N80	N100
V1	4,559	4,150	4,451	4,081	5,019	5,007
V2	4,246	4,993	4,621	4,17	5,623	4,876
V3	4,303	4,154	4,110	4,550	4,316	4,584
V4	4,012	4,185	4,637	4,309	4,361	4,610
V5	4,774	4,679	4,733	4,766	4,958	5,014

V1 = ITA 212
V2 = ITA 222
V3 =Nang HP Hiep 75
V4 = Cisadane
V5 = CICA 8

7.2.4.2. Effect of planting dates on incidence of pyricularia.

For this trial, 4 planting dates were tested. The varieties utilized were our better selections. The trial revealed that there were more diseases (foliar spots) for the first date (18.9.89) as compared with other dates of planting and that there was also a significant difference in intensity of attacks between the second and third dates (26.9. and 9.10. 89) of seeding. (Table 4)

For these dates, the variety V5 (CICA 8) seems to be more sensitive than all other varieties. V4 (Cisadane) seems less sensitive at the 1st date of seeding (18.9.89) than other varieties. (Table 4)

Concerning pyricularia of the stem, the most favorable date seems be the 26.09.89 (second date of seeding). At this date the varieties most attacked were: V2, (ITA 222), V1 (ITA 212) and V5 (CICA 8). The effect of disease on yield was not evident. The data obtained are not yet sufficient to permit a definitive conclusion. These trials ought to be repeated.

Table 4: Effect of planting dates on incidence of foliar pyricularia average of 3 observations

	18.9.89	26.9.89	09.10.89	21.10.89
V1	2,75	1,50	1,00	1,25
V2	3,25	1,50	1,75	1,25
V3	1,75	2,00	1,25	1,25
V4	1,75	1,75	1,00	2,00
V5	3,50	2,50	1,50	1,50

18.9.89 = 1st date
26.9.89 = 2nd date
09.10.89 = 3rd date
21.10.89 = 4th date

7.2.4.3 Selection of varieties resistant or tolerant to cold.

We added our check varieties Tainan V and IR 7167-33-2-3 to 91 new introductions. Ten of these varieties were retained for their adaptability to cold and tolerance to pyricularia and sheath rot frequently found at high altitudes.

7.2.4.4. Characterization

A total of 100 germplasm accessions were purified, characterized according to their morphologic, physiologic and agronomic characteristics. We also recorded their reaction with respect to pyricularia.

7.2.4.5. Populations in segregation

A total of 673 populations in F2 and F3 were observed and noted at Santchou, Mbo plain and Dschang. These populations are still segregating. Several hundred populations observed will be retained in selections to be advanced in following years.

7.2.5 CONCLUSION

The program of the rice pathology working group has developed during the last few years. The growth of activities was along three axes:

a) Chemical Control

The testing of new fungicides is linked to several imperatives:

selection of effective formulations compatible with the economic level of the cameroonian rice farmer.

measure the effectiveness or non effectiveness of selected products and their economic importance for seed processing and foliar applications.

b) Study of the influence of cultural conditions on the incidence of pyricularia on rice in the Mbo plain. Within the framework of this theme detailed research will be done on effect of nitrogen nutrition, different planting dates population densities, methods of soil preparation, etc on the incidence of pyricularia. The average farmer uses a variety of cultural practices. These different practices can have an influence on our varieties.

d) Surveys

A survey on diseases of rice for all the rice growing zones of Cameroon is considered an operation of indeterminate duration.
Research on varieties resistant or tolerant to the principal diseases affecting rice in Cameroon is of primary importance. For the cameroonian rice farmer we need varieties of rice resistant or tolerant to Pyricularia oryzea, rhynchosporium oryzea, and Acrocylindrium oryzea.

8.1. HIGHLAND CEREALS ENTOMOLOGY

8.1.1 INTRODUCTION

Up to 1990, the IRA cereal entomologist based in Dschang and attached to the National Cereals Research and Extension (NCRE) Project had the mandate to design and execute research operation aimed at solving the post harvest handling and storage problems of the major cereal grain crops of Cameroon including Maize, Rice, Sorghum and Millet. Recently he has also been told to include Legume Seeds (i.e. Beans, Cowpea and Soya Beans). Some limited research is also carried out on Rice Field Insect problems on request from the Rice Sub-Program.

The main objectives of the research unit are as follows :

- To acquire and equip a laboratory suitable for maintaining stored grain insect cultures for experimental use and for grain post production systems work.
- To survey and document the traditional storage methods of each type of grain and the various stored grain insect pest species associated with each in the various ecological zones.
- To evaluate the efficacy of some traditional and introduced grain storage methods as regards to insect attack and grain quality.
- To investigate suitable methods (chemical and non-chemical) for controlling the grain storage pests.
- To screen grain varieties for natural resistance/tolerance to storage pests.
- To evaluate the efficacy of the available stored grain pest control chemicals.
- To survey and document rice field insects and screen popular rice varieties at multi-locations for resistance to rice stemborers.

The major accomplishments under the eight operations carried out during the period in review are summarized in section 8.1.2 below while detail results are reported in section 8.1.4.

8.1.2. OUTPUTS AND ACCOMPLISHMENTS

Sub-Goal	Outputs	Accomplishments
1. Indentify sources of stored maize insect pest resistance.	1.1. Seeds of some 20 maize varieties were obtained from breeders, grown and stored in three locations in the West Province for evaluation.	1.1 Six evaluation criteria were used but only seed viability was considered to rank varieties. The local checks ranked first in the two evaluations done after 5 months and 10 months of storage. Some 6 varieties performed fairly well and will be confirmed next year.

Sub-Goal	Outputs	Accomplishments
	1.2 At Ekona 12 early/intermediate and 16 intermediate/late maize varieties were harvested from breeders' trials and stored for evaluation.	1.2 At Ekona the local check performed worst. The CMS varieties along with Ekona yellow and Ekona white stored better than the other introduced varieties.
2. Evaluate plastic cans with tightfitting covers for safe maize storage.	2.1 Plastic cans of 3-and 11-liter capacities obtained locally were evaluated for short (6 months) and long term (12 months) storage.	2.1.1 The sealed cans effectively maintained the heavily infested maize in good condition for both short and long term storage. Unsealed cans were very ineffective. 2.1.2 Bigger containers of 11 liters and above are better than smaller ones.
	2.2 An economic analysis of the method compared with farmers' barn method was made.	2.2 An economic analysis revealed that the traditional barn method was less profitable than the hermetic method.
3. Select and recommend suitable doses of grain stored pest control insecticides.	3.1 Four doses of two new insecticides were tested on threshed maize stored in two types of containers.	3.1.1 Untreated maize under all the tested storage methods was bad after 3 months. 3.1.2 Treated threshed maize in plastic covered containers stored longer without spoilage than in flour bags.
	3.2 Two different ecological sites were used to find out if climatic differences affect insecticide performance.	3.2 The protective effect of the two insecticides tested (SOFAGRAIN and SUMICOMBI) were longer lasting in Dschang (higher and colder) than in Santchou (lower and hotter).
	3.3 The manufacturers' dose of 50 g/100kg of grain was tested on maize cobs stored in jute bags.	3.3.1 More protection was achieved with husked cobs than with cobs in husk treated and stored in jute bags. 3.3.2 For storage of maize cobs in jute bags, treatment should be repeated after 6 months.

Sub-Goal	Outputs	Accomplishments
4. Select a maize storage method that gives the least storage losses without insecticide treatment.	4. Three methods were tested including storage of husked and maize cobs in husk in jute bags hung under house roof varanda vs. storage of some underground pit and storage of infested threshed grain in clay pots.	4.1 Storage of husked cobs above groud ranked best. 4.2 Results revealed that husk cover provides a good environment for insect population growth. 4.3 Clay pot storage was a failure because the maize used was heavily infested and the pots were not air tight to abate life processes.
5. Screen phaseolus bean varieties for resistance against Brucids and select natural materials for storage protection.	5.1 Fifteen bean varieties were tested for resistnce to Acanthoscelides obtectus.	5.1 The 15 varieties of beans were ranked according to their level of resistance. PH 495, CT and PH 573 were the most susceptible while PH 653, PH 32P and PB were fairly resistant.
	5.2 Six additives (sand, black soil, red soil, wood ash, eucahyptus leaves and Actellic dust) were tested for the control of A. obtectus physhermetic storage.	5.2 All the treatments were effective in controlling the insect. Lower rates and other materials shall be tried.
6. Monitor farmers maize barns over a period to document storage problems.	6. In Bui Division and Ndop area 30 farmers' barns each were selected and monthly sampling done and losses assessed as well as insects identified.	6. Apart from the popular maize weevil, the Angoumois grain moth Sitotroga cerealella was identified as an important pest in parts of Bui.
7. Collect and document rice field insect pests.	7. Sweepnet and light trap collections were made in Ndop and Santchou.	7. Twenty insect genera have been identified and over 20 species pending identification. The stalk-eyed borer (Diopsis macropthalma is an important rice stem borer in the Western highlands.
8. Identify sources of resistance to rice stem borers.	8. National Rice Stem Borer Nurseries (NRSBN) were superimposed on rice breeders' yield trial plots at Ndop and Santchou.	8. Dead heart and white head counts have been completed for NCVT upland rice plots at Mbo and Ndop Plains, NCVT irrigated at Ndop, and AUPAT upland at Mbo Plain for further evaluations.

8.1.3. OTHER ACTIVITIES

During the greater part of October 1990, the researcher was assigned to accompany Dr. Robin A. BOXALL on his consultancy mission on "Farm-Level Grain Drying and Storage" in Cameroon. Dr. R. A. Boxall is a grain drying and storage specialist attached to the storage Department of the Natural Resources Institute of Britain. He was invited by IITA/USAID for 3 weeks with the following major terms of reference:

1. Visit each of four NCRE locations in Southern Cameroon to consult with researchers about their experiences concerning losses of grain stored on farms.
2. Visit at least 20 farm storage locations in Dschang and Bambui for the purpose of evaluating storage conditions and grain loss problems.
3. Prepare detailed research programmes and experiment protocol in order of priority for on-station and on-farm storage research with estimated costs and materials for each pro-gramme.
4. Recommend specific on-farm demonstrations to decrease on-farm storage losses. Working plans and descriptions of the recommendations will be prepared for use by TLU and extension personnel.

The visit extended from 9 - 27 October 1990 and took the consultant and his Cameroonian counterpart to all NCRE Stations in the South West, West, North West, Extreme North, and Center Provinces. Many organizations and individuals involved in grain storage problems were also visited including many peasant farmers barns. The consultant has submitted his report and action is being awaited.

8.1.4. RESEARCH FINDINGS

The research achievements during the period are reported under the various operations carried out. An Evaluation of the Relative Resistance/Tolerance of some maize varieties to Natural Infestations by Stored Grain Insect Pests at Various Ecological Zones.

8.1.4.1 Objectives

- To identify sources of stored maize insect pest resistance
- To find out if there are differences to insect attack due to ecological differences.
- To assess maize storage losses due to insect attack.

8.1.4.1.2 Methodology:

Seeds of old and new maize varieties were obtained from the low and highland breeders and planted in three sites (Dschang, Foumbot and Santchou) during the planting season of 1989, harvested around Sept. 1989 and stored with husk in jute bags in the three sites for the various observations. Twenty varieties were grown on the three sites plus an additional ten varieties at Dschang site. The collaborator at TLU Ekona harvested 12 early/intermediate plus 16 intermediate/late varieties from the low land maize breeder's trials and stored in the same manner on the 28/02/90 for evaluation. There were four replications for each site. Two evaluations at 5 and 10 months of storage were planned and achieved for the three sites in the West Province but only one evaluation was done at Ekona. The second

will be done sometime in December, 1990. The evaluation criteria during each observation include Husk tightness rating (1-5), husk extension (in cm), number of live insects per kg of grain, percentage of insect and mould damaged grain, % grain moisture content and % grain germination.

