REPUBLIC OF CAMEROON
MINISTRY OF SCIENTIFIC AND
TECHNICAL RESEARCH
(MRST)
INSTITUTE OF AGRICULTURAL RESEARCH
(IRA)

National Cereals Research and Extension Project (NCRE)

Three Year Report 1993

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

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EXECUTIVE SUMMARY

Highland Maize Breeding

The Highland Maize Breeding Unit, though not satisfied in the highland zones, has fulfilled its goals in the mid-altitude zones as testified by the release of 5 open-pollinated and 4 hybrid varieties The Unit feels frustrated by the delays trought by NCRE administration on the winding up operations especially as regards the nursery, training farmers and extension workers by the Unit, as well as genetic stocks preservation

Rice Breeding

The 1991, 1992 and 1993 cropping seasons were successfully conducted with more emphasis on breeding Over the years, the trials were harvested and data analyzed

In Ndop plain IR7167 - 33 - 2 - 3 and TOX 3145 - 33 - 2 - 4 were the most preferred varieties Other varieties such as Cisadane, ITA 212, ITA 222, CICA 8 and TOX 3145 - 33 - 2-3 are actually under cultivation in West and North West Provinces In Maga, ITA 212, AD 9246 are possible substitutes of IR 46 In the North, ITA 257, and IRAT 112 are the outstanding upland/rainfed varieties while ITA 3OO is progressively replacing BKN 7O33 - 33 - 3 - 3 - 2 - 2 - 3 under irrigated conditions

Cereals Agronomy

During the last 3 years (1991 - 1993) the researchers of Cereals Agronomy Unit have conducted more than 34 agronomic field trials on maize, sorghum and associated crops on station and in farmers' fields in the three Provinces particularly in the subhumid lowland savanna in North Cameroon Some technical papers and two compendiums of agronomic recommendations for maize and sorghum have been prepared Many training fields days, extension agents and farmers have been organized Much technical assistance to several agricultural agencies and farmers has been provided

Sorghum Breeding

During the last three years of NCRE project, the Sorghum and Millet Reseach Unit set its main objective to breed for various stress tolerance, improve local germplasms and evaluate introductions and advanced segregating materials Work conducted according to this plan led to encouraging results Some sorghum and millet varieties were found to be very performant in terms of yield, agronomic traits and/or stress factors

Sorghum Agronomy

Many forage legume species grew too slowly or did not accummulate enough biomass to be considered as cover crops *Cassia siamea* and pigeon pea hedgerows can be a sustainable cropping system *Striga* control package should be directed to reduce *Striga* seedbank in the soil Monitoring of the soil moisture in Muskwari sorghum should be given high priority Many goals, including training, were accomplished during the contract period of the TA

Bambui TLU

The Testing and Liaison Unit at Bambui is responsible for farming systems research in the Western Highlands of Cameroon, with an emphasis on maize and rice based cropping systems From 1991 to 1993, significant progress was made toward achieving this goal with the generation of farmer recommendations for sustainable agriculture, soil fertility and characterization, maize and rice built around new high yielding varieties (kasai, ATP, Synth 3 & 4, HAP, Early White and maize Hybrids, and the TOX rice varieties) that have been released and are being adapted by large numbers of farmers

Ekona TLU

The focus of research was on constraint diagnosis, identification of biological technologies for improving soil fertility and for weed control, identification of appropriate crop protection practices, dissemination of improved well adapted crop varieties and other technologies as well as monitoring technologies Dissemination of technologies is the project's future research focus

Maroua TLU

With less need for additional diagnostic studies, on-farm test results over 1991-93 point to promising technologies on improved sorghum/cowpea associations, soil moisture conservation, the use of leguminous trees in association with crops and improved cowpea storage techniques There is evidence that certain varieties of sorghum, cowpea, peanut and maize are being adopted by farmers Adoption and research impact studies are urgently needed to guide future research directions

Soil/Agroforestry

Overall, we have made some good progress towards solving some of the key soil-related constraints in our zone of service These were nitrogen deficiency and low phosphorus availability to crops due to soil acidity and fixation We explored the use of organic amendments and lime to address these problems Our impression was that the green manures supplied more nitrogen and less phosphorus but did enhance the availability of fertilizer phosphorus to crops in acid soils The green manure crops which showed promise in this respect were Mucuna, Crotalaria, Canavalia, Tephrosia The green manure crops performed poorly in the highly degraded soils (high in exchangeable Al and low basic cations), and were not effective as soil improvers Under such conditions, starter manuring was recommended

Calliandra was best for agroforestry followed by *Leucaena* and *Cassia* By aiding initial growth of *Leucaeua* with starter manure, its performance was comparable with that of *Calliandra* The advantage of using *Leucaena* is that it is precocious *Cassia* tolerated the dry season better than the rest but it is a non-nitrogen fixer and therefore, there is a tendency for it to deplete soil N if the biomass is exported out of the field for other uses *Albizia*, *Erythrina* and *Mellitia* performed poorly in the North-west Highlands

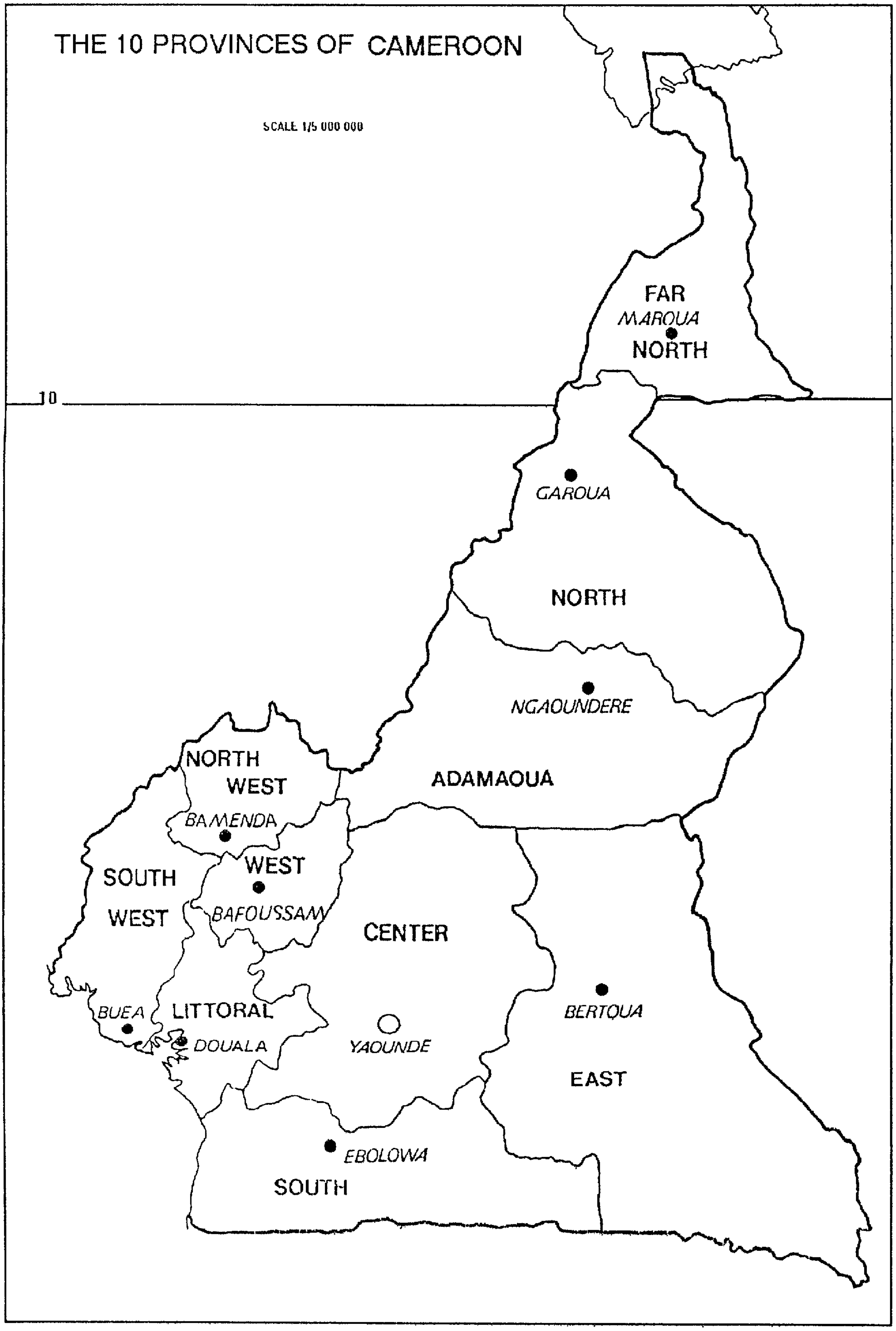
The unit's role was extended to include coordination of Peace Corps, NGOs and farmer groups involved in agroforestry and related green manuring research and extension activities nationwide Over 25 farmer groups in the South-West, North-West and West provinces were reached with our proposed interventions Our package for demonstration consisted of 1) Green Manure/Agroforestry (GM/AF) with NPK fertilizer, 2) GM/AF without NPK fertilizer and 3) control without GM/AF and no NPK *Crotalaria* and *Mucuna* featured most in these demonstrations because they were more stable in terms of biomass production than the other species Our protocol and experience were shared with the TLUs in Garoua, Maroua and Ekona