8.1.4.1.3 Results and Discussion

Seed viability measured by percentage germination was used as a criteria to rank the storability of the varieties at each location (see tables 1 and 2). Details of numbers of live insects/kg and four grain quality evaluation criteria data is given in appendix I -IV.

Grain quality deteriorated much faster than expected because the maize was not pre-dried before storage as seen from the grain moisture data which is mostly above 17 % . The enclosed situation in the jute bags did not allow for drying as is the case in farmers barns. The moisture contents did not change considerably over the period. The insect populations and % grain damage increased tremendously on all locations. The situation was worst at Ekona where the bags used had plastic linings and were kept on platform and not singly hung as was the case in the other three locations. The limited air flow situation at Ekona enhanced faster deterioration since there was enough air for insect population growth and high moisture for mould development. By comparing the average performance of the 20 varieties which were grown and stored in the three sites in the Western Province by seed viability, the locals ranked first followed by Swan I, Ndock 8701 and Ekona white respectively after 5 months of storage but after 10 months of storage the locals still ranked first but followed by Kasai I, Bambui synthetic and Ekona yellow respectively. The varieties that topped the performance in the first evaluation did not top in the second evaluation except the locals. However, the post harvest handling was not uniform on the three sites compared. The situation has been corrected in the last repeat of this trial by hanging each variety and each replication with husk on a string seperated from each other in all three sites. Twenty cobs of each replication have been stored and evaluation will be done bimonthly using 5 cobs to get a better consideration of the situation in 4 evaluations spread over 8 months. The varietal performance at Ekona is different where the local was at the bottom of the list after 5 months of storage. This is because the local variety has a soft flowry endosperm and was mainly used as a vegetable and not for storage. It is only when the maize eating population of the Western Highland migrated to the forest zone when other varieties were introduced along with long term storage. The CMS varieties are more suited for storage in the forest zone along with Ekona Yellow and Ekona White.

8.1.4.2 An Evaluation of Sealed and Unsealed Plastic Cans for the Storage of Dried Maize as Regards to Insect Population Dynamics and Grain Quality.

8.1.4.2.1 Objectives

- To investigate the effectiveness of 3 - and 11-liter plastic cans for protection of food maize against stored pest damage during short term (6 months) and long term (12 months) storage.
- To make an economic analysis of this storage method with a view of recommending to peasant grain farmers in Cameroon.

8.1.4.2.2 Materials and Methods

Threshed dried maize of about 12.5% mc from TLU Agronomic trials at Ekona was used. The two size cans with tight-fitting screw caps were filled with the grain. The experiment was installed at IRA Ekona on the 2/02/89 and terminated on the 28/02/90.

Treatment details were as follows: The maize in half the number of cans used was artificially infested with 10 weevils per kg of grain. Half the number of cans of each treatment (i.e. infested and non-infested) were sealed and half were not sealed.

The details of the four treatments and abbreviations used to identify each can are given below

1 Infested and sealed was abbreviated "IS"
2 Infested and not sealed was abbreviated "INS"
3 Not infested and sealed was abbreviated "NIS"
4 Not infested and not sealed was abbreviated "NINS"

There were four replications for the bigger cans designated A,B,C, and D while there were eight replications for the smaller cans designated A,B,C,D,E,F,G, and H.

All the bigger containers (4 x 4 = 16) were used for long term (12 months) storage while half of the smaller containers (1st 4 replications = 16 cans) were used for short-term (6 months) storage and the remaining half (last 4 replications = 16 cans) were used for long-term (12 months) storage.

The following seven observations were done at the start, 6 months later for half of the 3-liter cans and 12 months for the rest :

1) % Grain Moisture Content (mc).
2) % Seed Germination.
3) No of Maize Weevils per kg of Grain.
4) No of Other Insects per kg of Grain.
5) % Insect Damaged Grain.
6) % Mould Damaged or Rotten Grain.
7) Mould Count From Cultured Samples.

Mould count was only done at the end of the experiment.

8.1.4.2.3 Results and Discussion:

An evaluation of half of the 3-liter cans after six months revealed that the grain in the unsealed containers was unfit for human consumption (more than 50% insect damaged grains, more than 30% rotten grains, over 100 live insects/kg and many dead insects).
The grain from the sealed cans was good, free flowing and had no odor and less than 5 live insects/kg. Treatment means of the six evaluation criteria are given in table 3.

When the experiment was terminated after 12 months, the grain in the unsealed 3-liter cans was wet, caked and had a pungent smell such that it was not possible to sample. Although the grain in the unsealed 11-liter cans was also bad and unfit for consumption, it

could flow out when stired with a stick. The grain in the sealed containers of both sizes was quite good, free flowing with very few insects and could be consumed. However seed viability was very poor for the grain from the smaller cans (about 28%) and average for grain from the bigger cans (about 50%).

The evaluation data for the 3-liter cans is given in table 4 and that of the 11-liter cans (treatment means only) is given in table 5. Means followed by the same letter in each column (criteria) are significantly different while those followed by different letters are significantly different (P = 0.05).

After data collection, a few of the sealed cans were re-sealed and left in Dschang and up to December 1990, the grain quality was still good (i.e. after 22 months of storage). This shows that once dried grain is stored in a sealed container and the insects die, the grain will store for any length of time desired. Bigger containers of 10 liters and above are prefered and are readily available in Cameroon. An economic analysis of the hermetic method compared with the farmers' barn method (table 6) showed that, used over a full year, the barn method was as unprofitable as storage in unsealed containers.

8.1.4.2.4 Conclusions and Suggestions

From the results, it is clear that plastic containers with tightfitting lids can store dry maize in good condition for up to 12 months provided the lids are tightly screwed on after filling the can with the grain. If one starts with uninfested grain, the quality at the end of storage will be much better than that of the experiment which was heavily infested.

The big difference in quality and costs between the 11-liter and 3-liter containers in favour of the earlier is worth noting. The bigger containers reduce grain loss much more than smaller containers because changes in smaller containers are faster if a hermetic atmosphere is not created. Big containers are also cheaper per grain unit than small ones. The hermetic method provides greater profits to the farmer than the traditional method.

Unfortunately, the hermetic storage method as revealed by the results did not satisfy the need for seed grain storage since the germination rate was only about 50 %. This may be due to the poor initial handling of the grain before the trial was installed and improper sealing of some of the containers. In order to exploit the full benefits of hermetic storage, the container should be completely filled with the grain and well sealed.

It is suggested that other types of containers with sealing possibilities be tested for grain storage purposes. However, the principal investigator is also testing other local storage containers to quantify the storage losses attributable to each. A special report of the experiment was produced in August, 1990.

An Experiment to Evaluate the Efficacies of Two Stored Grain Insecticides (SOFA GRAIN and SUMICOMBI) for the Control of Maize Weevils and Other Stored Grain Insect Pests on Maize Stored in Three Different Methods.

8.1.4.3.1 Objectives

- To evaluate the efficacy of new chemical insecticides from Shell Cameroun and Roussel Cameroun for the control of stored grain insect pests.
- To determine the most effective and economic dose of each product.
- To investigate the effect of insecticide treatment of maize under different storage methods.
- To find out whether ecological differences do affect the efficacy of each product.

8.1.4.3.2 Materials and Methods

Three storage methods used were threshed maize in 16-liter plastic buckets with lids, threshed maize in flour sacs and maize cobs (dehusked and undehusked) in jute bags. For the first two methods, the following doses in parts per million (ppm) a.i. were used.

SOFAGRAIN: 1.1, 2.2, 3.3 and 5.5 and designated as SOFA 1, OFA 2, SOFA 3 and SOFA 4 respectively.

SUMICOMBI: 1.8, 3.6, 4.8 and 9.0 and designated as SUMI 1, SUMI 2, SUMI 3 and SUMI 4 respectively.

The highest doses are the manufacturers' recommended rates or 50 g commercial formulation per 100 kg of grain and was the rate used for the third storage method and presuming that both forms of maize cobs are equivalent to 80 % threshed grain by weight. The third method depended on natural infestation while for the first two methods the grain was artificially infested with 10 weevils/kg in addition to the natural infestation.

The commercial formulations contained the following active ingredients (a.i).

SOFAGRAIN Powder: Deltamethrine[1] = 1 g a.i./kg (i.e. 0.1 %) and Pyrimiphos methyl (Actellic) = 10 g ai/kg (1 %).

SUMICOMBI 1.8% Powder: Sumithion[2] = 1.5% and Sumicidin (or Fenvalerate) = 0.3%

1) Deltamethrine = Decomethrin = Decis and K-othrin named by Roussel Uclaf.
2) Sumithion is an Organo phosphorus insecticide, discovered and developed by SUMITOMO CHEMICAL COMPANY OF JAPAN.

There were two controls for the first two methods (Not artificially infested and not treated = C_1 and Artificially infested and not treated = C_2) while for the third method there was one control (i.e. not treated for each cob form).

The following observations were done to evaluate the treatments (chemicals) at 3 month intervals:

- Insect populations (No. of live insects/kg).
- Seed viability (Germination test).
- % Grain moisture content (MC).
- % Mouldy or rotten grain.
- % Insect bored kernels.

8.1.4.3.3 Results and Discussion

A summary of the anlaysed evaluation data is given in tables 7 - 12. Duncan's Multiple Range Test (DMRT) was used to separate all treatment means of each evaluation criteria at 5 % significance level. Means followed by the same letter under each evaluation criteria are not significantly different while those followed by different letters are significantly different.

By the sixth month the maize in the two control treatments of the plastic buckets was caked. The rapid insect population increase created an unhabitable environment for themselves by their respiration which produced a lot of moisture (see table 9) which encouraged mould growth (see table 8). Insect population growth and grain quality deterioration was much faster at Santchou (low and hot) than in Dschang (high and cold). Also the protective effect of the insecticide treatment was longer lasting in Dschang than in Santchou as evidenced from the data on tables 7-9. The lower 2 doses of both chemicals were generally not effective after 3 months in the plastic containers. The higher 2 doses were effective up to 9 months but SUMICOMBI was a bit more effective.

For the flour bag storage of threshed maize, treatment with both products needed to be repeated after every 3 months. For the treatment of maize cobs, more protection is obtained with husked cobs than with cobs having husk.

8.1.4.3.4 Conclusions And Suggestions

Dust formulations of insecticides are the preferred forms of chemicals for peasant grain farmers. They are easy to mix in grain and also to store. For loose grain (e.g. threshed maize or beans) it is ideal to treat in enclosed containers with dose No. 3 above 30 g/100kg which is less than the manufacturers' recommendation for more safety. If stored in jute bags, the dose should be 50 g/100kg and repeated after 6 months. This dose is also effective for husked cobs in bags. Treatment of cobs in husk is not effective.

Sale of the insecticides should be in well sealed plastic sachets in weights of 25g and 50 g considering the quantity of grain handled by peasant farmers. Labelling of each sachet must meet chemical labelling requirements i.e name and active ingredients, LD 50, note of caution etc. clearly written.

8.1.4.4 An Evaluation of 3 Maize Storage Methods.

The three methods evaluated during the period included underground pit storage of maize cobs with and without husks, above ground storage of same forms in bags hung under roof veranda and storage of threshed grain in clay pots.

8.1.4.4.1 Objectives

- To find out if any of the methods is worth recommending.

8.1.4.4.2 Materials and Methods

An ITA Dschang student was supervised and wrote a thesis on the first two methods after storing for 118 days while the third method was tried in the laboratory for 9 months. The thesis reports all experimental details but the evaluation treatment means and some conclusions will be reported here.

Eight clay pots of about 50 liters capacity each were bought from Ndop area where they are produced and some people use them for grain storage. Maize of about 13 % MC was used. Four pots were filled with maize that was artificially infested and 4 with maize not artificially infested.