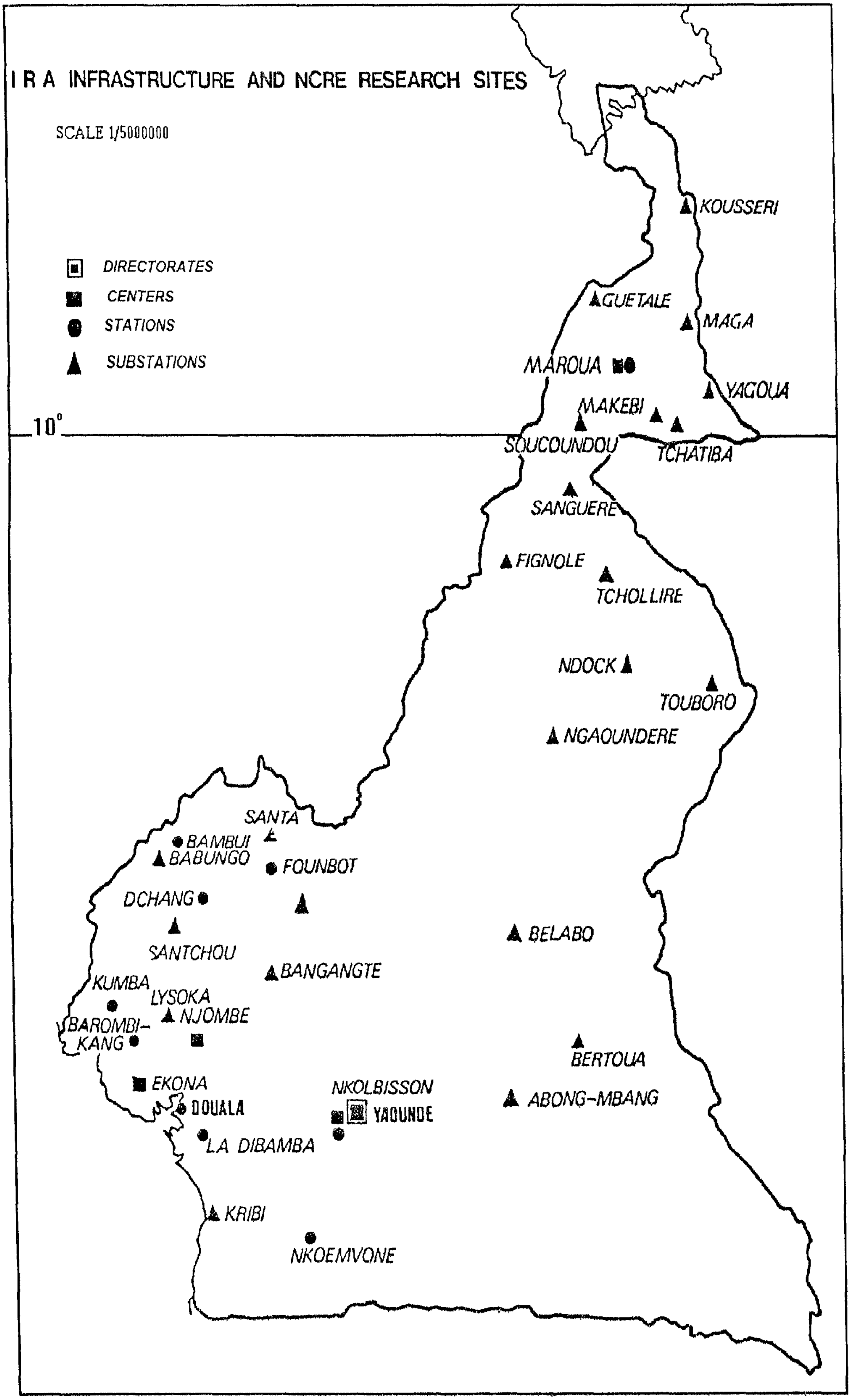
Plant Pathology

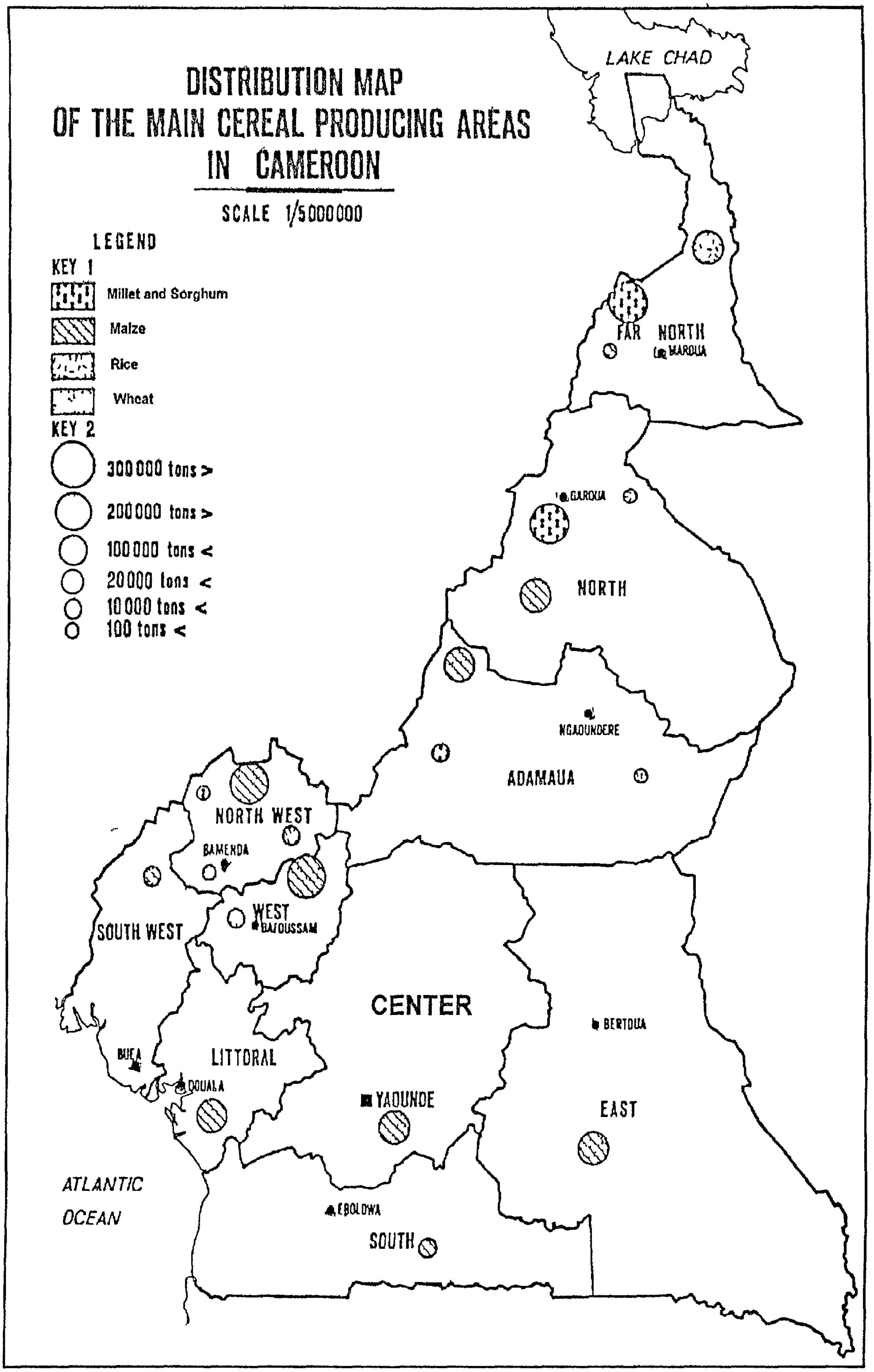
PPB continued to identify, localize, and to monitor the major diseases of sorghum, millet and maize in Cameroon Though less attention was given to sorghum, millet emphasizes were placed on screening maize genotypes from their resistance to the major pathogens (*Exerohilum turcium, Puccinia polysora, Sporisorium reliana*) Varieties such as CHC 201 (Kasai), Syn 4, COCA, CMS 8704, EC 573, ATP were tolerant to these diseases Though the personnel remained very limited, financial and technical support to the unit was better than in NCRE I and NCRE II More screening techniques need to be identifed Funds will be our major challenge We hope to identify sources of finances

Highland Cereals Entomology

During the period in review, the major maize insect storage pests in the Western Highlands were identified and the losses associated with at least four popular maize storage methods assessed through on-station experiments Two new grain storage insecticides (SOFAGRAIN and SUMUCOMBI) plus two old ones (Actellic and Permethrin) were screened and special reports including findings and recommendations were circulated The use of natural plant materials by peasant farmers for stored grain protection was identified to be fairly popular in many parts of the Western Highlands and studies to improve and increase their use are underway Rice field entomology received a fair attention following supplementary funding by WARDA in 1992 through intergrated pest management task force


THE 10 PROVINCES OF CAMEROON
SCALE 1/5 000 000
10
FAR NORTH
MAROUA
GAROUA
NORTH
NGAOUNDERE
ADAMAOUA
NORTH WEST
BAMENDA
WEST
BAFOUSSAM
SOUTH WEST
BUEA
LITTORAL
DOUALA
CENTER
YAOUNDE
EAST
BERTOUA
SOUTH
EBOLOWA


I R A INFRASTRUCTURE AND NCRE RESEARCH SITES
SCALE 1/5000000
DIRECTORATES
CENTERS
STATIONS
SUBSTATIONS
10°
KOUSSERI
GUETALE
MAGA
MAROUA
YAGOUA
MAKEBI
SOUCOUNDOU
TCHATIBA
SANGUERE
FIGNOLE
TCHOLLIRE
NDOCK
TOUBORO
NGAOUNDERE
SANTA
BAMBUI
BABUNGO
FOUNBOT
DCHANG
SANTCHOU
BELABO
BANGANGTE
KUMBA
LYSOKA
NJOMBE
BAROMBI-
KANG
BERTOUA
EKONA
NKOLBISSON
ABONG-MBANG
DOUALA
YAOUNDE
LA DIBAMBA
KRIBI
NKOEMVONE


DISTRIBUTION MAP
OF THE MAIN CEREAL PRODUCING AREAS
IN CAMEROON
SCALE 1/5000000
LEGEND
KEY 1
Millet and Sorghum
Maize
Rice
Wheat
KEY 2
300 000 tons >
200 000 tons >
100 000 tons <
20 000 tons <
10 000 tons <
100 tons <
LAKE CHAD
FAR NORTH
MAROUA
GAROUA
NORTH
NGAOUNDERE
ADAMAUA
NORTH WEST
BAMENDA
WEST
BAFOUSSAM
SOUTH WEST
CENTER
BERTOUA
BUEA
LITTORAL
DOUALA
YAOUNDE
EAST
ATLANTIC
OCEAN
EBOLOWA
SOUTH

1 ADMINISTRATION UNIT

1 1 INTRODUCTION

The Administration Unit consists of the Chief of Party, Deputy Chief of Party, Administrative Officer, and various support staff The goal of the Administration Unit is to ensure achievement of project objectives The administration's most important task is assisting researchers to accomplish the project's research and in-service training objectives This entails administrative support to researchers for housing, travel arrangements and necessary formalities with the Government of Cameroon, procurement of necessary supplies and equipment, management and disbursement of project funds, and hiring and supervising support personnel A particular responsibility of the Chief of Party is to review research work plans, methods and findings in order to ensure good performance of the technical assistance team and consistency with project objectives

Another important function of the Administration Unit is maintaining liaison among the sponsoring organizations IRA, IITA and USAID In this regard, the administration ensures timely and proper preparation of project reporting documents, including annual work plans and progress reports The administration also developed research and technical management procedures which not only meet project requirements but hopefully can serve as models for future use by IRA Long term training and procurement are two liaison and support activities which took less time than in the past As the project nears its end, increasing amounts of time are being devoted to ensuring smooth transition after phase out of IITA staff and publication and dissemination of project findings

1 2 OBJECTIVES

During the first 10 years of project activities the administration concentrated on addition of programs and streamlining administrative procedures for an increasing number of technical staff During the 1991-94 period emphasis was placed on phasing out expatriate staff and the takeover of existing programs by IRA researchers

A major focus of this period was to phase out expatriates and hand over research programs to national researchers Another objective was to coordinated program budgets with the phase out plan and with IRA objectives Program work plans and reports were modified to be compatible with IRA plans and reports

A second major focus was to extend research results to the extension service This was to be accomplished primarily through individual program field days and demonstrations The role of the administration was to develop a series of published pamphlets and bulletins outlining exendible research results

Long term training was a third major objective with the provision of funds for 12 graduate degree students Because the project was scheduled to end, these scholarships were provided with the limitation that all students had to be finished and returned to Cameroon before December 31, 1994 Therefore all training activities had an especially hard deadline to meet

1 3 CONSTRAINTS

The period 1991-1993 was an especially stressful period for NCRE researchers and administration During this period the project actively started to "phase-out" expatriate Technical Assistants and to reduce project financial support to levels judged to be sustainable by IRA Additional stress came from periodic strikes due to political unrest and lack of IRA salary payments The reduction of the IRA operational budget caused many other programs to reduce or halt their research activities It is a tribute to the IRA Cereals and Farming Systems researchers that their activities were not severely affected by these problems

1 4 ACCOMPLISHMENTS

Phase out of Expatriate Staff

A total of 15 expatriate staff were involved with NCRE during this phase of project activities Although a few staff left earlier than planned the transition to IRA researcher management went smoothly There was no appreciable change in unit activities other than that normally be expected by loss of an researcher Both the quality and quantity of research performed has remained high

Returning IRA researchers have been able to easily take over the leadership and administrative roles of their respective units They have assumed all activities including management of expenditures, supervision of field activities, management of research equipment and use of vehicles

Purchasing and Inventory

During the 1991-93 period the project depended entirely on a computerized inventory system to keep track of over 5000 items valued at $2 6 million in seven IRA stations in Cameroon Yearly verifications were made of all items with signature of inventory by the responsible researcher

NCRE initiated a purchasing sub-contract with Winrock International to handle all international purchasing During the period of this contract (2 years) 50 purchase orders were issued with a value of more than $700,000 Included in this total were 22 computers and 27 vehicles for project use All international purchasing was completed in 1992

As each expatriate staff left the IRA researcher concerned assumed responsibility for the equipment and supplies of the program Ownership of these items was then formally transferred from USAID to IRA and removed from the project inventory

Long Term Training

At the beginning of 1991 there were 7 students studying in the USA and Nigeria All these students were supervised by a USAID sub-contractor, PIET, in the USA All but one of these 7 students successfully completed their programs of study and returned to IRA in Cameroon during the 1991-94 period One continued to a PhD program under Winrock of these 7 students successfully completed their programs of study and returned to IRA in Cameroon during the 1991-94 period One continued to a PhD program under Winrock supervision An additional 2 students were enrolled at universities in the USA and Nigeria under direct USAID financing during 1991-94 Both have since returned to Cameroon and resumed their posts in IRA

In 1991 NCRE was given responsibiltiy for long term training A sub-contract was awarded to Winrock International for supervision of students in the USA Application for scholarships was limited to IRA researchers who had collaborated with NCRE for at least two years Successful candidates were nominated by a committee of IRA and NCRE TAs according to defined criteria Final nominations were made by the Minister of MESIRES A total of 12 scholarships were awarded All candidates successfully applied to, and were accepted to universities in the USA Each student was supervised by Winrock Inernational from their arrival to their departure from the USA At the time of this report all were progressing well with their programs

Project Paper Database

In 1993 a project technical paper database was established at Nkolbisson This attempted to collect in a central file at least one paper copy of all technical reports, conference presentations, refereed journal articles and program reports writeen by NCRE staff counterparts or NCRE supervised students Over 350 papers are listed and over 300 are currently in files Plans are being made to microfilm the entire collection and distribute it to libraries in Cameroon and West Africa This collection will be handed over to the IRA/IRZV library for cataloging and registration A condensed listing of the titles appears in the appendix of this report

1 5 CONSULTANTS

Dr Y Jeon visited Cameroon to start a post-harvest processing initiative between IITA and IRA He joined a USAID sponsored group that visited all regions of the country to evaluate the need for post-harvest research or extension He subsequently formed a proposal for backstopping the IRA post-harvest processing program His proposal was funded and implemented during the last months of the project

2 MAIZE RESEARCH UNIT

2 1 HIGHLAND MAIZE BREEDING

2 1 1 INTRODUCTION

The Highlands Maize Breeding Unit is responsible for the development of varieties adapted to improved and current farming systems between 1000m and above the mean sea level The target zones are mainly found in the North West, West and Adamaoua Provinces and include a large range of soil types and farm sizes The Western Highlands, comprising the North West and West Provinces, cover less than 10% of the land area in Cameroon, but contain 25% of the population, and produces over 60% of the national maize crop

The purpose of this report is to summarize the activities and results of the Highland Maize Breeding Program during Phase III (1991-1994) of the National Cereals Research and Extension Project (NCRE)

The goal of the unit during this period was to develop a comprehensive breeding program including both open pollinated and hybrid varieties During phase III, the unit has emphasized the testing of its germplasm which was able to provide new varieties

A maize streak virus screening facility was installed in 1991 at Foumbot and a new seed processing and storage facility was put into operation in April, 1993 at the headquarter of the unit at Bambui station

This period was characterized by increasing budgetary constraints, and the normal work schedule was often disturbed by IRA workers strikes and socio-political agitations

Since the departure of the T A Breeder in October 1992, the program is currently being led by National Counterparts One of them, I Tabi was transferred to Foumbot site in late 1992