8.1.4.4.3 Results and Discussion

Data of evaluation of the three methods are jointly reported in table 13. The above ground storage of husked cobs ranked best. Husk cover appears to provide a good atmosphere for insect growth. This is true for both above ground and pit storage. Though the pit storage with husks ranked second, the pit storage without husks would have been better if the pit wall lining did not permit moisture migration. In fact the plastic linings in some of the replications had holes.

The clay pot storage was a failure because all the maize was heavily infested before the experiment was installed in January, 1990 and the pots were not sealed.

8.1.4.4.4 Conclusion and Suggestions

Hanging of husked maize cobs under house roof verandas do store fairly well in cold areas where sources of infestation are not near and insect fecundity is much lower than in warm areas. Clay pot storage should be re-inforced by insecticide treatment and the pots covered to enhance the insecticides activity. Pit storage is better adapted in dry regions like Northern Cameroon.

8.1.4.5 Screening of 15 Phaseolus Bean Varieties for Resistance to the Bean Weevil Acanthoscelides obtectus and Evaluation of Six

Natural Materials and Actellic for the Control of the Weevil. Work on post harvest problems of beans is lacking in Cameroon and it is an important food crop in the Western Highlands. The legumes program at IRA Dschang has concentrated efforts on bean collection and agronomic research on the various varieties.

8.1.4.5.1 Objectives

To find out whether any of the existing bean varieties in the area is resistant to the bean weevil which is the most important storage pest of the crop.

- To investigate whether some natural materials like sand and soil being used in other countries to protect beans and other grains from stored grain insect pest attack are actually effective.

8.1.4.5.2 Materials and Methods.

An ITA Dschang student was supervised to write his thesis on the two topics. Experimental details are reported in the thesis. Briefly 15 bean varieties provided by the legumes program were screened for resistance to the bean weevil in the IRA Dschang Entomology laboratory using the insect (A. obtectus) maintained in cultures in the same laboratory. The six additives tested for the control of A. obtectus attack included Sand, Black soil, Red soil, Wood Ash, Eucalyptus leaves and Actellic dust. Two other treatments were control (no additive) and hermetic storage. The 8 treatments were repeated 4 times.

8.1.4.5.3 Results and Discussion

Newman Keul's test was used to separate the means of % insect attacked grains. The varieties were ranked from the most susceptible to the least as follows: PH 495; CT; PH 237; GR; PNV; PH 560; PNN; GB; PH 564; PH 609; PH 573; PH 653; PH 320 and PB.

The experiment is to be repeated because the student did not select the beans properly before the start. However, the number of live insects had a high positive correlation with the % of insect bored grain. For the additives, 250 g of each was mixed with 500 g of beans for each container of about 1000 cc capacity. All the additives were effective in controlling the insects.

8.1.4.5.4 Conclusions and Suggestions

The insects used for the above two experiments were a bit too old. The quantities of additives (except the chemical) were too much and may not be conducive or practicable for farmers. The experiment shall be repeated taking all the abnormalities into consideration.

8.1.4.6 Survey of Farmers' Maize Storage in Ndop Sub-division and Bui Division in North West Province.

8.1.4.6.1 Objectives

- To estimate farmers' maize storage losses over time.
- To document maize drying and storage problems.
- To document maize storage pests and intensities over the storage period.

8.1.4.6.2 Materials and Methods

This operation had been planned since 1986 but due to lack of means the researcher periodically distributed the farmers' questionnaires to those who had more frequent contacts with farmers including Agric. Extension workers, TLU researchers, UNDP/FAO Post Harvest Food Loss Reduction Project (PHFLRP), PAFSAT Bamenda, RTC Mfonta etc. All those contacted had no obligation to respond to the researcher and in most cases they revised

the questionnaires to suit their own purposes and they carried out their own surveys to satisfy their own project needs and wrote their reports.

There has however been good collaboration with NCRE researchers particularly those of TLU Ekona and TLU Bambui. A special report of a survey in South West Province sponsored financially by TLU Ekona in March 1988 had been produced while field enumerators of TLU Bambui had helped to complete some questionnaires in Ndop and Bui and reported in 1987 and 1988 reports.

The present survey has been planned by TLU Bambui using their own questionnaires and involved the reporter only to identify insect species separated from their monthly samples since the PHFLRP is helping out with loss assessment. However, by a special compromise sub samples are being submitted for this researcher to make some necessary entomological evaluations.

8.1.4.6.3 Results and Discussion

There has been a lot of delays in the collection and processing of the 60 samples scattered over very difficult terrain. The only technician in the UNDP/PHFLRP laboratory who does the first analysis before forwarding the insects and sub samples also has to analyse many maize and rice samples submitted by the field staff of their project such that some samples remain unattended to for over 3 months.

The sample size has been reduced and other arrangements are being made. Although the problems have distorted some of the needed data, the clear problem of the Angoumois grain moth in Bui has been noted. More detailed results will be reported in future.

RICE ENTOMOLOGY

8.1.4.7 Survey and Documentation of Rice Field Insect Population Dynamics and Their Effect on Rice Plants.

This operation was terminated during the year and the data has been prepared for publication. Other areas could be surveyed in future depending on available means and staff.

8.1.4.8 Establishment of National Rice Stem Borer Nurseries (NRSBN)

8.1.4.8.1 Background Information

Stem borers constitute perhaps the most important group of insects that cause yield losses in rice fields in many parts of the world. The International Rice Research Institute (IRRI) has been carrying out a lot of field screening of promising varieties for resistance to stem borers. Several national programs are also screening and have identified several sources of resistance. IRRI has therefore organized that sources of resistance which have been identified should be exchanged to determine their level of resistance to a range of stem borer populations.

The rice breeder obtained entries and the Fourteenth International Rice Stem Borer Nursery (IRSBN 1989) was planted, scored and results forwarded to IRRI. This year we applied for the 1990 set but received no response. Last year a National Rice Stem Borer Nursery (NRSBN 1989) consisting of 8 entries and one international check was planted, evaluated and the data has been compiled for publication. To continue this operation, arrangements have been made with the rice breeders to superimpose rice stem borer nurseries on their advance yield trials both national and international.

8.1.4.8.2 Objectives

- To identify sources of resistance to rice stem borer among the lines being selected for Cameroon rice farmers.
- To identify sources of resistance to the rice stem borer among varieties in international trials conducted in the country.
- To exchange identified sources of stem borer resistance with other researchers involved in screening for stem borer resistances.

8.1.4.8.3 Screening Methodology

Screening is conducted in the field under natural infestation. Screening is done in breeders' advanced yield trials. The following trials were selected for stem borer screening during the main cropping season this year:

1) National Coordinated Varietal Trial (NCVT) both Upland and Irrigated at Ndop and Mbo Plains with 14 and 18 entries respectively.
2) African Upland/Irrigated Rice Advanced Trials (AURAT/AIRAT) at Mbo Plain (15 entries each).
3) Advance Yield Trial (Early Medium) at Mbo Plain.
4) Elite Varietal Trial at Mbo Plain.

Three trials earmarked for Extreme North Province were not planted. Evaluation consists of dead heart and white head counts and scoring in accordance with the IRRI scale.

8.1.4.8.4 Results and Discussion

The irrigated trials at Mbo Plain did not reach the stage of scoring by the time of the report. The results will be compiled for later reports.

It is important to note that stem borer insect pressure was generally very low this year and it was not easy to rank the varieties by scores since almost every variety scored 1 (one) on both locations. In any case ranking will be done by actual percentage damage for at least two growing seasons. Data of the screening of eight national varieties last year has been compiled for publication.

Table 1: Evaluation of seed viability (from percent germination) of 20 mid-high altitude maize varieties grown and stored in three locations.

1 A - % Germination After 5 Months Storage

	LOCATION							
	Dschang		Foumbot		Santchou			
Variety	% Germ.	Rank	% Germ.	Rank	% Germ.	Rank	Mean	Rank
MSR	33	15	55	5	64	14	50.67	14
Bambui Synthetic	40	10	47	10	70	10	52.33	11
Kasai 1	24	17	38	16	89	1	50.33	15
Across 8701	38	12	44	13	85	4	55.67	8
Composite 290	60	2	35	17	75	7	56.67	7
HLC	36	14	58	3	67	12	53.67	9
Ekona yellow	56	4	30	19	89	1	58.33	5
8321-18	40	10	40	15	74	8	51.33	12
Swan I	60	2	55	5	74	8	63.00	2
BACOA	50	8	58	3	52	19	53.33	10
LOCAL	56	4	75	1	82	5	71.00	1
Bertoua 8701	-	-	59	2	40	20	49.50	17
Ekona white	52	7	49	7	81	6	60.67	4
CHS 8507-CI	23	8	44	13	68	11	45.00	18
CHS 8509-CI	20	19	34	18	60	16	38.00	20
COCA	38	12	48	8	67	12	51.00	13
CHS 8501-CI	42	9	46	11	62	15	50.00	16
CHS 8505-CI	33	15	30	19	56	18	39.67	19
Ndock 8701	56	4	46	11	87	3	63.00	2
CHS 8503-CI	66	1	48	8	58	17	57.33	6
Means	43.32		46.95		70		53.52	

1 B - % Germination After 10 Months Storage

Variety	LOCATION AND RANK Dschang % Germ.	Dschang Rank	Foumbot % Germ.	Foumbot Rank	Santchou % Germ.	Santchou Rank	Mean	Rank
MSR	15	8	22	7	14	11	17	7
Bambui Synthetic	37	1	26	4	11	16	24.67	3
Kasai I	17	7	36	1	26	3	26.33	2
Across 8701	7	16	12	11	14	11	11.00	17
Composite 290	7	16	10	14	10	17	9.00	19
MLC	12	11	11	13	22	5	15.00	13
Ekona yellow	24	4	10	14	28	2	20.67	5
8321-18	6	18	22	7	18	6	15.33	12
Swan I	12	11	12	11	12	15	12.00	16
BACOA	14	10	26	4	16	8	18.67	6
LOCAL	25	2	28	3	43	1	32.00	1
Bertoua 8701	-	-	29	2	17	7	23.00(1)	4
Ekona white	25	2	9	17	13	13	15.67	10
CHS 8507-CI	4	19	9	17	25	4	12.67	14
CHS 8505-CI	9	14	8	19	8	20	8.33	20
COCA	8	15	6	20	15	9	9.67	18
CHS 8501-CI	21	5	16	10	13	13	16.67	8
CHS 8505-CI	18	6	10	14	10	17	12.67	15
Ndock 8701	11	13	21	9	15	9	15.67	10
CHS 8503-CI	15	8	25	6	9	19	16.33	9
Means	15.11		17.4		16.95		16.52	

(1) Mean of 2 locations only.

Table 2: Evaluation of Seed Viability (from percent germination) of 12 Cameroon National Early/Intermediate and 16 Intermediate/Late Maize Varieties Harvested and Stored at Ekona 28/02/90 and Evaluated on 17/07/90.

Early/Intermediate Varieties			Intermediate/Late Varieties		
Variety	% Germ.	Rank	Variety	% Germ.	Rank
BSR 81	31.5	4	SwanixGene PoolW	8.8	16
CHS	41.5	1	Ndock 8701	16.3	13
TZUT	29.0	5	Gusau x Gene Pool	33.8	6
TZESR-SE	35.0	2	CHS 8507	37.5	3
BSR-S101	17.5	9	Across 8701	24.8	11
TZESR-W	6.5	13	Bertoua 8701	33.8	6
CHS 8602	16.5	10	SuwanxGene PoolY	12.5	14
DHR-ESRY	34.0	3	EV 8422 SR	31.3	8
Pool 16 SR	29.0	5	8321-18	31.3	8
BSR SYN II	18.0	8	Ktui T2PB SR	37.5	3
DHR ESR W	29.0	5	Yaounde 8701	31.3	8
EV 8435 SR	9.0	12	CHS 8503	35.0	5
LOCAL FAKO	10.0	11	CHS 8501	20.0	12
			T2PB Suakoko	50.0	1
MEANS	23.58		Suwani SR	6.3	17
			EV 8428 SR	38.8	2
			Local Fako	10.0	15
			MEANS	27.0	

Table 3: Treatment Means of Live Insect Populations and Four Grain Evaluation Criteria of Maize Stored for 164 Days in 3-Liter Plastic Cans - Means Are Seperated by Duncan's Multiple Range Test at Alpha = 0.050.

		No. of live Insects/kg		% of Damaged Grains		Percentage	
Time	Treatment	Weevils	Others	By Insects	Mould/ Rotten	MC	Germ'tion
Start	Overall means	0.75	2.00	1.25	1.25	12.75	80.00
After 164 Days	NIS	4.50^{B}	12.75^{A}	3.40^{B}	4.00^{C}	16.24^{B}	52.00^{A}
	IS	8.00^{B}	0.25^{A}	2.19^{B}	5.16^{C}	16.12^{B}	52.00^{A}
	NINS	184.25^{A}	3.00^{A}	16.08^{A}	32.74^{B}	22.99^{B}	0.00^{B}
	INS	14.75^{B}	0.25^{A}	13.56^{A}	71.33^{A}	37.11^{A}	1.00^{B}
	LSD	12.42	148.90	6.86	24.22	8.32	9.54

Means followed by the same letter under each column are not significantly different while those followed by different letters are signficantly different.

Table 4: Summary Grain Evaluation Data and Insect Populations in Maize Stored in 3-liter Plastic Cans for 12 Months Under 4 Treatments.

Details of Treatment		No of Live insects/kg		% damaged grains		Percentage	
		Weevils	Others	Insect	Mould/rotten	Mc	Germ'tion
Means at start		0.75[I]	2.00	1.25	1.25	12.75[II]	80.00
MIS	a	0.00	0.00	1.16	2.43	13.70	11.00
	b	0.00	0.00	2.61	1.81	13.80	50.67
	c	2.00	0.00	1.71	3.19	14.00	12.83
	d	6.67	0.00	4.20	8.23	14.80	12.67
Means		2.17	0.00	2.43	4.76	14.24	30.03
IS	a	0.6	0.00	2.52	5.41	13.8	40.50
	b	0.00	0.00	1.65	4.61	13.67	40.17
	c	0.00	0.00	1.53	4.56	13.70	22.33
	d	6.67	0.67	2.34	19.60	15.47	3.00
Means		2.40	0.17	2.02	8.54	14.16	26.50

MINS } Too caked and not possible to collect samples.
INS }

(I) Add 10 weevils/kg for artificially infested treatments.
(II) The value by the oven dried method. It was 16.0% by the Insto Moisture Tester.

Both the F-Test and T-Test indicate that there are no significant differences between the two means for all the 6 criteria.

Table 5: Treatment Means of Live Insects Populations and Four Grain Evaluation Criteria of Maize Stored for 12 Months in 11-Liter Plastic Cans-Means are Separated by Duncan's Multiple Range Test at P = 0.050.

		No. of live insects/kg		% of damaged Grains		Percentage	
Time	Treatment	Weevils	Other insect species	By insects	Mould/ rotten	MC	Germ'tion
Start	Overall Means	1.00	2.00	0.75	1.25	11.20	85.00
After	NIS	4.00^{A}	0.84^{B}	2.46^{C}	2.95^{C}	13.12^{C}	55.38^{A}
12	IS	4.00^{A}	0.00^{B}	2.30^{C}	3.99^{C}	14.44^{C}	47.56^{A}
Months	NINS	4.50^{A}	14.50^{A}	12.94^{A}	62.66^{B}	25.43^{B}	2.92^{B}
	INS	3.67^{A}	9.17^{AB}	7.25^{B}	92.88^{A}	32.32^{A}	1.04^{B}
	LSD	6.73	9.54	3.12	3.61	3.06	19.36

Table 6: Net Benefits in Francs per Kilogram of Stored Maize for Hermetic vs. Traditional Barn Storage, using Single and Phased Withdrawal, Fako Division, 1989-90.

Withdrawal Method		Hermetic Method 3-liter*	Hermetic Method 11-liter*	Barn Method (1.8 m^3 cobs)
Single withdrawal at end:	6 months	44.0	nd	11.6
	12 months	12.4	28.1	-97.4
Phased monthly withdrawal:	6 months	23.9	nd	8.9
	12 months	-13.5	-10.7	-46.3

* Mean of IS and NIS treatments.

Table 7-9 Numbers of Insects/kg of Grain and Four Grain Quality Evaluation Criteria Data of Threshed Maize Stored in Plastic Buckets in Two sites (Dschang and Santchou) and Treated with Four Rates Each of Two Insecticides.

Table 7: Numbers of Insects/kg of Grain at (a) Dschang and (b) Santchou Storage Sites.

7 A: Dschang Site No. at Start = 31.25

TREATMENT (Insecticide Dose)	WEEVILS 3 Months	6 Months	9 Months
Control 1	193.250 A	117.500 A	2.000 B
Control 2	230.250 A	103.250 A	0.000 B
SOFA Dose 1	20.250 B	41.500 B	18.250 B
SOFA Dose 2	1.500 B	4.000 B	25.750 B
SOFA Dose 3	0.750 B	0.000 B	2.000 B
SOFA Dose 4	0.750 B	0.000 B	1.500 B
SUHI Dose 1	2.500 B	31.500 B	108.750 A
SUHI Dose 2	4.000 B	13.250 B	17.250 B
SUHI Dose 3	2.750 B	5.250 B	6.000 B
SUHI Dose 4	2.750 B	0.000 B	0.750 B
L.S.D.	47.33	56.70	25.71
C.V.	71.45	124.15	97.69

7 B: Santchou Site No. at Start = 34

TREATMENT (Insecticide Dose)	NO. OF WEEVILS/KG 3 Months	6 Months	9 Months	NO. OF OTHER INSECTS 3 Months	6 Months	9 Months
Control 1	253.250 A	111.00 A	0.000 B	4.500 A	12.00 A	0.000 B
Control 2	208.250 B	27.50 C	0.000 B	2.750 A	10.75 A	0.000 B
SOFA Dose 1	34.750 C	69.50 B	0.000 B	0.000 A	0.00 B	0.000 B
SOFA Dose 2	14.000 CD	107.00 A	1.250 B	0.000 A	0.00 B	0.000 B
SOFA Dose 3	3.250 CD	33.50 BC	43.250 A	0.000 A	0.00 B	1.250 B
SOFA Dose 4	0.000 D	7.00 C	0.7540 A	0.000 A	0.00 B	0.000 B
SUHI Dose 1	7.500 CD	142.50 A	2.750 B	3.750 A	0.00 B	0.000 B
SUHI Dose 2	2.000 CD	46.00 BC	65.250 A	5.000 A	0.00 B	6.250 A
SUHI Dose 3	2.750 CD	35.25 BC	51.000 A	0.000 A	0.00 B	1.250 B
SUHI Dose 4	0.000 D	8.750	5.250 B	0.000 A	0.00 B	1.250 B
L.S.D	29.52	36.07	22.63	28.68	6.59	3.955
C.V.	38.88	42.48	92.46	226.64	200.59	273.86

Table 8: % Grain Damage By Insects and Mould at (a) Dschang and (b) Santchou - Storage Sites.

8 A : Dschang % Insect Damage at Start = 0.68;
% Mould/Rotten at Start = 4.21.

TREAMENT (Insecticide Dose)	BY INSECTS 3 Months	6 Months	9 Months	BY MOULDS 3 Months	6 Months	9 Months
Control 1	11.293 B	20.213 B	21.875 B	5.428 A	20.750 A	61.502 A
Control 2	19.358 A	25.147 A	27.615 A	5.725 A	17.443 B	45.725 B
SOFA Dose 1	5.430 C	11.578 CDE	19.750 BC	0.435 C	12.807 C	33.682 C
SOFA Dose 2	5.070 D	12.020 CD	16.697 BCD	1.718 BC	10.108 D	18.130 D
SOFA Dose 3	7.710 BCD	9.638 EF	17.810 DE	4.105 AB	7.507EF	10.513DE
SOFA Dose 4	6.345 CD	6.450 G	11.825 E	3.705 AB	9.023DE	12.485DE
SUHI Dose 1	9.572 BCD	12.445 C	16.472 CD	3.140 AB	7.550EF	8.692 E
SUHI Dose 2	9.245 BCD	8.877 F	11.928 DE	3.440 AB	5.060FG	10.998DE
SUHI Dose 3	10.150 BC	10.790 CDEF	12.202 DE	4.002 AB	5.325FG	6.177 E
SUHI Dose 4	7.745 BCD	10.390 DEF	9.955 E	3.373 AB	4.460 G	4.905 E
L.S.D.	4.047	1.812	4.959	2.459	2.357	7.515
C.V.	30.49	9.84	22.06	48.56	16.31	24.45

8 B : Santchou % Insect Damage at Start = 1.15 ;
% Mould Rotten at Start = 4.17.

TREATMENT (Insecticide Dose)	BY INSECTS 3 Months	6 Months	9 Months	BY MOULDS 3 Months	6 Months	9 Months
Control 1	33.935 A	27.99 A	24.455 AB	12.680 A	27.54 A	55.408 A
Control 2	20.043 B	22.74 B	27.543 A	10.692 A	24.92 A	47.325AB
SOFA Dose 1	17.213 BC	17.49 C	15.885 CD	4.303 C	19.45 B	44.262 B
SOFA Dose 2	14.445 C	18.58 C	20.335 BC	7.317 B	19.04 B	32.125 C
SOFA Dose 3	9.257 D	10.81 DE	17.432 CD	5.793 BC	10.57 D	23.937CD
SOFA Dose 4	9.978 D	10.24 DE	8.075 EF	5.800 BC	8.71 DE	10.515 E
SUHI Dose 1	16.493 BC	24.35 B	17.613 CD	5.475 BC	15.59 C	29.822 C
SUHI Dose 2	10.982 D	13.03 D	14.737 CD	6.177 BC	8.35 DE	18.43 DE
SUHI Dose 3	9.803 D	8.65 E	11.510 DE	5.830 BC	6.86 E	12.547 E
SUHI Dose 4	8.955 D	9.34 E	5.475 F	5.312 BC	6.54 E	9.567 E
L.S.D.	3.401	2.725	5.537	2.327	2.825	9.341
C.V.	15.59	11.56	23.52	23.23	13.26	22.78

Table 9: % Grain Moisture Content (mc) and Germination at (a) Dschang and (b) Santchou Storage Sites.