2 1 2 OBJECTIVES

The objectives of the Highland Maize Breeding Unit during phase III were

1) Develop maize varieties (open pollinated and hybrid) which meet the requirements of farmers and the demands of the market in the Cameroon Highlands
2) Establish germplasm development strategies which will cyclically improve the varietal and line sources while producing a stream of new varieties
3) Maintain and provide foundation seed of released varieties to the seed multiplication and distribution organizations
4) Train counterpart scientists through an integrated program of on the job experience alternated with U S graduate degree studies and International Research Centers short courses
5) Train technicians through on the job experience or short courses

2 1 3 CONSTRAINTS

Constraints encountered during this phase may be classified as follow

Operating Funds

A crisis in operating funds which occurred in late 1986 continued during phase III Consequently, 50% reduction in the number of locations and plot sizes used for trials was necessary to overcome various budget cuts

Facilities

The two screen houses installed at Foumbot in 1991 were already out of use in 1992 due to the melting of the plastic roof at the contact point with the iron frame The drying and storage facilities are not fully functional at Bambui station Only one tractor is at this point operational at Bambui Station

Target environment

The major mid and high altitude maize growing areas were not well represented The Adamaoua Plateau, one of our most important sites, was completely cancelled in 1993 For the High altitude zone (>1500m) only one site was available

Varietal Constraints

Varietal constraints identified through the Testing and Liaison Unit (TLU) indicated a need for the following

- Late maturing, white and yellow flinty grain varieties with high yield and improved strorability
- Early maturing, white and yellow flinty grain varieties,
- Varieties resistant to poor environments (acid soils),
- Hybrids for medium and large farm scales

2 1 4 ACCOMPLISHMENTS

A comprehensive breeding system of germplasm improvement, variety formation, and variety testing, was well integrated in the program This system includes multilocational evaluation, both during germplasm improvement and final variety testing Only two Highland Provinces out of three were included in the testing in 1993, North-West and West Provinces

During phase III (1991-1994) several open-pollinated varieties confirmed their potential as releasable varieties in the mid-altitude zones The hybrid program has resulted in good and producible single cross varieties with a high yield potential for medium and large scale farmers A set of good inbred lines has been registered and new promising ones were identified and tested The best ones are available at breeder's level for release Population improvement continued in introduced source populations which serve as sources of inbred lines for hybrid and synthetic varieties

Germplasm development

Identify and develop source populations, improve and convert populations through selection and recombination were the objectives of the germplasm improvement program Population 32, Population 43SR and EMSR have been used as improved sources of new inbred lines for varietal and hybrid formation While the source population possess important characteristics (e g good plant type and flinty white grain for population 32, and earliness for EMSR) on which future progress can be based, budgetary constraints limited the effort that could be made on their improvement Substantial progress was made with the maize streak virus varieties improvement Converted varieties (Coca-SR, KASAI-SR, SYNTHETIC 3-SR, ATP-SR, SYNTHETIC 4-W-SR, SYNTHETIC 4-Y-SR and Early White-SR) proved to be better or equal to their non SR counterparts, and therefore would normally replace them Unfortunately, the SR genes incorporated into these varieties appears unfitted to the highland ecology of Cameroon due to the high streak incidence observed on the SR material when grown under heavy streak virus disease pressure Streak resistant screening under artificial infestation, planned for 1993 was not implemented due to deterioration of screen houses at Foumbot Nevertheless, the best EMSR S1 lines were selected and recombined as donors of the SR and earliness genes through a S1 family evaluation and selection process in order to improve the Early White SR Population

Two collections of local germplasm were evaluated at mid-altitude and high altitude level at Babungo (1100m) and Mbiyeh (200m) respectively None of the locally collected germplasm was declared satisfactory at mid-altitude level At the high altitude location of Mbiyeh where yield, earliness and resistance to *Phaeospheria* sp were the major traits under selection, two local varieties (Ndu White and Nkambe 1-white) were selected for their good yield performance and disease reaction

Specialty maize varieties were also under limited improvement From a small program of U U pop corn conversion to mid-altitude adaptation, three inbred lines (I28, SG32, SG1533) were selected to form single hybrid combinations and a pop corn synthetic variety A small program in sweet corn conversion to mid-altitude adaptation continued MSR-Sh, a very sweet type with poor germination was improved through germination tests The MSR-Su type has good germination but is less sweet MSR-Su lines were selfed and selected for minimum grain starch content Subsequent crosses with soft endosperm material, planned for 1994, should improved the grain quality

Varieties Testing

The objectives were to identify well adapted varieties for release to farmers or potential seed growers, and to test and assess introduced material The open-pollinated variety trials were a continuation of the mid-altitude National Variety Trials (NVT) reconstituted annually in Cameroon They were divided into an Early Set (NVT-MAE) and a late set (NVT-MAL)

In the mid-altitude zone, trials were sown at Foumbot (1000m), Nfonta (1300m), Babungo (1100m) Tibati (100m) and Mbang Mbirni (1100m) The NVT-high altitude trials sown at Mbiyeh (2000m) and Upper Farm (2000m) Mbang Mbirni, Tibati and Upper farm were discarded in 1993 cropping season

Results

NVT-MAL

In National Variety Mid-altitude Late trials, eighteen varietes were tested during three years over a total of 9 locations Synthetic 4 and ATP confirmed their potentialities as releasable varieties The split yellow and white versions of Syn 4-SR basically had the same performance as the original Syn 4 population, suggesting that the genetic base of the population was not altered by color separation KASAI-SR, ATP-SR, SYN4-SR-Y, SYN4-SR-W are the suggested open pollinated recommendations for mid-altitude zones, if no objections come from Testing and Liaison, and Pathology Units In compliance with the new variety naming system in the highlands, they will be known to public as CHC 201, CHC 202, CHC 203, and CHC 204 respectively in the pamphlets In acid and phosphorus fixing soil like Nfonta, ATP-SR and COCA-SR would be the best alternatives to the Syn 4 versions The mean grain yields of major varieties over three years are presented in Table 1 The varieties exhibited an appreciable level of stability with respect to major traits like days to 50% silk, ear height and yield The final decision on what to choose would then rely on agronomic traits like plant aspects, and ear rot scores based on the prevailing environmental conditions

NVT-MAE

The National Variety Mid-altitude Early was initiated in 1990 to test the earliness, yield and adaptation of Early White and Early MSR in comparison with the released varieties BACOA and KASAI The streak resistant versions of KASAI and EW were included in 1992 and 1993 respectively Results confirm the superiority of KASAI-SR (CHC 201) Early White was not significantly earlier than KASAI-SR Half-sib recurrent selection to improve earliness of the EW continues as well as other characteristics such as ear aspect and ear rot The commercialized Pioneer hybrid (PHB 3435) would not be a better alternative to KASAI-SR because of its weakness on husk cover and ear rot

NVT - HA

Of the two High altitude locations only Mbiyeh was operational in 1993 Entries in the trials were the following various cycles of the High Altitude Population (HAP), Pool 9 Synthetic, Ndu Local, Coca, Syn 4, and a Local check Yield, earliness and resistance to *Phaeosphaeria* sp were the major traits under selection

Results in Table 3 suggested a high incidence of *Phaeospheria maydis*, but that all the tested varieties with the exception of HAP C_0 show a good level of tolerance to the disease The local check outyielded the best improved entry HAP C_2, indicating that, there would be no need to recommend an improved variety at Mbiyeh But, this being one year and one site results, no strong conclusion could be drawn from it

Inbred Trials

Inbred trials were sown at two locations (Foumbot and Babungo) in 1992 and 1993 All the inbred lines identified as good parents for hybrid seed production have confirmed their potential as releasable materials The following inbred lines are available at Breeder's level for release 87036, 88069, 88094, 88099, 89182 89258, M131, 90323, 89274, Z28 and 90219 It is important to note that inbred lines are most of the time site specific (Location x Variety interaction significant at $P < 0.05$) and seed production should take it into consideration if the operation needs to be feasible

Hybrid Trials

Results indicated that this program has bred high yielding hybrids with good agronomic and grain characteristics 88069 x 87036, 88094 x 90219, 89258 x 89182, 88094 x M131, and 88094 x 87036 single cross hybrids have confirmed their performance in the midaltitudes The production information will soon be available in pamphlets under the names CHH 101, CHH102, CHH 103, CHH 104 and CHH 105 respectively Nevertheless, new inbred lines from the 1991 test-crosses showed high performance in crosses, but their stability still needs to be confirmed before they could be recommended Considering the location x interaction, CHH 105 would be recommended for Ndop Plains only, due to its good and constant performance in that area

Introduction and Evaluation

Light TZ (flint) from IITA and 6 IRA inbreds (floury) were evaluated for their reactions to rust (*Puccinia polysora*) and (*Exerohilium turcicum*) Forty eight crosses (floury x flint) from these lines were realized and evaluated in a preliminary trial Six inbreds (230, 2096, 2097, 5012, 9499, 9613) were tolerant to rust, 5 inbreds (74, 230,9432, 9499, 9613) were tolerant to blight Inbreds 9431, 9499, and 230 were tolerant to both diseases Cross (9432 x 273) outyielded all the others crosses with 5 3t/ha compared to Kasai 4 9 t/ha which was used as check The identification of lowland inbreds tolerant resistant to *P polysora* and/ or *E turcicum* opens goods avenues for the improvement of low and mid-altitude maize genotypes for their resistance to these diseases

Breeder Seed Maintenance and distrbution

The objectives were to grow breeder seed for purity and improvement, to monitor foundation seed production, and to provide seed to collaborators In phase III, hundreds of kilograms of breeder's seed of extended and yet to extend highland maize varieties have been produced in the different ear-to-row isolation plots and small quantities were available for research purposes Foundation seed of extended varieties under production went to extension services in West and some NGO's and MIDENO in North West province for multiplication purposes The varieties produced were CHC-201, CHC-202, CHC-203, CHC-204, CHC-205, COCA, EKONA WHITE and EKONA YELLOW

Four hybrids were produced for on-farm testing by TLU Under USAID and PNVFA (National Extension Program) requests, two special foundation seed plots were grown off-season at Foumbot and Bambui in 1993 The varieties produced were CHC- 201 (85ha) and CHC- 202 (0 5ha)

2 1 5 IN-SERVICE TRAINING

In phase III, NCRE has provided on-the-job, advanced degree, and short course training to IRA staff in the Highlands Maize Breeding Unit To the credit of IRA,they have all remained in the unit after their training The two most senior breeders, Jacob Eta-Ndu and Ndioro à Mbassa, have completed M Sc degrees in plant breeding at the University of Minnesota (USA), and Mr Eta-Ndu is currently working on a Ph D at the same institution The third scientist, Isidore TABI, was trained at IITA in hybrid maize germplasm in 1991, and in phytogenetic ressources in 1992 Three technician cycle graduates from Regional college of Agriculture, Lucas Fofe, Albert Nde and George Fotaw, joined the unit in 1990 Albert Ndea and Fofé Lucas have been to IITA, where they have been trained in maize technology transfer, and maize streak virus resistance screening respectively

In addition to on-the-job training of the above mentionned staff, five Bambui station workers assigned to the unit have become specialized in the activities of the maize breeding program, and form an integral part of the staff Of particular specialization, are John Mbossi for his management of field operations, and Benard Wanki for his management of seed stocks

2 1 6 PRIORITIES FOR FUTURE RESEARCH

Future progress in the program will directly depend on available operation funds and the quality of unit management The Highland Maize Breeding Unit should seek for new operation funds now that the NCRE Project has phased out Sub program priorities are listed below by order of retention from minimal to optimal funding levels

Variety Maintenance

Varieties being produced and distributed to farmers must be maintained and foundation seed delivered to the seed producers each year Selection pressure must be maintained to avoid genetic drift in agronomic characteristics, such as maturity, plant height, lodging, husk cover, and grain texture As a priority, one variety in each major category should be maintained Late white, early white, late yellow and early yellow for the midaltitude, and one white or mixed color for the high altitude zone Additional varieties with special characteristics (short plant type, specific adaption to acid or fertile condition, etc) can be maintained as resources permit Small quantities of these varieties have been sent to IITA and CIMMYT for long-term storage

Streak screening facilities

The roofing system of the screen houses should be re-built in accordance with Foumbot environmental conditions The unit will therefore still rely on outside cooperation to implement its streak virus resistant germplasm development program

Population improvement

Open pollinated populations, such as population 32, population 43 SR, EMSR and ATP, which serve as varieties or sources of varieties, can be improved at a faster rate than that obtained in ear-to-row selection by using more intense selection methods, such as half-sib family or S1 family recurrent selection across location with recombination of selections from remnant seed Inbreeding should be employed in improving disease resistance of these populations in selection for resistance to leaf blight (*E turcicum* and *E maydis*), rusts (*P sorghi*), *Phaeosphaeria* leaf spot (now observed in the high altitude zone), *Diplodia macrospora* leaf stripe, and streak virus

Inbred development

Systematic inbred development should continue, producing parents of hybrids and varietal synthetics Good inbred parental lines are now available in the Highland Maize Breeding Program, therefore a self sustaining (private sector) seed industry capable of producing and distributing high quality seed will be necessary

2 1 7 PLANS TO SUSTAIN RESEARCH EFFORT

To improve the efficiency of the Highland Maize Breeding Unit in developing varieties that can be extended to Cameroonian farmers, mechanisms need to be established, for deciding on varietal release, for seed certification and control, and for seed production Given the fact that research funds are limited or sometimes unavailable, adequate and urgent measures need to be taken to sustain research activities These measures include production constraints identification and research prioritization

Production constraints identification should continue through extension services of the Ministry of Agriculture in order to provide the necessary feed-back on traits on which future selection would be based

By carrying out a prioritization of research activities, scarce funds could be allocated more efficiently to various research operations