9 A : Dschang % of Moisture Content at Start = 16.5 ;
% of Germination at Start = 89.

Sample I.D.	% Moisture Content 3 Months	6 Months	9 Months	% Germination 3 Months	6 Months	9 Months
Control 1	19.300 B	28.425 A	29.875 A	29.000 B	3.000 D	0.000
Control 2	20.350 A	28.450 A	31.025 A	26.000 B	1.000 D	0.000
SOFA Dose 1	16.925 C	19.800 B	22.225 B	71.000 A	7.000 D	0.000
SOFA Dose 2	16.775 C	17.300 C	19.125 CD	67.000 A	43.000 C	14.000
SOFA Dose 3	16.550 CDE	17.250 C	17.650 DE	72.000 A	43.000 C	21.000
SOFA Dose 4	16.500 CDE	16.900 C	17.225 E	81.000 A	52.000 ABC	28.000
SUHI Dose 1	16.000 E	17.450 C	19.325 C	70.000 A	47.000 BC	2.000
SUHI Dose 2	16.525 CDE	16.800 C	17.500 DE	80.000 A	56.000 AB	31.000
SUHI Dose 3	16.100 DE	16.400 C	17.150 E	71.000 A	58.000 AB	27.000
SUHI Dose 4	15.975 E	16.475 C	16.650 E	80.000 A	62.000 A	42.000
L.S.D.	0.6835	2.212	1.577	12.20	11.29	12.71
C.V.	2.77	7.84	5.25	13.05	21.01	53.34

9 B : Santchou % of Moisture Content at Start = 16.6 ;
% of Germination at Start = 92.

Sample I.D.	% Moisture Content 3 Months	6 Months	9 Months	% Germination 3 Months	6 Months	9 Months
Control 1	21.300 A	24.52 B	32.600 A	14.000 C	1.00 F	0.000 B
Control 2	20.125 A	26.13 A	32.050 A	14.000 C	0.00 F	0.000 B
SOFA Dose 1	17.600 B	21.30 C	28.625 B	25.250 C	6.00 EF	0.000 B
SOFA Dose 2	17.600 B	20.50 CD	27.700 B	41.000 B	15.00 D	0.000 B
SOFA Dose 3	16.525 B	17.20 E	22.350 C	56.000 A	24.00 C	2.000 B
SOFA Dose 4	16.625 B	16.52 E	17.750 D	59.000 A	39.00 B	3.000 B
SUHI Dose 1	17.075 B	19.60 D	26.875 B	50.000 AB	11.00 DE	0.000 B
SUHI Dose 2	16.550 B	17.55 E	21.100 C	57.000 A	24.00 C	0.000 B
SUHI Dose 3	16.725 B	16.92 E	18.675 D	58.000 A	44.00 B	2.000 B
SUHI Dose 4	16.575 B	16.73 E	17.000 D	65.000 A	51.00 A	7.000 A
L.S.D.	1.246	1.373	1.982	14.02	6.732	2.888
C.V.	4.88	4.84	5.61	22.10	21.68	142.86

Tables 10 -12: Numbers of Insects/kg of Grain and Four Grain Quality Evaluation Criteria Data of(a) Trheshed Maize Stored in Flour Bags in Dschang and Treated with Four Rates Each of Two Insecticides and (b) Maize Cobs (Dehusked and Undehusked) Stored in Jute Bags in Dschang and Treated with the Manufacturers' Recommended Rates.

Table 10: Number of insects per kilogram of grain

10a: Threshed Maize Stored in Flour Bags.

TREATMENT	WEEVILS 3 Months	WEEVILS 6 Months	WEEVILS 9 Months	OTHER INSECTS 9 Months Only
Control 1	581.30 A	1213.25 A	1285.00 ABC	785.500 A
Control 2	456.30 B	991.50 B	1512.50 AB	573.000 AB
SOFA Dose 1	67.75 C	802.50 C	1091.25 ABCD	58.000 B
SOFA Dose 2	11.50 C	61.50 E	789.25 BCD	68.000 B
SOFA Dose 3	5.25 C	7.75 E	91.75 D	3.250 B
SOFA Dose 4	2.75 C	4.00 E	94.25 D	6.250 B
SUMI Dose 1	37.75 C	242.50 D	1867.50 A	102.500 B
SUMI Dose 2	8.00 C	64.50 E	553.00 BCD	41.250 B
SUMI Dose 3	4.25 C	29.00 E	283.75 CD	36.250 B
SUMI Dose 4	4.00 C	10.50 E	115.75 D	10.750 B
L.S.D.	58.70	140.1	907.9	642.1
C.V.	34.48	28.32	81.82	263.60

10b: Dehusked and Undehusked Maize Cobs Stored in Jute Bags.

TREATMENT	WEEVILS 3 Months	WEEVILS 6 Months	WEEVILS 9 Months	OTHER INSECTS 3 Months	OTHER INSECTS 9 Months
1 Control & Dehusked	80.00 B	715.00 A	480.00 AB	0.000 D	85.000 B
2 Control & Undehusked	360.00 A	731.00 A	246.00 BC	120.000 A	258.000 A
3 SUMI & Dehusked	15.50 CD	19.50 CD	103.80 C	0.000 D	36.250 BC
4 SUMI & Undehusked	73.50 B	133.75 B	577.30 A	41.000 B	63.000 B
5 SOFA & Dehusked	2.50 D	2.00 D	54.00 C	1.500 D	0.750 C
6 SOFA & Undehusked	34.50 C	94.75 BC	715.50 A	15.000 C	47.000 BC
L.S.D.	21.51	76.80	262.00	11.39	55.56
C.V.	15.35	18.29	48.62	25.93	45.79

Table 11. % Damage Grain.

11a: Threshed Maize Stored in Flour Bags.

TREATMENT	% DAMAGED BY INSECTS 3 Months	6 Months	9 Months	% DAMAGED BY MOULDS 3 Months	6 Months	9 Months
Control 1	41.792 B	72.660 A	97.845 A	5.873 AB	2.185 F	0.707 D
Control 2	50.120 A	66.838 A	97.745 A	5.470 AB	2.710 F	0.795 D
SOFA Dose 1	17.800 C	59.240 A	81.940 B	3.850 B	3.527 EF	3.338 CD
SOFA Dose 2	10.723 D	15.873 B	43.468 D	7.492 AB	5.960 CD	5.360 ABC
SOFA Dose 3	12.615 CD	15.710 B	18.565 EF	12.017 A	7.877 B	7.400 AB
SOFA Dose 4	12.297 CD	12.288 B	19.290 EF	4.217 B	5.127 DE	5.755 ABC
SUHI Dose 1	11.893 CD	27.655 B	63.010 C	11.350 A	6.337 BCD	8.370 A
SUHI Dose 2	10.440 D	12.450 B	29.732 E	9.517 AB	0.115 A	7.195 AB
SUHI Dose 3	10.865 D	14.320 B	14.188 F	11.163 A	5.467 D	6.673 AB
SUHI Dose 4	3.678 E	11.978 B	8.473 F	11.370 A	7.743 BC	4.435 BC
L.S.D.	6.149	21.87	10.87	5.771	1.750	2.785
C.V.	23.37	10.18	15.87	48.51	21.22	38.55

11b: Dehusked and Undehusked Maize Cobs Stored in Jute Bags.

TREATMENT	BY INSECTS 3 Months	6 Months	9 Months	BY MOULDS 3 Months	6 Months	9 Months
Control & Dehusked	19.470 C	23.030 B	57.250 A	24.700 BC	32.460 B	3.100C
Control & Undehusked	30.590 A	46.010 A	57.790 A	31.090 A	41.040 A	29.730A
SUHI & Dehusked	13.000 D	4.308 C	9.825 B	21.068 C	19.757 D	12.817BC
SUHI & Undehusked	29.195 AB	21.308 B	47.857 A	26.870 B	29.390B	21.033AB
SOFA & Dehusked	7.972 D	5.755 C	13.225 B	14.320 D	10.780 E	14.510B
SOFA & Undehusked	24.238 BC	19.150 B	49.658 A	15.030 D	25.047 C	14.510B
L.S.D	5.072	5.717	14.53	3.991	3.813	10.12
C.V.	16.46	19.31	24.90	12.11	9.72	44.57

Table 12. % Grain Moisture Content and Germination

12a: Threshed Maize Stored in Flour Bags.

TREATMENT	% Moisture Content 3 Months	6 Months	9 Months	% Germination 3 Months	6 Months	9 Months
Control 1	13.525 D	12.275 C	9.575 D	8.000 B	1.000 D	0.000 C
Control 2	13.250 D	12.575 C	9.675 D	8.000 B	1.000 D	0.000 C
SOFA Dose 1	14.500 BC	14.675 B	11.250 CD	47.000 A	6.000 D	0.000 C
SOFA Dose 2	14.775 AB	15.650 A	13.350 BC	55.000 A	38.000 B	1.000 C
SOFA Dose 3	14.725 BC	15.675 A	17.275 A	66.000 A	60.000 A	15.000 B
SOFA Dose 4	15.075 A	16.250 A	17.850 A	60.000 A	58.000 A	36.000 A
SUHI Dose 1	14.625 BC	14.625 B	14.150 B	58.000 A	16.000 C	0.000 C
SUHI Dose 2	14.575 BC	15.625 A	16.900 A	59.000 A	61.000 A	1.000 C
SUHI Dose 3	14.425 BC	15.375 AB	17.550 A	59.000 A	45.000 B	16.000 B
SUHI Dose 4	14.400 C	16.200 A	17.200 A	58.000 A	62.000 A	33.000 A
L.S.D.	0.3197	0.8040	2.271	18.26	9.254	9.723
C.V.	1.55	3.74	10.86	26.42	18.41	66.01

12b: Dehusked and Undehusked Maize Cobs Stored in Jute Bags.

TREATMENT	% Moisture Content 3 Months	6 Months	9 Months	% Germination 3 Months	6 Months	9 Months
Control & Dehusked	15.300 A	17.300 BC	17.200 A	36.000 BC	16.000 C	0.000 C
Control & Undehusked	14.500 B	17.100 C	18.200 A	20.000 C	8.000 C	0.000 C
SUHI & Dehusked	15.175 A	17.650 AB	17.000 A	57.000 A	69.000 A	37.000B
SUHI & Undehusked	15.325 A	17.400 AB	17.125 A	42.500 AB	42.000 B	1.000 C
SOFA & Dehusked	15.650 A	17.725 A	17.325 A	52.000 AB	57.000 AB	51.000A
SOFA & Undehusked	15.275 A	17.500 AB	17.500 A	49.000 AB	43.000 B	1.000 C
L.S.D.	0.4837	0.3547	1.707	18.59	21.02	5.424
C.V.	2.14	1.36	6.61	29.27	36.13	24.34

Table 13: Treatment Means of Evaluation Data of 3 Methods of Maize Storage.

Storage method and treatment	No. of live insects/kg weevils	other insects	% Damaged grains by insects	by mould	% MC	% Germ.
PIT with Husks	61.45	11.29	8.08	1.89	13.4	81.75
PIT with no husks	5.88	1.77	2.77	6.52	15.9	67.75
Above with husks	66.43	4.86	10.07	6.05	13.7	73.75
" without husks	28.97	3.41	1.97	2.19	13.4	89.25
Clay pot infested	574	139	94.99	0.95	14.87	0
" non-infested	561	14	59.44	18.24	17.67	3

APPENDIX I

Summary of Storability Evaluation Data of 30 Maize Varieties Harvested and Stored in Dschang on 18/09/89 and Evaluated on the 13/02/90 and 17/07/90.