At the level of the unit, priority needs to be given, first to supply adequate information to the extension agents, in collaboration with the PNVFA, on the varieties that are released Second, adequate quantities of foundation seed should be supplied to selected private seed producers at a regular base The goverment needs to encourage seed production through the development of a private seed industry Third, mechanisms for a strict control of the seed multiplication process should be put into operation to insure the control of the seed quality and purity In order to achieve these goals, a seed production legislation needs to be instituted in Cameroon Fourth, HighLand Maize Breeding Unit should concentrate on improving and maintaining open-pollinated and inbred line varieties and consider minimizing variety development and testing Fifth, the unit must look for ways to generate funds to insure the maintenance of the acquired rich genetic stocks This could be achieved through many possible mechanisms including research grant applications, production of foundation seed to be sold to private seed producers, production of grain maize and specialty corns for the local market Consideration could also be given to charging a small fee for any consultation or service related to seed or grain maize production requested by a private producer

Table 1 Agronomic performance of Open-pollinated varieties in the late national variety trial, 1991-1993

Variety	Yield (t/ha) 1991	1992	1993	Mean	Plant Aspect (1-5)	Ear Rot (1-5)	Shelling %
Synthetic 4	7 6	9 3	7 8	8 2	2 1	2 3	79
MSR 89	7 1	8 6	-	7 8	2 3	2 4	-
ATP - 90	7 1	8 7	7 0	7 6	2 2	2 0	81
MSR 87	6 8	8 0	-	7 4	1 9	2 7	-
Synthetic 3	7 1	8 0	6 8	7 3	2 0	2 3	78
COCA SR	-	8 0	6 6	7 3	2 5	2 6	78
KASAI SR	-	8 6	-	-	2 0	2 6	-
Syn 3 SR	-	-	7 3	-	2 2	2 5	81
Syn 4 SR-Y	-	-	7 8	-	2 5	2 2	78
Syn 4 SR-W	-	-	7 8	-	2 8	2 6	80
ATP - SR	-	-	7 8	-	2 6	2 2	82
KASAI	6 8	-	-	-	2 0	2 6	-
Controls							
COCA[1]	6 5	8 0	4 6	6 3	2 8	2 6	77
Shaba[1]	7 4	8 4	6 2	7 3	2 4	2 5	78
ZS 206[2]	7 7	10 5	-	9 1	1 8	2 4	-
88069 x 87036[3]	-	-	9 4	9 4	2 2	2 0	73
Nber of locations	4	4	2	10	10	10	3

1 - Open pollinated variety checks
2 - Commercial hybrid check
3 - NCRE hybrid check

Table 2 Agronomic performance of Open-pollinated varieties in the Early National Variety Trial, 1991-1993

Variety	Yield (t/ha) 1991	1992	1993	Mean	Plant Aspect (1-5)	Ear Rot (1-5)	Days to 50% silk
Kasai - SR	-	8 7	4 9	6 8	1 9	2 4	69
Early White	7 1	7 5	4 6	6 4	1 9	2 7	66
Kasai	7 3	-	4 1	5 7	1 8	2 1	70
Early MSR	6 6	7 2	2 3	5 4	2 3	3 1	67
Early White SR	-	-	4 1	-	2 1	2 4	65
Controls							
Bacoa[1]	5 6	7 3	3 1	5 3	2 5	2 7	71
PHB 3435[2]	-	-	3 6	3 6	2 1	3 4	64
YIF 64 White[3]	-	-	4 3	4 3	2 5	2 7	66
Nber of Locations	3	4	2	9	9	9	9

1 - Open pollinated variety check
2 - Pioneer commercial hybrid
3 - Pioneer Experimental hybrid

Table 3 Agronomic performance of top yielding NCRE hybrids in Advanced Hybrid trials, 1991-1993

Variety	Yield (t/ha)			Mean	Plant Aspect (1-5)	Ear Rot (1-5)	% SYN 4
	1991	1992	1993				
88069 X 88091	9 6	10 3	-	9 9	1 9	2 2	124
88069 X 87036	10 2	10 7	8 1	9 7	2 0	2 3	121
89223 X 89258	9 5	9 4	-	9 4	1 6	1 8	117
88094 X M131	9.2	10 4	8 3	9 3	2 1	2 2	116
89258 X 89182	8 5	9 6	9 3	9 1	1 9	1 7	114
90219 X 88094	-	9 9	8 4	9 1	2 5	1 8	114
90251 X 88094	-	9 1	8 1	8 6	2 5	2 0	107
CONTROLS							
ZS 206[1]	8 6	9 6	-	9 1	2 1	2 7	114
PHB 3435[2]	-	-	4 4	-	2 3	2 4	-
SYN 4[3]	7 8	8 2	-	8 0	2 3	2 5	100
Nber of locations	4	4	2	10	10	10	

1 - Commercial hybrid
2 - Pioneer commercial hybrid
3 - NCRE Open-pollinated check

Table 4 Agronomic Characterisitics of to yielding inbreds in Inbred Trials in Cameroon, 1992-1993

Variety	Yield (t/ha)						
	1991	1992	Mean	Plant Asepect (1-5)	Ear rot (1-5)	Ear Aspect (1-5)	Days to 50% silk
88069	5 1	6 5	5 8	2 0	3 0	2 4	79
87036	4 3	7 0	5 7	1 7	1 9	2 0	78
M131	3 5	5 4	4 5	2 2	3 0	2 3	79
Z28	2 3	6 5	4 4	1 4	2 5	1 7	81
88094	1 9	6 3	4 1	2 0	2 2	1 6	78
89258	6 5	-	-	1 8	2 1	2 1	76
89182	5 1	-	-	2 4	3 1	2 1	75
88091		3 4	-	2 5	2 3	2 3	76
91298	-	2 7	-	2 4	2 [illegible]	2 6	80
302[1]	4 2	-	-	1 5	1 8	1 9	81
Nber of locations	2	2	4	-	-	-	-

1 - IITA inbred line

Collaborators and Visitors

Disease observations and inoculation of maize breeding trials were done in collaboration with the Pathology unit The Unit was part of maize diseases and pets survey team that worked in Center, South, Littoral, South West, West and North West Provinces of Cameroon in June 1993 One highland maize breeder visited on-farm hybrid trials in July 1993 to proudly assess and conclude that the mid altitude maize hybrids behavior in farmers' fields could be rated as good to very good

The Highland Maize Breeding Unit actively took part in two of the PNVFA workshops in West province in 1993 and explained some maize seed related problems to extension workers We also visited intended extension seed plots and met with potential seed producers in the West province Collaborative trials with IITA Jos Program, Pioneer-Harare and CIMMYT-Harare were successfully run in 1991 and 1992 The unit recently organized, in collaboration with Pathlogy and TLU Units of IRA Bambui as well as the provincial delegation for agriculture in Bafoussam and the center of agronomic research, (CRA) Foumbot the first part of the maize seed production training course in West province on the 7th and 8th of February 1994 in Bafoussam and Foumbot respectively The second part of the course will soon be held in Bamenda for participants from the North West province

VISITORS

- Dr Alix Paez, Research Director, Pioneer, USA
- Dr Osman Arikoglu, Regional Trial Coordinator, Pioneer Egypt
- Dr Mohamed Mostafa, Research Manager, Pioneer, Nigeria
- Dr Sarvesh Paliwal, Production Manager, Pioneer, Cameroon
- Mr Sunday Olojeday, Maize Entomology, IITA, Nigeria

2 2 LOWLAND MAIZE BREEDING

2 2 1 INTRODUCTION

Prior to 1991, the lowland breeding unit evaluated more than 10,000 genotypes for their adaptation to varying agro-ecological zones and various farmer requirements

In addition, the lowland breeding unit devoted lots of its efforts in developing materials with better adaptation to new stress much as Striga, drought, acid soil

By the end of 1990, the following accomplishments were made

1) Release of the following 12 varieties CMS 8501, CMS 8507, CMS 8509, CMS 8611, CMS 8704, Ndock 8701, CMS 8710, CMS 8806, CMS 9015, BSR 81, BSR Syn I, BSR Syn II
2) Varieties in the pipeline were Suwan I-W, NCRE synthetic late, NCRE synthetic early, and numerous hybrids
3) 3 heterotic pools formed
4) Inbred lines trait donor source identified
5) Formation of specific pools tolerant to various stress such as striga, acid-tolerant, disease resistant

From 1991 to 1992, the program cut down on the number of introduced genotypes Emphasis was put on varieties already in the pipeline and great efforts were devoted in improving the 3 heterotic pools by reciprocal full-sib selection

Finally, starting in 1991, new materials from the Cameroon mid-altitude program were used by the program Preliminary results showed high complementarity between germplasm from both programs

2 2 2 OBJECTIVES

The ultimate objective of the program is to improve the maize farmer's well being To achieve this, the unit has as a related objective, to develop high yielding and stable varieties and or hybrid adapted to diverse farmers requirements in each of the various lowland zones of Cameroon Additional objective is the development of varieties suitable to industrial uses such as beer, animal feed or human, and snack foods

Important selection criteria includes the following

* High grain yield potential
* Days to maturity
* Grain color and texture
* Resistance to disease and pest (streak, borer, striga)
* Tolerance to abrotic stresses(drought, acid-soil, Zn deficiency)
* Grain quality(sweetness, soft and hard endosperm)

2 2 3 CONSTRAINTS

The main constraints encountered are

- Poor soil fertility
- Erratic rainfall pattern in Savanna
- Poor drying facility
- Frequent breakage of the cold storage room
- Lack of support staff
- Untimely availability of funds and research equipment and funds
- Limited research equipment
- No driver for the Unit

2 2 4 ACCOMPLISHMENTS

I Germplasm introduction

From 1991 to 1993 the unit introduced and evaluated 668 new germplasms This represented a reduction of 93% from the number introduced from 1986 to 1990 His reduction is partly due to financial constraints of the unit but also it's mainly due to the fact that the program has already tested and identified most of the available world maize populations

Germplasm introduction is to identify adapted materials that could be released as is or with some minor modification of materials with traits needed in the breeding program

The following varieties were selected from introduction

- TZEE-W-SR Extra-early maize from SAFGRAD maturing in 82 days and adapted to Soudan Savanna zone
- TZE comp 3x4 An early white good yield potential and disease resistance
- IRAT 374 and pioneer, Yog 64, Yog 66 all of which are hybrids with good yield potential
- Dr Synt, MAKA SR, DR-SR-Wz, DR-SR-Y_1 are all varieties from IITA good potential for drought tolerance
- Tomboritsa, Hp04, Dr 1066 were identified as having potential for acid-soil tolerance

II NCRE Varieties and Hybrid Testing

From 1991 to 1993, the unit developed and evaluated 2343 varieties The trial names and numbers evaluated are shown in table 2 for each year The number of varieties developed and evaluated increased from 536 in 1991 Results obtained from their evaluation allowed for selection and for retesting the following years At the end of 1993, 144 varieties and hybrids are in the pipeline of the release pathway

During testing the following varieties distinguished themselves,

- Maroua 90 Pool 16 Dt(early white drought tolerant varieties)
- SYN E_2 early white striga tolerant varieties
- CMS 9213 which is the white version of CMS 8704
- NCRE SYN_2, first white high yielding varieties issued from the herotic pool
- 8321-18x Exp_1 24 the best 3 way white crosses
- HLM 5 x NCRE gp_2 8(88094 x NCRE gp_2 8) the best white single cross issued from crosses between mid-altitude and lowland program
- 9021-18 x Exp_1 7 the best striga tolerant variety

The summary advanced trial in Savanna zone (table 5) as well as in Forest zone (table 6) revealed a significant zone variety interaction as well as variety x location within zone interaction From the stability point of view the CMS 8501 and CMS 8507 remained the recommended white varieties for both zones and CMS 8704 a very popular yellow is still recommendable in both zones

III Population Improvement

The unit is currently working in 17 populations Those populations are used to derive trait donor sources for the following constraints striga, drought, acid-soil, streak vips, and Borers to minor extent A total of 145 families and or populations have been evaluated from 1991 to 1993(table 3)

The objective was

1) To develop new varieties with improved plant characteristics such as a plant height, and disease tolerance
2) To improve by recurrent selection the varieties as a trait donor source ie striga pool, Busseola pool and grain yield At the end of 1993, the following has been accomplished

1- improvement by half-sib selection of all released varieties
2- improvement by reciprocal recurrent selection of the 3 herotic pools
3- identification of varieties and hybrids with some tolerance to striga, drought and acid-soil

IV Lines or Families Development

Line extractions were performed on 18 populations listed in table 4 Prior to 1991, the breeding of those populations were measured Currently 1131 line and families are being evaluated for

i) their combining ability
ii) their value as trait donor source lines with best breeding value has been used in population improvement as shown in part III

IV <u>Breeder and Foundation Seed</u>

Seeds of all major varieties are annually maintained due to frequent break downs of the cold storage facilities At the end of 1993, the estimated seed request is around 14 tonnes of foundation seed and 20 tons of certified seed for the following varieties, CMS 8704, CMS 8501, CMS 9015, CMS 8806 and hybrid

Because of the lack of a sound seed production unit, the unit has produced and distributed over 10 tons of seed between 1991 and 1993 In addition some seeds have been produced by farmer under the TLU and breeding unit

2 2 5 IN SERVICE TRAINING

Two casual laborers, Mr BEYEGUE Jean and Mr ASHU TAMBE were on the job trained to technician level

In Savanna zone, Blaise MONGMONG an Ingenieur agronome was sent to IITA for training in computer utilization Mr Jean FAKREO received training in maize pollination in Nkolbisson and Mr HOUNWA Anatole was sent to IITA for training in striga research Finally, Mr Celicard ZONKENG went to IITA for an orientation tour and for training in striga work