I A - 1st Evaluation on 13/02/90 (i.e. 5 Months Storage)

Sample I.D.	No. of live insects/kg		% Mould damaged grain	Percentage		
	Weevils	Others		MC	Germ'tion	Rank By % Germ.
BSR - 89	30.5	33.5	18.08	19.2	56	5
ACROSS 8701	25.5	60.5	49.17	16.5	38	17
CMS 8507	36.7	102	52.2	18	23	29
Ndock 8701	25	79	57.6	17.1	56	5
Ekona Yellow	20	47.5	34.76	17.3	56	5
Acid Toler AF 1066	22	63	54.75	18.8	26	26
Ekona White	22.5	62.5	44.03	17.3	52	9
8329-15	32	21	45.12	19.6	36	19
8321-15	8	25	14.49	18.4	60	2
8321-18	49	158	67.56	18.3	40	14
CMS 8704	29	82.5	39.44	18.9	25	27
CMS 8503-CI	34.5	104	47.33	17	66	1
BACOA	17.3	49.3	28.01	18.1	50	10
CMS 8509	41	112.5	56.84	19.1	20	30
LOCAL	45	87.5	30.9	16.4	56	5
Acid Toler-B-CMS-36						
SAFRA	40	70.5	38.62	17.9	48	11
MIC Bambui 87 A	35	47	37.84	16.2	36	19
Synthetic Fbot 88A	32.5	76	45.06	18.6	40	14
Acid Toler F1-T2P	34.5	58	50.25	19.1	31	24
Acid Toler-B-CMS 20133		92.5	41.33	16.7	33	21
Acid Toler-E-SHABAI	58.5	62.25	33.16	16.3	44	12
COCA	48	39.5	50.62	17.2	38	17
Gusau T2B-G-Pool	18.5	62	43.07	16.5	28	25
Fbot(3)MSR B'go 88A	35.5	80	42.53	16.1	33	21
Kasai Fbot 88 A	21	47	55.18	17.5	24	28
CMS 8501-CI	61.5	75	47.45	17.5	42	13
Composite 290	47.3	113.3	58.62	17.4	60	2
SUWAN	15.3	56	58.76	16.3	60	2
Acid Toler-C-CMS	19.5	33.5	45.6	16.5	40	14
CMS 8505-CI	22	87	53.03	17.3	33	21
Means	32.00	71.16	44.71	17.57	41.67	

I B - 2nd Evaluation on the 17/07/90 (i.e. 10 Months Storage

Sample I.D.	No. of live insects/kg		% mould damaged grains	percentage		Rank By % Germ.
	Weevils	Others		MC	Germ'tion	
BSR 89	295.5	145	59.03	17.93	42	1
Across 8701	343	260	76.76	18.32	7	27
CHS 8707	451.7	119.33	78.79	17	4	30
NDOCK 8701	476	111.5	81.55	18	11	21
EKONA Yellow	418	232.5	80.39	18.25	24	6
ACID TOLER AF 1066	566	390	62.49	18.75	17	12
EKONA WHITE	436.5	217.5	90.18	18.37	25	4
8329-15	251	122	78.12	19.05	22	7
8321-15	231	133	98.01	17.65	40	2
8321-18	540	348	92.31	19.3	6	29
CHS 8704	483	248	80.69	18.23	8	24
CHS 8503-C1	217.5	121	42.90	18.6	15	14
BACOA	726.7	210.7	74.60	17.9	14	16
CHS 8509	297	122	61.79	17.17	9	22
LOCAL	373	102	66.03	17.63	25	4
ACID TOLER-B-CHS-36 SAFRA	397	158.5	70.77	16.7	16	13
HIC Bambui 87A	521	135.5	82.82	17.5	12	18
Synthetic FBOT 88A	280	114	53.02	18.4	37	3
ACID TOLER-F_1-T2P	652	255	65.67	16.57	14	16
ACID TOLER E-SHABAT	380	126	78.92	17.1	9	22
COCA	421	216	69.62	17.98	8	24
GUSAU T2B-G-POOL	204.5	74.5	78.30	17.5	12	18
ACID TOLER-H-CHS-201	352.25	149	88.04	18.25	18	9
Fbot (3) HSR 85 - B'go 88A	458	311	56.62	17.7	15	14
KASAI FBOT 88A	502	98	80.14	18.2	17	11
CHS 8501-C1	299.5	121.5	80.34	17.9	21	8
COMPOSITE 290	392	276	76.77	17.1	7	27
SUWAN I	640	116	63.14	19.9	12	18
ACID TOLER-C-CHS	250	196.5	71.19	17.43	8	24
CHS 8505-C1	213	110	55.1	18.25	18	9
Mean	402.37	178.0	73.14	18.59	16. 3	

APPENDIX II

Summary of Storability Evaluation Data of 20 Maize Varieties Harvested and Stored in Foumbot on 23/08/90 and Evaluated on the 24/01/90 and 07/08/90.

II A - 1st Evaluation on the 24/01/90 (i.e. 5 Months Storage).

Sample I.D.	No. of live insects/kg		% Mould damaged grains	Percentage		Rank By % Germ.
	Weevils	Others		MC	Germ'tion	
MSR	81.5	104.5	52.07	17.35	55	5
Bambui Synthetic	99.5	157	39.33	17.83	47	10
KASAI	33	22.5	49.50	17.23	38	16
ACROSS 8701	77.5	22	33.12	17.83	44	13
Composite 290	56	108.5	40.68	17.58	35	17
MLC	46.5	61	34.26	17.28	58	3
Ekona Yellow	99	73	22.64	17.55	30	19
8321-18	20	14.5	35.69	17.98	40	15
SUWAN I	52.5	17	44.99	17.65	55	5
BACOA	67	98.5	25.52	17.73	58	3
LOCAL	26	12.5	24.38	17.35	75	1
Bertoua 8701	5	20	25.45	17.9	59	2
Ekona White	23.5	28	33.89	18	49	7
CMS 8507-CI	124.5	133.	25.46	17.3	44	13
CMS 8509-CI	65	94.5	60.14	17.1	34	18
COCA	146.5	524	43.89	16.95	48	8
CMS 8501-CI	10	16.5	24.40	17.98	46	11
CMS 8505-CI	42	15	41.20	17.5	30	19
Ndock 8701	19	47.5	42.82	17.68	46	11
CMS 85o3-CI	106	105.5	27.32	17.37	48	8
Means	60	83.78	36.34	17.56	46.95	

II B - 2nd Evaluation on the 07/08/90 (i.e. 10 Months Storage).

Sample I.D.	No. of live insects/kg		% Mould damaged grains	Percentage		Rank By % Germ.
	Weevils	Others		MC	Germ'tion	
HSR	329	56	68.76	16.15	22	7
Bambui Synthetic	233	109.5	42.41	17.95	26	4
KASAI I	453	181	73.74	16.73	36	1
ACROSS 8701	452.5	90	68.41	16.73	12	11
Composite 290	459	114	59.62	15.35	10	14
HLC	325.5	85	65.55	15.98	11	13
Ekona Yellow	326	44	54.69	16.35	10	14
8321-18	583	92	69.8	16.9	22	7
SUWAN-I	597	166	58.17	16.6	12	11
BACOA	440	256.5	50.12	13.7	26	4
LOCAL	158	40	37.44	15.98	28	3
BERTOUA 8702	133	40	19.06	17.1	29	2
EKONA WHITE	344	92	66.07	17.13	9	17
CHS 8507-C1	348	177	62.48	14.6	9	17
CHS 8509-C1	358	138	68.12	16.6	8	19
COCA	443	125.5	64.23	14.6	6	20
CHS 8501-C1	335	109	40.46	16.65	16	10
CHS 8505-C1	343.5	100	50.69	17.02	10	14
HIXOCK 8701-C1	426	50	50.35	16.47	21	9
CHS 8503-C1	400	114	47.5	15.05	25	6
Mean	374.33	108.98	55.88	16.18	17.4	

APPENDIX III

III A - 1st Evaluation on the 26/01/90 (i.e. 5 Months Storage).

Sample	No. of live insects/kg		% Mould damaged grains	Percentage		Rank By % Germ.
	Weevils	Others		MC	Germ'tion	
CMS 8501-CI	2.5	31.5	13.37	20.65	62	15
Bambui Synthetic	25.5	55	10.59	20.7	70	10
Ekona Yellow	28	49	7.07	20.5	89	1
CMS 8507-CI	51.5	70.5	5.66	20.57	68	11
Ndock 8701	10.5	45	11.2	20.5	87	3
Ekona White	36	37	13.79	20.25	81	6
Kasai I	17	58	10.02	20.4	89	1
MSR	23	33.5	11.65	20.45	64	14
MLC	74	71.5	11.56	20.27	67	12
Bertoua 8701	7.5	41.5	10.54	20.5	40	20
LOCAL	19.5	51	6.19	20.6	82	5
8321-18	63.5	24.5	14.21	20.4	74	8
BACOA	28.5	165.5	10.35	20.57	52	19
ACROSS 8701	18	66.5	13.89	20.57	85	4
COCA	102.5	77	35.58	20.47	67	12
Composite 290	25	130	8.31	20.1	75	7
CMS 8506-CI	54	36	13.97	20.35	60	16
CMS 8503-CI	0.5	65	17.25	20.47	58	17
CMS 8505-CI	31	129	18.45	20.25	56	18
SUWAN I	31	72.5	9.08	20.5	74	8
Means	32.45	64.48	12.66	20.45	70	

III B - 2nd Evaluation on the 26/08/90 (i.e. After 10 Months Storage).

Sample I.D.	No. of live insects/kg		% mould damaged grain	Percentage		Rank By % Germ.
	Weevils	Others		MC	Germ'tion	
CMS 8501-CI	108.5	207	40.24	17.1	13	13
Bambui Synthetic	130	184.5	31.57	17.15	11	16
EKONA Yellow	178	112.5	42.71	17.05	28	2
CMS 8507-C1	119	170.5	38.45	16.87	25	4
Ndock 8701	254	311.6	37.71	16.85	15	9
EKONA WHITE	257	208	46.11	17.07	13	13
KASAI I	245	263.5	43.28	16.97	26	3
MSR	175.33	162	41.81	16.56	14	11
MLC	366	374.5	41.38	16.89	22	5
BERTOUA 8701	172.5	121.5	38.44	17.25	17	7
LOCAL	89.5	162.5	26.19	16.62	43	1
8321-18	221.5	162.25	44.11	17.1	18	6
BACOA	169	261	46.86	17.35	16	8
ACROSS 8701	63.5	97.5	30.88	17.2	14	11
COCA	541	585	65.46	15.02	15	9
COMPOSITE 290	291	310.5	69.06	13.82	10	17
CMS 8509-C1	282	401.5	69.59	16.77	8	20
CMS 8503-C1	314	398	52.05	17.16	9	19
CMS 8505-C1	388	522.5	61.72	16.75	10	17
SUWAN I	248.5	284.5	42.91	16.95	12	15
Mean	230.67	265.04	45.53	16.73	16.95	

APPENDIX IV

Summary of Storability Evaluation Data of 12 Cameroon National Early/Intermediate and 16 Intermediate/Late Maize Varieties Harvested and Stored in Ekona on 28/02/90 and Evaluated on the 17/07/90.

IV A - Early/Intermediate Varieties Stored for 5 Months.

Sample I.D.	No. of live insects/kg		% Damaged Grains		Percentage		Rank By
	Weevils	Others	Insects	Mould/ rotten	MC	Germ't.	% Germ.
BSR 81	515	140	34.5	4	17.1	31.5	4
CMS 8503	335	150	32	7.5	17.8	41.5	1
T24T	335	255	32.5	2	17.7	29.0	5
TZESR-SE	205	113	37.5	0.5	17.75	35.0	2
BSR-SYHI	260	185	33	5.5	18.0	17.5	9
TZESR-W	125	85	31.5	3.5	17.2	6.5	13
CMS 8602	195	60	40.8	0.8	16.8	16.5	10
DMR-ESRY	295	140	29.5	1	16.9	34.0	3
POOL 16 SR	200	250	23.5	1.5	17.4	29.0	5
BSR SYHII	210	180	28.0	1.0	18.1	18.0	8
DMRESR W	30	225	14.3	5.3	17.9	29.0	5
EV 8435 SR	247	260	26.5	1.5	18.6	9.0	12
LOCAL FAKO	400	150	-	-	19.4	10.0	11
Means	218.65	168.69	30.28	3.26	17.74	23.58	

IV B - Intermediate/Late Varieties Stored for 5 Months (Stored in Ekona on 28/02/90 and Evaluated on the 17/07/90).

Sample I.D.	No. of live insects/kg		% Damaged Grains		Percentage		Rank By
	Weevils	Others	Insect	Mould/ rotten	MC	Germ'tion	% Germ.
Suwan x Gene Pool W	205	290	28.5	0.5	21.4	8.8	16
Ndock 8701	2	310	27.5	11.0	21.3	16.3	13
Gusau x Gene Pool	77	205	15.5	6.0	21.7	33.8	6
CMS 8507	40	180	34.0	5.2	39.8	37.5	3
Across 8701	100	65	14.5	22.7	20.8	24.8	11
Bertoua 8701	235	80	19.0	5.0	21.3	33.8	6
Suwani x Gene Pool Y	340	195	33	-	20.9	12.5	14
EV 8422 SR	10	90	23	1.5	20.6	31.3	8
8321-18	17	95	10	9.5	21.0	31.3	8
Ntui TZPB SR	75	55	20	0.64	21.0	37.5	3
Yaounde 8701	110	105	20.0	2.0	20.8	31.3	8
CMS 8503	325	330	32.0	-	21.4	35.0	5
CMS 8501	85	85	25.0	0.5	21.0	20.0	12
TZPB Suakoko	15	215	18.0	0.75	20.5	50.0	1
Suwani SR	645	115	39.0	0.25	21.2	6.3	17
EV 8428 SR	5	110	11.5	9.0	20.8	38.8	2
Local Fako	400	150	-	-	19.4	10.0	15
Means	158	157.35	21.3	5.32	20.91	27.0	

8.2 LOWLAND CEREALS ENTOMOLOGY

INTRODUCTION

During the 1990 cropping season (march to december), ten experiments were conducted in experimental plots at Minkomeyos. An eleventh experiments in collaboration with the TLU team was conducted in farmers fields. The results of these trials will not be included in this report since the harvests of the second season are not yet finished. Nevertheless, we will try to present the different methodologies utilized as well as some available results.