2 2 6 PRIORITIES FOR FUTURE RESEARCH

- Breeding for tolerance to striga, drought, acid soil
- Breeding for low input technology
- Improvement for herotic pool development
- Hybrid development
- Special quality maize development (popcorn, sweetcorn, maize for brewery)

Table 1 Trial names and origin of introduced varieties from 1991-1993

Trial names	Origin	1991	Entries 1992	1993	TOTAL		
1 EVT - LSR-W	IITA	12	13	25	4		
2 EVT - LSR-Y	"	9	9	18	5		
3 EVT - ISR	"	10	10	20	5		
4 EVT ESR	"		11				
5 TZL COMP 3 COTC	"	169	-	180	5		
6 TZE COMP 4 C T C	"	200	-	200	5		
7 International white hybrid	"	14	12	28	8		
8 International yellow hybrid	"	9	8	17	6		
9 Striga observational O P	"	12	10	22	3		
10 Striga observational hybrid	"	10	10	20	3		
11 R U V T extra early	SAGFRAD	10	10	10	30	9	
12 R U V T early	"	14	15	14	43	9	
13 Pionners hybrids	U S A	15	33	-	48	7	
14 Amul 92 French hybrid	CIRAD	-	-	20	-	-20	2
TOTAL		484	160	246	668	(73)	

Table 2 IRA/NCRE Trial evaluated from 1991-1993

Trial names	1991 entries	nber	1992 entries	nber	1993 entries	nber	TOTAL entries	nber
1 Commercial trial (C H)	-	-	-	-	10	8	10	8
2 N V T (E)	15	17	18	15	17	11	50	43
3 N V T (L)	18	19	19	15	19	11	56	45
4 N H T	19	11	18	13	20	8	57	32
5 NCRE Single crosses(W)	62	20	37	16	18	8	117	44
6 NCRE Single crosses (Y)	24	7	41	(4)	39	10	104	21
7 Tester single crosses	166	11	102	10	35	8	303	29
8 Highland x Lowland	53	4	349	(8)	134	(13)	536	25
9 EVT NCRE	31	(4)	20	6	18	7	69	17
10 Laposta x Lowland	82	(4)	80	8	17	3	179	15
11 Three-way crosses	-	-	40	3	507	24	547	27
12 Four-way crosses	-	-	-	-	68	(4)	68	4
13 MIR Single crosses	66	2	44	3	-	-	110	5
14 Diallel Highland x Lowland	-	-	-	-	123	6	123	6
15 On farm forest					10	3	10	3
16 On farm Savanna					4	20	4	20
TOTAL	536(99)		768(101)		1039	(144)	2343	(344)

Table 3 Population improvement

Trial names	1991		1992		1993		TOTAL	
	entries	nber	entries	nber	entries	nber	entries	nber
Striga population			4	4	6	6	10	10
Striga white pool	51	1	-	-	12	2	63	3
Striga yellow pool	14	1	36	4	22	2	72	7
Striga open pollinated	-	-	36	4	18	6	54	10
Striga diallel	-	-	76	3	-	-	76	3
Striga single crosses	-	-	-	-	100	4	100	4
Drought trial	96	(8)	42	4	129	6	267	18
Acid tolerant	35	4	33	4	108	2	176	10
Busseole trial	84	(2)	-	-			84	2
Hetoretic pool	-	-	-	-	161	9	161	9
Half-sib improvement	12	12	13	13	13	13	38	38
Streak conversion					44	4	44	4
TOTAL	292	(28)	240	(23)	613	(41)	1145	(92)

Table 4 Number of lines or families developed and evaluated

Populations	1991	1992		1993	
	Selected	Tested	Selected	Tested	Selected
TZB test crosses	240	373	177	177	64
Suwan I test crosses	360	355	158	158	63
Crosses test crosses	160	77	25	25	14
Mid-altitude	11	41	40	40	9
Laposta line	20	80	60	151	151
DMR-LSR-W	107	50	50	107	107
Pionneer	43	43	43	43	43
Pop 28 DMR LSR-W	107	107	107	108	108
TZUT	48	102	64	64	22
French pop	37	37	37	49	49 *
Busseola lines	84	84	84	174	55
Acid tolerant	35	108	108	108	57
MIR	66	-	-	-	-
Suwan I white	-	-	-	109	109
Striga inbred	260	129	129	129	105
Popcorn	-	-	-	159	159
Experiment 1, 2, 3	19	18	10	10	5
NCRE group[1],group[2], group[3]	62	37	18	18	11
	1659	1641	1110	1629	1131

Table 5 Summary N V T Late savanna from 1991-1993

	Varieties	Mean grain yield locations			
		1991	1992	1993	Means
1	CMS 8501	5 9	4 7	3 9	4 8
2	CMS 8507	6 1	4 7	4 3	5 0
3	CMS 8704	5 8	5 2	3 9	5 0
4	CMS 8710	6 1	4 6	-	5 4
5	Ndock 8701	6 2	4 6	3 8	4 9
6	Yaounde 8701	5 7	?	4 1	4 9
7	CMS 9213	6 7		3 4	5 1
8	832-18	6 9	5 3	4 4	5 5
9	EU 8722	6 4	?	3 0	4 7
10	EU 8843	5 9	4 1	4 0	4 7
11	TZPB SR	6 3	?	3 8	5 1
12	8321-18 x Exp[1] 24		5 0	5 0	5 0
13	" x Exp[3] 7	7 0	5 5	3 6	5 4
14	" x Exp[1] 42	6 8	5 1	3 6	5 2
15	Yog 64	6 8	?	-	6 8
16	Yog 66	6 8	4 8	-	5 8
17	Yog 67				
18	HLM 5 x NCRE gp[2] 8			5 5	5 5
19	9071 x NCRE gp[2] 3			3 8	3 8
20	9071 x NCRE gp[2] 8		5 6	4 9	5 3
21	9071 x NCRE gp[2] 45			4 0	4 0
22	NCRE Syn[2]			4 3	4 3
23	8321-18 x Exp[3] 10		5 6		5 6
24	Yog 62	6 2			6 2
25	TZUT	5 6			5 6
26	TZB SE	2 8			2 8

Table 6 Summary of N V T Late forest from 1991-1993

Varieties	Mean	grain	yield	locations
	1991	1992	1993	Means
1 CMS 8501	7 2	6 9	6 1	6 7
2 CMS 8507	7 0	6 9	6 2	6 7
3 CMS 8704	6 8	6 8	6 4	6 7
4 CMS 8710	-	6 4	-	6 4
5 Ndock 8701	6 6	6 8	5 7	6 4
6 Yaounde 8701	6 3	5 0	5 7	5 7
7 CMS 9213	7 4	-	6 2	6 8
8 8321-18	6 2	6 8	6 8	6 6
9 8321-18 x Exp[1] 24		7 6	7 0	7 3
10 " x Exp[3] 7	7 0	5 5	3 6	5 4
11 " x Exp[1] 42	6 8	5 1	3 6	5 2
12 EV 8722	6 8	6 0	4 8	5 9
13 EV 8843	6 6	6 3	6 2	6 4
14 TZPB SR	6 6	6 1	6 1	6 3
15 Yog 64	7 3	6 9	-	7 1
16 Yog 66	7 4	7 3	-	7 4
17 Yog 67			-	
18 HLM 5 x NCRE gp[2] 8			7 7	7 7
19 9071 x NCRE gp[2] 3			6 9	6 9
20 9071 x NCRE gp[2] 8			6 8	6 8
21 NCRE Syn[2]			6 7	6 7
22 9071 x NCRE gp[2] 45			6 1	6 1
23 Yog 62	7 4			7 4
22 TZUT	6 4			6 4
23 TZB SE	6 2			6 2

3 RICE RESEARCH UNIT

3 1 RICE BREEDING

3 1 1 INTRODUCTION

The overall mandate of the rice research Unit in Camerooon is to improve on the quality of existing germplasm either by selecting from introductions sent by the International Network for Genetic Evaluation of Rice (INGER-Africa), the West Africa Rice Development Association (WARDA) or from other National Agricultural Research Systems (NARS), to mention just a few

In 1991 rice research activities were focused on varietal improvement through the development and maintenance of high and stable yielding rice varieties for release to farmers, along with investigations aimed at determining the effect of management levels on cost of cultivation and yield performance of promising cultivars Trials were conducted at the main production sites of Maga/Yagoua in the Far North Province, Lagdo in the North Province, Mbo Plain in the West Province and Ndop Plain in the Northwest Province where the Society for the Expansion and Modernization of Rice production in Yagoua (SEMRY), Projet Lagdo, Society for the Development of Rice production in Mbo Plain (SODERIM) and the Upper Nun Valley Development Authority (UNVDA) are respectively located

In 1992, the mandate to improve the quality of existing materials remained a priority together with accompanying agronomic packages In addition to the sites mentioned in 1991, Bokle in Garoua went operational for Upland and Lowland rainfed rice

In 1993, the rice research Unit's goals remained the same with a view to getting the farmers more involved In the Northwest Province, activities intensified in the Menchum Valley Region

However, the major goal over the past three years has been focused on the development of new, high and stable yielding agronomically improved rice varieties with better grain characteristics, with tolerance or resistance to the major diseases such as blast, sheath rot, leaf blight, glume discoloration and to environmental stresses such as low temperatures prevailing during the growing season or drought for the upland/rainfed ecologies

Hundreds of lines have been introduced and widely tested and many have been identified as breeding lines and some recommended for cultivation in each production zone

3 1 2 OBJECTIVES

The major objective of the rice Unit is precise in that varieties superior to those already recommended need to be developed for the parastatal irrigated rice development projects and for the traditional peasant farmers who cultivate both irrigated and upland rice

Activities undertaken in order to achieve project objectives, therefore, include the following

* Development of suitable rice varieties for the different rice growing areas in Cameroon
* Assist in the extension of improved varieties to farmers
* Assist in institutional development
  - Manpower
  - Physical facilities

* Establish linkages with international and national organizations

3 1 3 CONSTRAINTS

Rice production, extension and research activities in Cameroon encounter certain problems which prohibit the much desired high level of efficiency required Constraint analysis carried out under irrigated and upland conditions in the Extreme North, North, Northwest and West Provinces unfolded the following

Biological Factors

Inadequate number of suitable varieties with

- High and stable yield potential
- Resistance to local diseases such as
  - Leaf and neck blast
  - Sheath rot
  - Leaf scald
  - Brown spot
  - Bacterial leaf blight

- Short/medium cycles
- Resistance to lodging
- High milling recovery
- Tolerance or resistance to low temperature, hot, dry and dust laden wind
- Adaptation to low sunshine hours especially in the Western high lands (Mbo Plain)
- Tolerance to imbalanced soils
- Good grain properties

Natural Factors

- Vagaries of weather e g cold, hot, dry, dust-laden winds, cloudiness, rainfall intensity and distribution
- Low soil fertility and erosion

Infrastructure Factors

- Inadequate infrastructural development for rice research and production
- Poor storage, processing and marketing
- Inadequate irrigation, soil and water management systems

Technological Factors

Inadequate application of inputs (e g fertilizer, pesticide etc) due to high cost

Management and Labour Factors

Inadequate trained manpower for research, extension and production
Non-availability of adequate labour especially at peak farming periods at some sites notably Mbo and Ndop Plains

The above outline reviews a series of production constraints in the rice sector It suggests, among other factors, that biological and climatic conditions have affected grain quality over the years It is clear from the results that constraints in the North and Far North Provinces are less severe than in North West and West Provinces

3 1 4 ACCOMPLISHMENTS

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
Operation 1 Screen germplasm of local and exotic sources for release as variety or as donor in hybridization program, and select new lines from segregating populations		
1 1 Identify varieties for future yield testing or later use in the breeding program	1 1 Fifty seven new irrigated cold tolerant (IRCTN) lines were tested in Ndop Plain and 250 accessions (AURON + AURPSS) were screened in Mbo Plain under upland conditions	1 1 Seven lines were selected out of 106 lines tested in the cold tolerant Nursery in Ndop (IRCTN, 1991), and 29 selections from AURON and 44 from AURPSS at Mbo Plain under Upland conditions
1 2 Development of new locally created lines in Mbo and Ndop Plains	1 2 868 F_4-F_5 segregating lines from Ndop Plain and Dschang underwent pedigree selections under irrigated conditions in Ndop Plain and 59 F_4-F_5 segregating populations under upland conditions in Mbo plains	1 2 Over 110 lines from F_4-F_5 segregating progenies and 18 segregating populations were selected for further evaluations in Ndop and Mbo Plains respectively

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
Operation 2 Assess yield potential and test adaptability at different locations		
2 1 Promising lines for breeding and for future use as variety per se	2 1 Fifty eight irrigated varieties irrigated in Ndop Plain and 80 Upland lines in Mbo Plain were tested in observational yield trials	2 1 Twenty two irrigated in Ndop Plain and eleven Upland lines in Mbo Plain were selected from observational yield trials
2 2 Selections for advanced yield varietal trial	2 2 Sixteen irrigated varieties in Ndop Plain and 16 Upland varieties in Mbo Plain were compared in replicated varietal trials	2 2 Eight irrigated selections in Ndop and 5 upland selections in Mbo were evaluated in advanced yield trial in 1992
	2 3 In Yagoua, 7 medium duration varieties were compared with the existing IR46	2 3 CICA8 and ITA212 outyielded the local IR46
2 4 Confirm adaptability and suitability of elite lines	2 4 Twelve irrigated promising or recommended varieties from Ndop Plain, Mbo Plain, Lagdo and Maga were tested in a national coordinated trial in Ndop Plain	2 4 The locally grown IR7167-33-2-3 followed by Tox3145-34-3-2 outyielded all other varieties across locations
Operation 3 Assess the yield potential of elite varieties under farmers' conditions, and assess the farmers choice		
3 1 Evaluate the adaptability, yield potential of promising selections under farmer managed conditions	3 1 Two sets of 5 promising varieties were replicated in large plots in 10 farmers' fields under irrigated conditions in Ndop Plain and in the Mentchum Valley	3 1 IR7167-33-2-4 and Tox3145-34-3-2 were most preferred ITA212 and CICA8 were also chosen as preferred varieties