It is useful to indicate that the work of this year was greatly influenced by rainfall. The rains began with a delay (mid april), the seeding was also retarded, and the harvests retarded. The pages which follow give a report of the work performed.

EXPERIMENT NUMBER 1:

Study of methods of use of carbofuran (furadan) to control the stem borer of maize.

This trial is a repeat of the same experiment done for two years and of which preliminary results had already been presented in previous reports. The objective is to determine an effective, economic method to recommend to the average farmer.

Material and methods

a) **General Conditions of the Trial**

The location of the trial is Minkomeyos situated 9 kilometers from Yaounde, between latitudes 3o51' and 3o53'n and the longitudes 11o27' and 11o27'e. The soil is ferralitic modal typical to red facies. The average annual rainfall is 1500mm, and is divided in a bimodal manner. This allows us two cropping seasons per year. The first goes from March to July and the second August to December.

b) **Experimental Method**

The experimental design was randomized blocks with four treatments and four replications. The maize was planted in plots 5 x 4,80m m with two meters between plots. Each plot consisted of 6 rows of maize with 0,80m between rows and 0,25m between plants, giving a density of 50.000 plants per hectare after thinning.

The insecticide tested was carbofuran (2,3-dihydro -2,2-dimethyl-7-benzoforanyl methylcarbamate) marketed under the name of Furadan. The choice of this product is due to its availability in the market and because farmers are familiar with its use. This product was applied at the rate of 2,5 kg active ingredient/ha and the three following methods of application were compared: Application of granules in the rows at the moment of seeding (T1); application of granules in the whorls 40 days after seeding (T2); application of granules in the rows with a second application in the whorls 40 days after seeding (T3); The check (T4).

Starting the third week after seeding through the twelfth, 40 plants were sampled at random every three weeks in the different treatments. These plants were dissected and the insects encountered collected and identified. The rate of infestation (percentage of plants attacked) as well as the distribution of species encountered were determined at every visit. At harvest, the yield in dry grain and the degree of losses on stems were also evaluated.

RESULTS AND DISCUSSION

a) Variation of the rate of attack

Information on the rate of attack presented here concerns only the first crop cycle. The observations for the second crop cycle year are not yet finished. Table 1 presents the results recorded in the first crop cycle. It can be seen that there were almost no attacks during the season. This could have been caused by the very dry long season recorded this year. The rains began only at the end of april, a month late with respect to normal. A good part of the insects in diapause probably perished because of the heat. This indicates that strong temperatures should be damaging to the development of stem borers. This remains to be confirmed from the experiments.

Table 1: Variation of the rate of attacks of stem borers on maize treated with Furadan, Yaounde 1990 (first agricultural cycle)

Treatments	Rate of attacks				Yield (t/ha)
	3 ITS*	6ITS	9ITS	12ITS	
1	0	2.5	0	7.5	7.5
2	0	7.5	0	0	7.9
3	0	0	0	0	7.5
4	0	2.5	0	0	7.1

ITS : Weeks after seeding

b) Yields

The variety of maize utilized for this trial was the improved variety DMR (Downy Mildew Resistant) with yellow grain and short season (less than 100 days). The results of the above table show that very high yields were recorded on the four treatments. The differences among the treatments are not significant. This is not surprising when we note that there were very few attacks. It was evident that the application of the product gave no advantage. To the contrary, it was a useless expenditure.

c) Distribution of species

Table 2 presents the distribution of species of borers encountered during the first season. Examination of this table shows that few insects were harvested during the season. This is not surprising in view of the reasons given above. It can be seen that all three species are represented in small numbers. This leads us to say that populations of the three species were influenced in a similar manner by the rough climatic conditions. The very elevated temperatures should have been unfavorable to the development of the three species.

Table 2 : Distribution of different species of stem borers after treatment of maize with Furadan Yaounde 1990

Treatments	Insects encountered			Bf
	Total	Sc	Are	
		61TS*		
T1	3	0	0	3
T2	-	-	-	-
T3	-	-	-	-
T4	0	1	0	1
		12ITS		
T1	0	3	2	5
T2	-	-	-	-
T3	-	-	-	-
T4	-	-	-	-

ITS : Weeks after seeding

EXPERIMENT NUMBER 2:

Study of rates of application of carbofuran (furadan) to control stem borers of maize

Furadan, is often used to control stem borers of maize. The rates of this product vary with the different users. The object of this study to try to determine an economicaly profitable rate to recommend to the average farmer.

Material and methods

a) General Conditions of the trial

They are identical to those presented for experiment number 1

b) Experimental Method

The experimental design was randomized blocks with five treatments and four replications. The maize was planted in plots of 5 x 4,8m with two meters between plots. Each plot consisted of 6 rows of maize with 0,80m between rows and 0,25m between plants giving a density of 50.000 plants per hectare after thinning.

The insecticide tested was carbofuran (2,3-dihydro-2,2-dimethyl-7-benzoforanyl methylcarbamate) marketed under the name of Furadan. The choice of the latter is related to its availability in the market and familiarity of farmers with regard to his use. This product was applied 40 days after seeding and the five following application rates compared:

1 0kg/ha
2 5kg/ha
3 10kg/ha
4 15kg/ha
5 20kg/ha

Starting the third week after seeding until the twelfth, 40 plants were sampled at random every three weeks on the different treatments. These plants were dissected and the insects encountered collected and identified. The rate of infestation (the percentage of plants attacked) as well as the distribution of species present were determined at every visit. At harvest, the yield and degree of losses on the stems (expressed in average number of cavities per foot) were recorded.

RESULTS AND DISCUSSION

a) Variation of the rate of attack

The information concerning the variation of the rate of attack presented here are valid only for the first agricultural cycle. The results of the first agricultural cycle indicate that there were not a large number of attacks, the plants examined being sound (cf table). This was certainly caused by the very long dry season recorded this year in the zone or was due to the management of the experiment.

Table 1: Variation of rate of attack of stem borers on maize treated to different rates of carbofuran, Yaounde 1990 (1st agricultural cycle).

Rate/ha	Rate of attack (%)				Yield
	3ITS*	6ITS	9ITS	12ITS	(t/ha)
0	-	-	-	-	5.6
5	-	-	-	-	6.4
10	-	-	-	-	6.3
15	-	-	-	-	6.7
20	-	-	-	-	6.8

* ITS : Weeks after seeding.

b) Yields

The variety of maize tested was DMR (Downy Mildew Resistant) with a short cycle (less than 100 days). Examination of table 1 indicates:

* High yields were recorded on every treatment. This is not surprising since there were almost no attacks.

* The differences of yield among treatments were insignificant. However we noted an increase of these differences as the rate increased. That indicates that the treatments had some influence on the yield, though this remained insignificant.

EXPERIMENT NUMBER 3

Study of the influence of the relationship maize-peanut on the dynamics of populations of stem borers of maize.

The objective of this experiment was to repeat the same experiment done the past year. That was to determine the impact of the maize crop in relationship with peanut on the development of attacks due to borers and on the distribution of species present.

Material and Methods

a) Experimental Conditions

They are identical to those described for experiment number 1.

b) Experimental Method

The experimental design was randomized blocks with two treatments and four replications. The maize was planted on plots 5 x 4,8m spaced two meters apart. Each plot of associated maize consisted of three rows of maize and sixteen rows of peanut (with four lines of peanut between two lines of maize). The maize was planted 0,25m between plants and 2m between rows giving a density of 20.000 plants per hectare. The peanut was sowed 0,25m between rows and 0,10m between plants giving a yield of 400.000 plants by hectares. The variety utilized was the local variety Mbam. The plots with pure maize consisted of 6 rows sowed to 0,80m apart and 0,25m between plants giving a density of 50.000 plants per hectare.

Two varieties of maize were been tested in this study. They were the local variety "Bafia" with short cycle and an improved variety with short cycle, the DMR (Downy Mildew Resistant).

Starting with the third week after seeding, until the twelfth, 40 plants were sampled at random every three weeks on the different treatments. These plants were dissected, the insects encountered collected and identified. The rate of infestation as well as the distribution of species presents were determined at every visit. At harvest yield in dry grain and the degree of loss on the stems (expressed in average number of cavities per foot) were recorded.

RESULTS AND DISCUSSION

a) Variation of the rate of attack

For reasons already given above it will not be possible to present here the results of the entire year. The information given is only for the first cropping cycle. Because of the climatic changes which have been recorded this year (a very long dry season) it was not possible to record attacks in the field, the plants examined being sound.

b) Yields in dry grain

The results of this section are not yet analyzed. They will figure only in the next report.

EXPERIMENT NUMBER 4

Study of the influence of the relationship maize-manioc on the dynamics of populations of stems borers of maize.

The principal objective of this trial was to determine the influence of maize in relationship with manioc on the distribution of the species present. This trial is a continuation of the same experiment done last year.

Material and methods

a) Conditions of the trial

They are identical to those described for experiment number 1.

b) Experimental Method

The experimental design used was randomized blocks with two treatments and four replications. The maize was planted in plots of 5.0 x 4.8m, each plot being two meters from the other. Every plot with associated maize was composed of 4 lines of maize and 5 lines of manioc (a line of maize between 2 lines of manioc). The maize was planted 1m between rows and 0,25m between plants giving a density of 40000 plants/hectare. The manioc was planted in rows 1m apart with 1m between plants giving a density of 12500 plants per hectare. The plots of pure maize were composed of 6 lines sowed 0,80m between rows and 0,25cm between plants giving a density of 50000 plants per hectare. Two varieties of maize were compared in this study; the local variety "Bafia" a short season variety and the improved variety DMR (Downy Mildiou Resistant). The variety of manioc utilized was the local variety.

Starting the third week after seeding, until the twelfth week samples of maize were collected and treated according to the method already described in the preceding experiments.

RESULTS AND DISCUSSION

a) Variation of the degree of attacks

The information given here are of the first cropping cycle, the observations on the second being unfinished. For the same reasons given in the preceding experiments, there were no record of attacks in the first crop season.

b) Yields of Dry Grain

The analysis of this section is not yet complete and so cannot be included in this report.

EXPERIMENT NUMBER 5

Study of the influence of soil fertility on the dynamics of the populations stem borers.

This experiment, done for the first time had the following objectives: The determination of the impact of three rates of NPK (20-10-10) on the development of the rate of attacks the evaluation of the influence of soil fertility on the sequence of appearance and distribution of Busseola fusca, Sesamia calamistis and Eldana saccharina.

Material and Methods

a) Conditions of the trial

(See experiment number 1)

b) Experimental Method

The experimental design was randomized blocks with four treatments and four replications. The maize was planted on plots of 5 x 4.8m, with two meters beween plots. Each plot consisted of 6 rows of maize with 0,80m between rows and 0,25m between plants giving a density of 50000 plants per hectare after thinning.