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
	Maroua/Garoua (1992)	

Operation 1 Varietal Improvement for High and Stable Yields in North and Far North Provinces

1 1 To identify useful germplasm for irrigated and rainfed conditions in various ecologies	1 1 African Irrigated Rice Preliminary Screening Set (AIRPSS)	1 1 Twenty entries were selected for yield trials
	1 1 1 African Upland Rice Preliminary Sreening Set (AURPSS)	1 1 1 A total of 21 entries were selected out of 150
1 2 To assess the yielding ability of some agronomically suitable selections	1 2 African Irrigated Rice Observational Nursery (AIRON)	1 2 Fourteen entries were selected for replicated yield trials
	1 2 1 African Upland Rice Observation Nursery (AURON)	1 2 1 Nineteen entries were selected from 96 genotypes
	1 2 2 Segregating Population Observational Nursery (SPON)	1 2 2 Seventeen entries were selected
	1 2 3 Fixed Lines Observational Nursery (FLON)	1 2 3 Twenty four of the lines were pre-selected for yield trials
1 3 To compare the performance of some promising genotypes under lowland rainfed, upland and irrigated conditions	1 3 African Irrigated Rice Advanced Trial (AIRAT)	1 3 Six genotypes were retained for further testing
	1 3 1 Irrigated Lowland Observational Yield trial (ILOYT)	1 3 1 Twelve genotypes were pre-selected for further testing

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
	1 3 2 African Upland Rice Advanced Trial (AURAT)	1 3 2 Twenty five genotypes will be advanced to elite varietal trial
	1 3 3 Replicated Yield Trial-Early (RYTE)	1 3 3 Will be repeated to confirm selections
	1 3 4 Replicated Yield Trial-Medium (RYTM)	1 3 4 Need to be reconfirmed
	1 3 5 Rainfed Lowland Observational Yield Trial (RLOYT)	1 3 5 Seven out of 20 entries were preselected on basis of plant phenotype
1 4 To compare the suitability and performance of some elite genotypes in large plots (irrigated, lowland and upland conditions)	1 4 Elite varietal trial in Yagoua/Maga	1 4 Most of the elite varieties yielded 6t/ha and above notably ITA212, IR46, IR35366
1 5 To multiply breeder seed of some elite varieties by ecological zone	1 5 Seed multiplication of elite line on plots above 1000 m^2	1 5 Elite varieties were multiplied on a total of about 1 5 ha in Lagdo and Bokle

MBO/NDOP PLAINS (1992)

Operation 1 Varietal improvement for High Stable Yields in Western Highlands and Mid-altitude regions of the West and North-West Provinces

1 1 Identify useful exotic germplasm in rainfed and irrigated conditions	1 1 AIRPSS	1 1 Twenty seven entries were selected for further testing
	1 1 1 AIRON	1 1 1 Twenty seven entries were selected for observation Yield Trials (OYT)
	1 1 2 AIRAT	1 1 2 Five out of 18 entries were selected for further testing

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
1 2 Assess the yielding ability of some agronomically suitable selections from previous years	1 2 OYT	1 2 Out of 120 entries tested in Mbo Plain, 20 were selected for further testing In Ndop Plain, out of 61 entries none was superior to the local check
	1 2 1 Preliminary Yield Trial (PYT) and Advanced Yield Trial (AYT)	1 2 1 Out of 12 irrigated lines in PYT, none was selected Four out of 12 AYT lines were retained for further testing
1 3 Confirm adaptability and suitability of elite lines	1 3 National Coordinated Varietal Trial (NCVT)	1 3 IR7167-33-2-3 widely recommended in Ndop outyielded all test entries in 1992
Operation 2 Screen Germplasm of Local and Exotic Sources for Release as Varieties or as donors in Hybridization Program and Select Head Lines from Segregating Populations		
2 1 Development of newly created local lines	2 1 Segregating population	2 1 Out of 168 F_3/F_6 upland lines, 35 were selected for further testing in OYT in Mbo Plain In Ndop Plain 40 were selected out of 155
2 2 Seed production	2 2 Breeders' seed production (head row selection)	2 2 Ten varieties in Mbo Plain and seventeen in Ndop were used to produce head rows after purification
Operation 3 Screen Germplasm from International Institutes for Regional Constraints		
3 1 Screen varieties adapted to low temperatures	3 1 OYT of previous selections	3 1 Five out of 10 cold tolerant entries were selected for yield testing
3 2 Screen varieties for tolerance to blast	3 2 International Rice Blast Nursery (IRBN)	3 2 Six out of 160 entries were selected for OYT

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
	3 2 1 Selection of fixed population	3 2 1 Twelve entries out of 50 from WARDA leaf and Neck Blast and 14 out of 60 were also selected from the Leaf and Panicle Blast Nursery (LPBN) for testing in 1993 OYT
3 3 Screening varieties for yield and stress	3 3 Special Yield and Stress Trial (SYST)	3 3 Twenty out of 100 lines screened for yield, drought, blast and plant type showed satisfactory performance

NORHT/FAR NORTH (1993)

Operation 1 Varietal Improvement

1 1 Screen exotic germplasm for irrigated conditions	1 1 1 African Irrigated Rice Preliminary Screening Set (AIRPSS)	1 1 1 Ten out of 150 entries were selected for further tests in observational yield trial (OYT)
	1 1 2 African Irrigated Rice Observational Nursery (AIRON)	1 1 2 Eight out of 100 entries were selected for further testing
	1 1 3 African Irrigated Rice Advanced Trial (AIRAT)	1 1 3 This was accomplished Selected entries slightly outyielded the local check but the difference was not statistically significant
1 2 Screen exotic germplasm for upland conditions	1 2 1 African Upland Rice Preliminary Screening Set (AURPSS)	1 2 1 Twenty two entries were selected as short duration varieties including the two local checks Fourteen entries were selected as medium duration types

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
	1 2 2 African Upland Rice Observation Nursery (AURON)	1 2 2 Twenty two entries out of 100 were selected including the two local checks
	1 2 3 African Upland Rice Advanced trial (AURAT)	1 2 3 This was accomplished Selected entries with yields slightly over 4000 kg/ha will be tested as elite lines during the next growing season
1 3 Assess adaptation of elite material	1 3 1 National Coordinated Varietal Trials	1 3 1 This was carried out as a coordinated rice evaluation trial (CRET)
	1 3 2 Multi-location trial for SEMRY production units	1 3 2 Elite varieties including the local check were tested on farmers field
1 4 Overcome deficiencies of lines or varieties, and select donors for line improvement	1 4 1 Segregating Population Observation Nursery (SPON)	1 4 1 Ten out of 50 F_2 were selected for their phenotype, resistance to local stresses and uniformity in the field
	1 4 2 Fixed Lines Observation Nursery (FLON)	1 4 2 Advanced generations were selected based on plant phenotype and uniformity in field
	1 4 3 Replicated Yield Trials	1 4 3 Both early and medium duration varieties were tested
	1 4 4 Hybridization	1 4 4 Parents were nominated for crosses to be done in Bouake

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
Operation 2 Maintenance and seed multiplication		
2 1 Pure seed for on-farm trials and national programs	2 1 1 Seed multiplication (Bokle and Lagdo)	2 1 1 At Bokle IRAT112, ITA257, Cisadane, ITA222, ITA212 and CICA8 were multiplied on $50m^2$ plots per variety In Lagdo, ITA300, BKN7033 and IR46 were multiplied on plots of 2500 m^2
	2 1 2 Seed multiplication (Yagoua and Maga)	2 1 2 IR46, AD9246 and ITA212 were multiplied at Maga
Operation 3 Cultural Practices and Soil Management		
3 1 Improve cultural practices for rice	3 1 1 Transplanting dates for elite varieties	3 1 1 Transplanting of rice during the rainy season has best been done between June 15 and July 30
3 2 Improve and sustain soil fertility in rice-based land use systems	3 2 1 Management of rice straw	3 2 1 Rice straw was used as compost in Maga
	3 2 2 Soil nutrient analysis of rice-based land use systems	3 2 2 Results are still awaited from Cornell University
	3 2 3 Seeding rate for Crotalaria	3 2 3 Enough seeds of *Crotalaria caricia* have been multiplied and will be used next growing season as green manure in rice plots
	3 2 4 Improve P efficiency with organic matter	3 2 4 Phosphate uptake will be determined on plots sown to Crotalaria

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
Operation 4 Post harvest losses and transformation		
4 1 Reduce post harvest losses	4 1 1 Method for field storing of unthreshed paddy	4 1 1 A survey on farmers' fields in Maga and Lagdo indicated that upright stacking of rice panicles was better than laying panicles flat in the field
4 2 Transformation of rice into consumable forms	4 2 1 Processing broken rice into flour	4 2 1 ITA300 and BKN7033 are being tested as potential rice flour sources

DSCHANG (MBO AND NDOP PLAINS/MENCHUM) (1993)

Operation 1 Varietal Improvement for high and stable yield		
1 1 Screen exotic germplasm for local stresses	1 1 1 International Rice Cold Tolerance Nursery (IRCTN)	1 1 1 Twenty entries from 1991 IRCTN and selections from Mbo Plain were tested
	1 1 2 Upland Observational Nursery	1 1 2 Fifteen entries and 80 lines were introduced and tested for leaf scald and other stresses Two entries and 20 lines were selected for further testing
	1 1 3 Upland Advanced Trial	1 1 3 Fifteen entries were tested in PYT Their yielding ability will be further assessed in AYT-1994
	1 1 4 Upland Preliminary Screening Set	1 1 4 Out of 120 entries screened for tolerance to blast, 15 were selected

OBJECTIVES	ACTIVITIES	ACCOMPLISHMENTS
1 2 Evaluate the yielding potential of promising varieties	1 2 1 Observational Yield Trial (OYT)	1 2 1 Sixty-six upland and 55 irrigated varieties were evaluated 20 upland varieties were selected Irrigated varieties are yet to be selected
	1 2 2 Preliminary Yield Trial (PYT) irrigated	1 2 2 Twelve entries were tested in a PYT in Ndop Plain 3 TOC lines outyielded the local check TOX3145-33-2-3
	1 2 3 Advanced Yield Trial (AYT)	1 2 3 In a replicated yield trial, 5 varieties outyielded the local check IR7167-33-2-3
1 3 Assess adaptation of elite material	1 3 1 National Coordinated Varietal Trials (NCVT)	1 3 1 The Traditional N C V T was conducted, Cisadane and the Newly adopted TOX3245-34-3-2 did better than IR7167-33-2-3
	1 3 2 Coordinated Rice Evaluation Trial (CRET)	1 3 2 In a C R E T ITA300 had good yield and was well accepted by farmers in the Menchum Valley
Operation 2 Seed maintenance and production		
2 1 Maintenance genetic purity and produce breeder's seed	2 1 1 Germplasm Conservation	2 1 1 Ten irrigated and 10 upland varieties were preserved in a germplasm conservation Nursery in Mbo Plain
	2 1 2 Produce breeder seeds	2 1 2 Breeder seeds of 200 recommended varieties from Ndop and Mbo Plain were produced

Table 1 Performance of Varieties from Replicated Yield Trial Early Duration at Bokle 1993 Wet season

Varieties	Plant ht (cm)	50 % Flowering (days)	Tiller No (m^2)	Grain Yield (kg/ha)
WAB33-25	133	71	171	5363 A
IDSA46	106	70	261	5332 A
WAB99-14	134	71	219	5272 AB
WAB56-50	125	69	208	5249 AB
WAB96-36	123	72	203	5195 AB
WAB96-44	118	70	240	4912 ABC
WAB99-5	119	70	235	4826 ABCD
WAB96-9-1	134	70	160	4811 ABCD
WAB181-18	124	70	176	4800 ABCD
CNA6656	123	80	128	4749 ABCDE
WAB56-39	123	71	235	4660 ABCDE
WAB96-10	131	69	235	4619 ABCD
WAB96-8-1	110	70	181	4521 ABCD
M-55	147	86	176	4515 ABCD
WAB99-17	132	70	187	4485 ABCD
IDSA27	122	72	235	4367 BCDE
IRAT112	112	73	187	4166 CDEF
WAB32-133	134	71	224	4105 CDEF
ITA257 (local check)	110	70	160	4077 CDEF
ITA150	136	70	192	3980 DEF
WAB99-10	126	69	224	3868 EF
WAB96-13	121	70	197	3352 F
Grand Mean				4601
C V (%)				14 23
LSD o5				925 6

* The Standard precedure for IRRI was used to Score Diseases

Table 2 Performance of Varieties from Replicated Yield Trial Medium Duration at Bokle 1993 Wet season

Varieties	Plant ht (cm)	50 % Flowering (days)	Tiller No (m^2)	Grain Yield (kg/ha)
WABIS675	144	87	176	6492 A
WABIS326-B-B-15-HI	133	84	300	6373 AB
IR47686	143	87	240	5990 ABC
TOX1870-48-10-1-4-3	134	81	160	5643 ABCD
IRAT169	147	87	208	5484 ABCD
ITA257 (local check)	124	71	184	5388 ABCD
ITA327	129	87	255	5259 BCD
IR47701-6-13-1	125	81	248	5223 BCD
WAB96-1-1	136	78	236	4975 CD
TOX3444-13-1-1-2	144	89	180	4710 D
TOX3440-34-1-3-1	148	89	126	4646 D
TOX3449-42-2-3-1	153	84	200	4642 D
Grand Mean				5402
C V. (%)				15 86
LSD o5				1232

Table 3 Perfomance of the II entries and check varieties in AYT conducted under irrigated conditions at Ndop 1993 season

Entries	50 % Flowering (days)	Disease reaction (0_9)**					Grain Yield (kg/ha)
		Leaf Blast	Neck Blast	Brown Spot	Leaf Scald	Grain Type	
TOX3145-38-2-3	122	2	3	2	1	L	4531
IRI5579-135-3	119	1	3	3	1	M	4531
TOX3145-34-3-2	122	2	3	2	1	L	4512
B2881FSR-62-5	121	3	3	3	1	M	4404
TOX3145-34-3-3-1	122	2	3	2	1	L	4377
IR7167-33-2-3 (Local check)	120	2	3	3	1	M	4345
TOX3145-34-3-2	125	3	3	2	1	L	4342
TOX13N9	128	3	3	2	1	L	4205
TOX3145-34-3-3-1	124	2	3	2	1	L	4112
TOX3145-15-2-1	124	2	3	3	1	L	3812
TOC9N9	120	3	3	3	1	L	3311
TOX3145-34-2-3	122	2	3	2	1	L	3299

Table 4 Performance of 10 Entries tested in a Coordinated Rice Evaluation Trial under irrigated condition at Ndop Plain during 1993 Wet season

Entries	Plant ht (cm)	50 % Flowering (days)	Reaction to (0-9) ** Leaf Blast	Neck Blast	Sheath Rot	Glume Discoloration	Grain Yield (kg/ha)
IR7167-33-2-3 (local check)	95	122	3	3	1	1	4893
AD9246	85	120	2	5	1	1	4494
ITA300	77	133	3	3	3	3	4348
IR46	81	133	4	3	1	1	4289
TOX3344-3-4-1	105	139	2	3	1	1	4242
BKN7033-3-3-2-3	88	125	2	5	5	1	4219
ITA222	73	129	3	3	3	2	4089
ITA212	81	128	3	5	3	1	3982
TOX3145-34-2-3	91	120	2	5	3	1	3750
CICA8	84	126	2	5	3	3	3585
Grand Mean							4189
C V (%)							8 62
LSD o5							5

** Scoring is according to the standard Evaluation system of rice IRRI 1988

Elite Variety Trial

Table 5 Performance of selected Elites of irrigated Rice at Ndop Plain 1993 Wet season

Entries	Plant ht (cm)	50 % Flowering (days)	Reactions to (0-9) ** Leaf Blast	Neck Blast	Sheath Rot	GLD	Grain Yield (kg/ha)
TOX3145-34-3-2 *	93	128	3	3	1	1	5064
TOX3145-34-3-3-1	93	134	3	3	1	1	5050
TOX3145-34-3-3-2	94	131	3	3	1	1	4710
IR7167-33-2-3 *	96	123	3	3	1	1	4524
ITA222	75	124	3	3	1	1	3458

* Local check
** Scoring diseases is based on the IRRI Standard Evaluation System for Rice

Sunmary of Activities

Since 1981, approximately 10,000 varieties/lines have been introduced and screened for their adaptation to rice growing conditions in Cameroon From a total of 6,840 varieties introducted between 1985 and 1990, over 192 varieties have been selected for further study and nomination for national co-ordinated variety trials Most of the selected varieties originated from IRRI and included both advanced breeding lines and traditional varieties

Selected introductions with high yielding ability/fertilize responsiveness, tolerance to low temperature, resistance to major diseases, suitable plant stature and good grain type have been identified and are being grown in the various zones During the last three years (1991 to 1993) a number of promising lines have been identified for irrigated and upland conditions

Recommented varieties for the major production zones including the existing varieties which are considered as local checks are as follows

Irrigated Rice

Extreme North - Yagoua Maga and Kousseri The most important physical and biological constraints are climatic, especially, dry atmospheric conditions during harvesting causing post harvest losses, as brittle rice grains shatter or break during milling

The variety, IR46 which is moderately resistant to the constraints mentioned above has been cultivated over the past fourteen years Other varieties that seem to be perform as well as IR46 are ITA212, CICA8, AD9246 These varieties yield on the average about 6t/ha

North- Lagdo area Apart from the climatic constraints mentioned above there are a number of important diseases such as blast, leaf scald, sheath rot and glume discoloration The variety, BKN 7O33-3-3-2-2-3 was released in 1986 is moderately resistant to these diseases It matures in 125-130 days and is of medium stature (115 cm)

However, ITA 300 is progressively replacing BKN7O33-3-3-2-2-3 ITA 300 has a better grain quality but the cycle is slightly longer (140 to 150 days)

Several other promising elite varieties as revealed in the 1993 results are in the pipeline

North West - Ndop Plain the rice crop is exposed to low air and water temperatures (13-20°C) which weaken rice plants, making them susceptible to sheath rot and glume discoloration diseases The variety IR7167-33-2-3 was released for general cultivation in 1987 As observed in 1993, the variety TOX3145 is also being accepted by farmers in this area

WEST - Mbo Plain The major constraint at this plain is the disease, leaf and neck blast Most of the lines rated as resistant or moderately resistant to blast in other parts of the world are found to be susceptible at Mbo plain This is partly because the climatic conditions there are highly conducive to blast

CICA 8 was officially released in 1985 and was widely cultivated by farmers at Mbo plain CICA 8 has long and slender grain type This variety has stood a test of time since it is moderately resistant to leaf blast However the variety IR7167 - 33 - 2 - 4 was about to be released when activities stopped due to financial problems within the main rice parastatal in the region

Upland /Rainfed Rice

Upland rice has received little research attention and farmers tend to cultivate tall, low tillering, upland varieties and, in some cases, irrigated varieties in the upland Efforts have been made in the last 3 years to identify, high yielding disease/stress tolerant varieties with good grain quality, adapted to upland/rainfed conditions Among the lines that have been found to perform well in upland/rainted conditions across locations are IRAT 10, IRAT 216, IRAT 79, IRAT 112, and ITA 257 At Mbo plain popular varieties that have been used as local checks are IRAT 10, a IRAT 216, IRAT 79 and Rok 16 In the North and Far North, IRAT 112 and ITA 257 are gradually gaining popularity due to their early maturity cycle A few WAB varieties and INGER, selections are in the pipeline that seem to outyield IRAT112 and ITA257

3 1 5 IN - SERVICE TRAINING

The rice research unit since its creation in 1981 has had the following staff training

Name	Degree(s) Sought
TAKOW, Julius A	B Sc, M Sc, Ph D (Agronomist/Soil Scientist)
JEUTONG Fabien	M Sc, Ph D (In training) (Plant Breeding)
NGNINBEYIE Pascal	M Sc (Agronomy/Breeding)
BIRANG à MADONG	M Sc (Agronomy)

Several techniciens have had short- term training and on the job training from the technical assistant staff

Despite the training, the rice unit is still short of trained manpower Presently, Mr Fabien JEUTONG presently in training will join the Sorghum research Unit since he is presently working on sorghum

3 1 6 PRIORITIES FOR FUTURE RESEARCH

Our priorities remain the same as stated in the objectives However, emphasis will be more on working with farmers In other words, farmer, participatory research will be a priority

3 1 7 PLANS TO SUSTAIN RESEARCH

The focus will be on external aid by way of presenting proposals for sponsorship to organizations such as the West Africa Rice Development Association, IITA, IRRI etc However, requests will also be made to the government of Cameroon, if the economic situation improves

For the meantime, I expect USAID to give us a boost by maintaining the existing facilities over a period of about 3 to 6 months Provide us with some fuel to continue present research activities and also help us identify financial donors

3 2 RICE PATHOLOGY

3 2 1 INTRODUCTION

The goal of the rice pathology unit is to reduce losses to plant diseases in both upland and lowland rice ecosystemes The unit continued to pursue its objective of monitoring and/or screening for disease resistant varieties upland and lowland ecologies

Factors contributing to low rice yields in Cameroon are many, the Rice crop in Cameroon is subject to attack by disease and insect pests, the effects of adverse soils and of an unfavorable physical environnment These could also influence rice disease development During 1991-1993 agricultural years the focus was on the study of the influence of cultural practices on the incidence of rice blast in Mbo Plain

3 2 2 OBJECTIVES

- Identification of the principal diseases of rice for the various rice zones of the high plateaux of the west and north-west of Cameroon
- Assess fluctuation in blast virulence in Mbo Plain
- Study of the influence of cultural practices on the incidence of rice blast in Ndop plain
- Screen for blast resistance and blast disease patterns during 1993 - 1994 (Mbo Plain)
- Study the methods of control for rice blast disease

3 2 3 CONSTRAINTS

- Insufficient budget granted to the unit This forced the unit to limit its activities to the Mbo Plain
- Delay of SODERIM in the preparation of the experimental plots
- Delay of SODERIM in turning in water to the experimental plots
- Lack of good collaboration by the local coodinator e g transport facilities etc

3 2 4 ACCOMPLISHMENTS

Identification of the principal diseases

Three of the most important fungal disease agents of rice have been Identified They are *Pyricularia oryzae*, *Rhynchosporium oryzae*, *Acrocylyndrium oryzae* Their frequencies of attack and the variability of these attacks have been established (Table 1)

Table 1 Observation of diseases on rice in September, October and November 1993

PERIOD										
			5-11 Sept			3-10 Oct			0/10-3/11	
PLACES BAIGOM	TYPES IRRI	VARIETIES CICA 8	JAS 31	ATT 14	SPORE P	JAS 60	ATT 18	SPORE P+1	JAS 99	SPORE R+PF+PC+H
BABUNGO	PLUV	IRAT 216	-	1	P+R	-	4	P+R	-	R+PF+PC
BAMUNKA	PLUV	IRAT 216	-	1	P+R	-	4	P+R	-	P+PF+PC
DSCHANG	IRRI	CICA 8	-	10	-	-	12	R+R	-	PF+PC+R
BEFANG	PLUV	IRAT 216	-	2	-	-	14	P+R	-	PF+PC+R
SANCTHOU	IRRI	CICA 8	-	18	-	-	20	P+R	-	PF+PC+R+C
ENVIRON	PLUV	IND	20	-	-	-	22	P+R	-	PF+PC+R+Has
NDOP	IRRI	CICA 8	55	0	R	100	4	P+R	RO	R+PF+PC+Has
MENCHUM VALLEY	IRRI	CICA 8		0	R	-	4	P+R	-	R+PF+PC+Has
PLUV	ABOUT	IND	50	3	-	-	6	P+H+R	-	R+PF+PC+H
TONGA	PLUV	IND	50	3	100		7	P+H+R	120	R+PF+PC+H
BABOUNGA	IRRI	CICA 8	50	4	P+R	100	6	P+R	120	R+PF+PC+H
ENVIRON	PLUV	RAIN	-	6	P+R	-	6	P+R	124	PF+PC+R+H

IRRI = Irrigated
PLUV = Upland
JAS = Days after seeding
ATT = Index of attack
IND = Indeterminate
P = Pyricularia
R = Rhynchosporium
A = Acrocylindrium
H = Helminthosporium
Pf = Pyricularia-foliar
Pc = Pyriculariose-stem

The principal observations to note in this table are

In September the majority of the infections observed were due to *Pyricularia* in the locations visited At Ndop and Menchum valley a few spots were observed The locations most severely attacked by *Pyricularia* were the Mbo Plain, Tonga and Baigom, 40 days after seeding, with an index of attack of 20, 16, 18% respectively

In October, the attacks on foliage due to *Pyricularia* disappeared in Ndop, Menchum, Befang, Babungo and Bamunka On the other hand one observes the presence of *Rhynchosporium* in Befang, Babungo, Menchum, Babungo and Bamunka, and *Acrocylindrium* in Ndop, Menchum and Badounga In this period the stems are still bearing *Pyricularia* in the Mbo Plain, Baigom, Dschang, Tonga and Badounga

Helminthosporium has been observed in October in Baigom, on late transplanted rice in Tonga, in upland rice fields in the Menchum valley On the whole the indices of attack decreases significantly

In November during our third visit, *Pyricularia* reappeared on necks and leaves at Befang, Mbo Plain, Baigom, Dschang and Badounga It was observed on leaves under rainy-conditions at Tonga, Babungo and Bamunka In the 10 locations visited, the leaves and the heads were especially attacked by *Cercospora* and *Helminthosporium* which at this time of year, are present everywhere and cause a significant discoloration of grains This work needs to be pursued

Sensitivity of rice varieties to the pathogenicity of *Pyricularia oryzea*

Tests to detect sensitivity of some varieties of rice to *Pyricularia oryzea* were done under rainy conditions at Dschang, Santchou and Ndop (Table 2) Seven different varieties and three check varieties (IRAT 10, TAINAN V and ANNA 2) were utilized

Table 2 Sensitivity of varieties of rice in three different sites

	Locations		
Varieties	Dschang	Santchou	Ndop
IRAT 10	R	R	MR
TAINAN V	R	S	R
ANNA 2	S	S	MR
ITA 116	R	MR	R
PIO-CAM-TAO	MR	MR	R
CO 25	S	MR	S
WAQ WAQ	MR	S	R
SPREADER	MR	MR	R
USEN	MR	S	R
IRAT 13	R	MR	R