The fertilizer tested was NKP (20-10-10) frequently used by farmers. The rates compared were the following:

1 0kg/ha
2 100kg/ha
3 250kg/ha
4 500kg/ha

Starting with the third week after seeding until the twelfth, 40 plants were sampled at random every three weeks on the different treatments. These plants were dissected and the insects encountered collected and identified. The rate of infestation (percentage of plants attacked) as well as the distribution of the species present were evaluated at every visit. At the harvest, we evaluated the yield and degree of losses on the stems.

RESULTS AND DISCUSSION

a) Variation of the rate of attack

Table 1 presents the variation of the rate of attack by the borers on the different rates. Examination of this table shows the attacks were not frequent during the period of trial. This was probably caused by the very long dry season recorded in the zone of study. When attacks were present, their rate increased with the rate of fertilizer. This may signify that the longer the maize is in the field the more preferential it is as a host for the borers. This hypothesis remains to be confirmed from the trials repeating this experiment.

Table 1 : Variation of the rate of attack of stems borers on maize fertilized at different rates, Yaounde 1990.

Treatments	Rate of Attack				Yield (t/ha)
	3SAS	6SAS	9SAS	12SAS	
1	0	0	2.5	5	6
2	0	0	0	10	6.2
3	0	0	2.5	12.5	6.9
4	0	0	2.5	12.5	7.15

b) Yields

Table 1 presents the variation of yield expressed in tons per hectare on the different treatments. The examination of this table shows a positive response of maize to fertilization. Meanwhile, this response remains very weak, the reason for which the differences recorded among treatments are insignificant.

c) Distribution of the species

Table 2 presents the distribution of species 12 weeks after seeding in the first crop season. It shows that the greatest part of the population was composed of representatives of eldana saccharina. This is not surprising when we consider that it is the prelevant period for this type. Meanwhile, it should be noted that the total number of insects was very low, surely caused by the fact that the attacks themselves were not serious.

Table 2 : Distribution of the different species of borers 12 weeks after seeding of maize fertilized at different rates; Yaounde 1990.

Treatments	Insects found Bf	Sc	Es	Total larvae par stalk
1	1	0	1	2
2	0	0	6	6
3	1	0	4	5
4	0	2	6	6

EXPERIMENT NUMBER 6

Study of egg laying places of Busseola fusca and Sesamia calamistis

The objective of this experiment was to determine the locations where Busseola fusca and Sesamia calamistis deposit their eggs in natural conditions of infestation and in controlled conditions.

Material and methods

a) Conditions of the trial

(See experiment number 1)

b) Experimental Method

The maize was planted on a plot of 400 m2 composed of 25 rows planted 0.80m apart with a plant spacing of 0.25m. The variety of maize utilized was Bafia. Starting with the 1st week after seeding and until the sixth, 5 to 10 plant samples of maize were collected every 4 days and dissected. The eggs collected were preserved until hatching and the insects so obtained identified. The number of the leaf or the foliar sheath carrying these eggs was also recorded.

Results

Since maize in the first crop season was almost not attacked (for reasons explained above), it was difficult to harvest the eggs in the field. The observations of the second crop season will be presented later.

EXPERIMENT NUMBER 7

Study of the location of egg laying of Eldana saccharina

The objective of this trial was to determine the place where Eldana saccharina deposits generally eggs (in field and laboratory) with a view towards a later study of methods of control for this insect. Material and methods

a) Conditons of the trial

(See experiment number 1)

b) Experimental Method

It was the same as that described for experiment number 6. The only difference was that the maize was sampled from the sixth week after seeding. Two treatments were utilized: plots where stalks of preceding harvest was left betwen rows and plots where the stalks had been removed and taken out of the field.

RESULTS

In first crop season very little egg laying was recorded. The observations continue on the same trial in the second crop season.

EXPERIMENT NUMBER 8

Selection of varieties resistant to Busseola fusca in conditions of natural infestation.

The objective of this trial, conducted in collaboration with maize breeding team, was to compare the behavior of 94 varieties of maize with respect to attacks of Busseola fusca under natural infestation.

Material and Methods

a) Conditions of the trial

The location of the trial was the old experimental fields of ENSA situated about 7 kilometers from Yaounde.

b) Experimental Method

The experimental design used was randomized blocks with 94 treatments and three replications. The maize was planted in rows of 5m length with 0,25m between plants. At six weeks after planting a sample of 5 plants per row will be chosen at random and the rate of attacks on leaves will be recorded. At harvest the losses on ears and degree of infestation of stems will also be recorded. The varieties compared are the following:

1. 101-1	32. 115-2	63. 130-1
2. 101-2	33. 115-3	64. 130-2
3. 102-1	34. 116-1	65. 130-3
4. 102-2	35. 116-2	66. 130-4
5. 120-3	36. 117-1	67. 131-1
6. 102-4	37. 117-2	68. 131-2
7. 103-1	38. 117-3	69. 131-3
8. 103-2	39. 119-1	70. 132-1
9. 104-1	40. 119-2	71. 132-2
10. 104-2	41. 120-1	72. 132-3
11. 104-3	42. 120-2	73. 133-1
12. 105-1	43. 120-3	74. 134-1
13. 105-2	44. 120-4	75. 134-2
14. 105-3	45. 122-1	76. 134-3
15. 106-1	46. 122-2	77. 135-1
16. 107-1	47. 123-1	78. 135-2
17. 107-2	48. 123-2	79. 137-1
18. 108-1	49. 123-3	80. 138-1
19. 108-2	50. 123-4	81. 138-2
20. 108-3	51. 124-1	82. 138-3
21. 108-4	52. 124-2	83. 140-1
22. 110-1	53. 124-3	84. 141-1
23. 110-2	54. 126-1	85. 142-1
24. 110-3	55. 126-3	86. 142-2
25. 111-1	56. 127-1	87. 142-3
26. 112-1	57. 127-2	88. 142-4
27. 112-2	58. 127-3	89. 142-5
28. 113-1	59. 127-4	90. 144 1
29. 114-1	60. 128-1	91. 144-2
30. 114-2	61. 128-2	92. EV 8443
31. 115-1	62. 129-1	93. 8428-19
		94. 1393

RESULTS

This trial was planted only in the second crop season. Consequently it is not possible to present the results here since the observations are not yet terminated.

EXPERIMENT NUMBER 9

Study of the distribution of species of borers of maize across time at Yaounde.

The objective of this experiment was to determine the sequence of appearance of species of stem borer during a year. It was undertaken in the experimental fields of IRA at Minkomeyos (Yaounde).

Material and Methods

a) General Conditions of the Trial

(See experiment number 1)

b) experimental Method

Every month samples of plants of maize showing signs of attack were collected, dissected and the different insects encountered collected and identified. The distribution of the species was made after every visit to the field.

RESULTS

The results of the trial in the first crop season have not been concluded. The climatic changes have not favored the pillulation of the insects. Consequently it was not possible to make a normal collection of insects.

EXPERIMENT NUMBER 10

Study of the influence of Mussidia nigrivenella on the yield in dry grain.

Since two or three years the presence has been noted of the larvae of a lepidoptera damaging stored grains, Mussidia nigrivenella which attacks maize shortly before harvest and which the larva strongly resembles that of Eldana saccharina. The objective of this experiment was to evaluate the impact of this insect on yield.

Material and Method

a) Conditions of the Trial

(See experiment number 1)

b) Experimental Method

Maize was planted on four plots of 100m2 each, consisting of 5 rows 0,80m apart with 0,25m between plants. The variety of maize utilized was Bafia. At maturity the plots were harvested at two weeks interval. The ears were classified according to the degree of damage according to the following three types:

1. Sound ears or lightly attacked
2. Ears severly attacked
3. Ears completly destroyed (unusable)

The average weight of 5 ears choosen at random in every category been recorded as well as the distribution of the species of insects present.

RESULTS AND DISCUSSION

a) Variation of the Rate of Attacks

The table 1 presents the variation of the rate of attacks on of the maize of which the harvests has been spread out over a month. On the examination of this table. The following appears.

* The average weight of 5 ears choosen at random in every category was reduced as the harvest was delayed. This same observation was made in passing from one category to another (by an order of magnitude) and for all three dates.

* It was not possible to record here the complete destruction of the ears due to the attacks. This was because of the rot or of the germination of the grains. The harvests were made in the rainy season.

b) Distribution of the Species

The distribution of the species of borers of the ears and grains of maize encountered during of the experiment is presented in table 2. The examination of this table reveals that Busseola fusca, Sesamia calamistis, Eldana saccharina and Mussidia nigrivenella are the lepidoptera encountered on the ears of maize. The two first species are found especially near the end of maturity of the plant, after which their proportions decline as the harvest is extended.

With respect to the two last species, their proportions remain important on the three dates. Meanwhile the rate of Eldana diminishes contrary to Mussidia which becomes more important when one goes from the 1st date of harvest to the last.

This information makes it possible to suggest that it should be advantageous to harvest this maize to avoid a loss of yield due to grain borers with time. All of the analyses and economic calculations subsquent to the replication of this experiment will give more weight to this hypothesis.

Table 1 : Evolution of the attacks of Mussidia nigrivenella on of the maize harvested at two weeks interva at Yaounde (1st crop season 1990)

Harvest date	Number of ear harvested	Categories 1		2		3	
		%	PM(g)/ 5 stalks *	%	PM(g)/ 5 stalks	%	PM(g)/ 5 stalks
28/8/90	476	97	600	1.3	400	1	400 **
12/9/90	395	85	450	13	375	1.5	375
26/9/90	261	88	500	6	300	6	300

* PM : average Weight
** The ears were unusable because of rot or germination and not due to attacks of insects.

Table 2: Distribution of the species of borers on of the maize harvested at two weeks of interval at Yaounde (1st crop season 1990).

Harvest Date	Total Number of insects	Species (%) Bf	Sc	Es	M.n
28/8/90	12	8.3(1)*	41.6(5)	33.3(4)	16.7(2)
12/9/90	16	0	6(1)	19(3)	75(12)
26/9/90	20	0	0	20(4)	80(16)

* The figures among paranthses represent the total number of individuals for the type.

9. LIST OF NCRE RESEARCHERS

9.1 International Staff

Name	Nationality	Position	Location
1. Dr. Emmanuel A. Atayi	Togolese	Chief of Party	Nkolbisson
2. Dr. Thomas C. Stilwell	American	Deputy Chief of Party	Nkolbisson
3. Mr. James O. Cross	American	Administrative Officer	Nkolbisson
4. Dr. V. Balasubramanian	Indian	Maize Agronomist	Nkolbisson
5. Dr. John Poku	Ghanian	Ext. Agronomist	Nkolbisson
6. Dr. Doyle Baker	American	Agric. Economist	Nkolbisson
7. Dr. Leslie Everett	American	Maize Breeder	Bambui
8. Dr. Joseph Kikafunda	Ugandan	Maize Agronomist	Bambui
9. Mr. Dermot McHugh	American	Agric. Economist	Bambui
10. Dr. Monty P. Jones	Sierra-Leonian	Rice Breeder	Dschang
11. Dr. Animesh Roy	Bangladeshi	Rice Agronomist	Dschang
12. Dr. T. Woldetatios	Ethiopian	Ext. Agronomist	Ekona
13. Dr. Susan Almy	American	Socio-Economist	Ekona
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15. Dr. Lallan Singh	Indian	Sorghum Agronomist	Maroua
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9.2 National Counterparts

9.2.1 In Country

	Name	Position	Location
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4.	*Mr. Jean Bosco Zangue	Maize Breeder	Nkolbisson
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6.	*Mr. Jupiter Ndjeunga	Agr. Economist	Nkolbisson
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32.	Mr. Mboussi A. Messia	Extension Agronomist	Ekona
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* Indicates degree received through NCRE financing

9.2.2 In Training

Name	Specialization		University
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Mr. Zachée Ngoko	Maize Pathology	MSc	Texas A & M
Mr. Pascal Ngninbeyie	Rice Agronomy	MSc	LSU Rice Res station
Mr. Andre Djonnewa	Sorghum Breeding	MSc	Nebraska State U.
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* Indicates previous degree received through NCRE financing