R = RESISTANT
MR = AVERAGE RESISTANCE
S = SUSCEPTIBLE

Assess fluctuation in blast virulence

Fifteen rice varieties consisting of differentials from WARDA - BOUAKE with known levels of resistance were sown in upland conditions for a period of seven months between May and November 1993 at Mbo Plain

The trial was based on the uniform blast nursery with spreader rows no artificial inoculation was done The blast incidence was natural Both leaf and neck blast were scored Based on the reaction of individual varieties over the test period, the reaction pattern of the used varieties can be classifified as follows

1- lesions seldom formed generally, but few, nonextending, elliptic
2- lesions formed more profusely especially during disease severe months

On the basis of the above key, varieties were classified into 3 groups Groups, score and varieties are shown in table 3

Table 3 Regrouping of blast reaction of differentials varieties based on foliar reaction at Mbo Plain

Group	Disease Score	Type of lesion (occurence)	Sporulation	Varieties
1	0 - 3	sporadic	nil	D1, D2
2	4 - 5	few	slight	D2 D7 D12 D6 D13
3	5 - 6	moderate	moderate	D3, D4, D5 D8, D9, D10 D11, D14, D15

This trial suffered from the methodology It was planted too dense Most of the test plant did not grow It is proposed that the trial be repeated, the methodology should be changed and the trial be planted in the period from February to March (First cycle)

Screen for blast resistance

Twenty-two varieties were tested for their reaction against blast in upland conditions in Mbo Plain The test entries included two resistant and two susceptible checks Scores of blast disease on leaves were taken up to seven weeks after sowing and later the neck infection was recorded after flowering Based on the reaction pattern of individual varieties over the test period, the reaction of the varieties are grouped as put in table 4

Table 4 Regrouping of the test varieties according to their reaction to leaf and neck blast

H R	Leaf blast			
	R	MR	S	HS
WAB 56-125	ITA 257	Moroberekan	WAB 96-13-1	IR S
WAB 181-11	WAB 56-104	IDESSA 13	WAB 56-50	USEN
	WAB 5 -57	Ishikari sheroke	FARO 33	FARO 29
		FARO 37	SIPI 692033	
		WAB 99 - 14	WAB 32 - 60	
		FKR 27	WAB 165	
		FKR 33	ITA 112	
		WAB 56 - 39		
		ITA 257		
	Neck blast			
Shekari				
sheroke	WAB 165	Moroberean	IR 5	
sheroke				
ITA 257	WAB 96-13-1	WAB 56 - 104	USEN	
	WAB 181-11	FARO 29	IDESSA 13	
	ITA 112	FARO 33	WAB 56 - 50	
	FKR 33	WAB 32 - 60	SIPI 692033	
		WAB 56 - 57	WAB 165	
		WAB 99 - 14	WAB 56 - 39	

The following entries showed good resistance in both leaf and neck blast ITA 257, Ishikari sheroke, WAB 181 - 11, WAB 56 - 125, WAB 56 - 104, WAB 56 - 57, FKR 27, FKR 33 Varieties with a high mark of incidence were the following IR5, USEN, FARO 29, WAB 56 - 50, SIPI 69 20 33

Blast disease pattern during 1993 - 1994

The blast disease pattern at Santchou, Mbo Plain during 1993, is not yet completed The objective of this exercise is to observe the peak periods of blast incidence and to devise screening trials to effectively screen for blast resistance The disease intensity is generally low in July - August (Fig 1)

Research on disease resistant varieties and new introductions in comparative trials.

From 1981 to date about 10,000 varieties or lines have been introducted to Cameroon They have been tested for their adaptability to local rice growing conditions

The varieties or lines having a good resistance to disease (*Pyricularia, Rhynchosporium, Acrocylindrium,* etc), cold tolerance and a good plant appearance have been proposed as parents for varietal selection

The materials of Global Inger and Inger Africa have been introduced within the framework of AIRPSS, AIRON, AND ARLRESS at Mbo Plain A good number have been selected and proposed for varietal improvement

AIRPSS this group was composed of 150 entries The material of this group was very sensitive to *pyricularia* (leaf and neck) Only 30 entries were kept for further testing

AIRON One hundred entries made up this group Thirty of these were retained and proposed for variety improvement

ALRESS This group of 100 entries was tested under irrigated conditions Thirty entries with good adaptability were selected and proposed for variety improvement

IRCTN This group of cold tolerant varieties was placed at Ndop Fifteen of these varieties or lines were retained especially for their tolerance to cold and also for their resistance to sheath rot and *pyriculria*

Study of the influence of cultural practices on the incidence of rice blast in Ndop Plain.

- Effect of Nitrogen nutrition on the incidence of the pyriculturia

This study was composed of six different levels of nitrogen applied under irrigated conditions at Santchou

The resultats indicate

The Friedman's test showed that there were no significant differences between nitrogen levels for levels of attack This confirmed the classification of the varieties from most to least resistant over all nitrogen levels The V4 (Cisadane) appears to be the most resistant while V5 (CICA 8) is the most susceptible to foliar *pyricularia* (table 5)

Table 5 Effect of Nitrogen application on pyricularia infection

Varieties	Mean return of the 4 replications (t/ha)					
	NO	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	4 475	4 623	4 876
V3	4 303	4 154	4 110	4 550	4 346	4 584
V4	4 012	4 185	4 637	4 309	4 958	5 014
V5	4 774	4 679	4 733	4 766	4 958	5 014

The results obtained for the attack of neck blast (table 6) are not analogous to those of the leaves The influence of the different rates of nitrogen on infection are not clearly demonstrated on the neck

This makes us believe that there is not only a difference of sensitivity among varieties but also, a variability of the virulence of the *Pyriculturaria oryzea* in the field or the cultural cycle The second cycle, the period of this test, is not favorable to the disease Based on these results there does not appear to be a relation between yields and nitrogen application levels on one hand and between the observations of attack and yield losses, on the other hand

<u>Table 6</u> Effect of Nitrogen application on incidence of Neck blast

Varieties	Scores on Stem blast Mean 3 Observations					
	NO	N20	N40	N60	N80	N100
V1	6 47	4 15	6 66	7 51	7 51	4 94
V2	5 68	5 22	6 69	7 04	5 49	8 06
V3	5 84	4 814	6 63	5 01	5 47	4 60
V4	3 54	3 34	5 24	2 94	2 94	4 30
V5	6 17	6 03	4 20	4 92	4 84	3 70

<u>Table 7</u> Effect of Nitrogen Fertilization on incidence of leaf blast

Varieties	Scores of blast on leaves mean of 3 observations					
	NO	N20	N40	N60	N80	N100
V1	2 5	3 25	4 00	3 75	3 5	4 25
V2	2 5	3 00	3 25	4 00	4 00	4 00
V3	2 75	3 00	2 75	3 75	3 50	4 00
V4	2 5	2 25	2 75	3 25	3 00	3 75
V5	3 2	3 50	4 00	4 75	4 7	4 75

<u>Effect of planting date on incidence of Pyricularia</u>

For this trial 4 planting dates were tested The varieties used were the best selections The trial showed that there is more infection for the first planting date (18 Sept) than for the others and that there is a significant difference between the second and third dates (26 Sept et 9 Oct)

For these dates variety V5 (CICA 8) is more susceptible than V4 (Cisadane) V4 is less susceptible at the first planting date than the others The last planting date (21 10) is the worst There was no evidence of any effect of the disease on yields The data obtained are still not enough to permit definite conclusions This trial should be continued

<u>Effect of Method of Soil Preparation on Incidence of Pyricularia</u>

Three types of Soil preparation were tested (table 8) Two of our best varieties (CICA 8 and ITA 222) were used

This trial showed that soil preparation method M1, puddling with cage wheels, was the best Methods M2 and M3 commonly used by farmers, predispose rice to blast attack

Table 8 Effect of soil preparation method on incidence of pyricularia

Caracteristique	Methods of preparation of soil		
	M1	M2	M3
Incidence of Disease	absent until flowering Light attacs of Phynochorium at tillering	presence pyricularia, Rhynchosporium after tillering	string infection after transplanting Pyricularia sporium on every variety
Toxicity	none	slight toxicity in iron	toxicity in iron very pronounced
Insect Damage	insignificant	average, CICA 8 attacked more	Very pronounced
Developement	Very good vegetative, vigor of plants	average	heterogenous
Tillering	Strong	average	weak
Plant	CICA 8 was better than ITA 222	CICA 8 and ITA 222 identical	These varieties were yellow indicating a lack of N

M1 = Puddling with cage wheels
M2 = tillage with daba and puddling by foot
M3 = tillage with daba

Blast disease pattern

A project on the blast disease pattern at Mbo Plain is not yet completed

The objective was to observe the peak periods of blast incidence and to devise screening trials to effectively screen for blast resistance The blast disease reaction during the studies under natural conditions on a hydromorphic soil at Mbo plain reveal

a) The intensity of blast attack varied from variety to variety and with planting dates
b) The degree of both leaf and neck blast increased with late planting
c) Resistant varieties like Nang NG hiep 75-5, cisadane showed considerable stability in resistance throughout the testing period

Chemical control of rice diseases

Fungicidal control of rice diseases is effective and economic when used by rice production autorities such as SEMRY, SODERIM and UNVDA It is used by big farmers in agriculturally advanced countries, where it has been widely adopted In any way the research should aim to select the chemical to be used, the appropiate time and method of application of these chemimicals In order to give an answer to these questions, many chemical trials have been conducted at Mbo Plain during 1991-1993 agricultural campagn Some of these are

Screening of fungicides

Three fungicides (Grex-Tx, Kitazine and Brestan 60) were compared to Pelt 44, a product used since 1980 on station

This study was done under irrigated conditions at Santchou, Mbo Plain It showed that Grex-Tx is statistically equal to Pelt 44 and better than the two other fungicides (Table 10, table 11)

Table 10 Performance of the fungicides

Treatments	Yield t/ha	% gain
Pelt 44	5 916	+ 25
Grex Tx	6 218	29
Kitazine	5 520	16
Brestan 60	4 985	5
Untreated Check	4 726	
Statistical significante		S**
CV %	21	
PPAS to 0 05 in t/ha		3,75

Periods of application of Grex-Tx

This study had the objective of determining the number and best times of application to stop the attack in the field at Santchou (Mbo Plain) The disease infected the plants during the vegetative phase (tillering) A seed treatment followed by a single foliar treatment at tillering gave a good production of green matter and grain yield Table 11

Table 11 Study of the application period of Grex-Tx

Treatment	Yield t/ha	% Gain
Check	5 324	
Treated with Brassicol + 1 treatment Treatment at tillering	6 355	+ 19
Treated at Tillering	6 128	15
Treated + treatment at tillering and again at 20 days after planting	6 166	15
Treated at tillering and 20 days after planting	5 895	
Mean	5 975	
S	statistic**	
%	16	
to 0 05 t/ha		

Soil treatment with Fungicides

Remarkable yield loss was observed at Mbo Plain after 2 to 3 crops on the same plot under rainfed conditions, even when well managed Comparaisons were made between the effects of soil treatment by a single fungicide, a mixture of fungicides and a non treated check The trial was planted in rainfed conditions at Santchou There was no evidence of treatment effects on disease development It was not verified that the lower yield was due to the disease organisms present This problem seems complex It could be due to an interaction between these organisme and soil microorganismes

In previous studies we have observed symptoms attributed to *Ditylenchus angustus*, a rice stem nematode on IRAT 10 at Santchou, galls related to *Meloidogyne* spp, on roots of Tainan V under rainfed conditions in experimental plots of Santchou

Although fungicidal control has been proved effective under research conditions, very few farmers have adopted the practice Some of the reasons for this are the following

* Low basic yields Average grain yields in small - scale farmer are between 300 and 500 kg/ha Even if fungicide application could double this yield, the result would not be economic

* Difficulties in obtaining fungicides and application machinery, and their high cost for small-scale farmers

* Lack of expertise and lack of advice on the use of spray machinery and on its maintenance

3 2 5 IN SERVICE TRAINING

In 1992 the unit leader went to a crop protection (pathologists - entomologists) monitoring tour to Nigeria and Cameroon

In 1993 the unit leader went to a multidisciplinary monitoring tour to Ivory coast and Ghana All these tours were organized and financed by the west African Rice Developpment Association (WARDA)

The following students of the university of Dschang wrote their memoires under the supervision of the unit leader

POKAM NANA Blaise 1990

Etude de l'éfficacité de quelques fongicides dans la lutte contre la pyriculariose et evaluation des pestes de rendement dues à Pyricularia Oryzae CW sur trois variété de riz dans la Plaine des Mbo

DOUANLA Denis 1991

Effet de la nutrition adoptée sur l'incidence de la Pyriculariose due a Pyricularia Oryzae sur cinq variétés de riz dans la Plaine des Mbo

TAKALA Samuel 1991

Etude de l'effet de la densité de populations et de deux niveaux de fumure sur l'incidence de la Pyriculariose due à Pyricularia Oryzae sur deux variétés de riz vulgarisées dans la Plaine des Mbo

3 2 6 PRIORIIES FOR FUTURE RESEARCH

* Assess fluctuation in blast virulence at Mbo Plain and Ndop Plain
* Screen for pest resistance IPM
* Blast disease pattern 1993 - 1994 to be continued
* Screen elite varieties for disease resistance (NCVT)
* Screen for leaf scald resistance
* Screening for resistance in breeding lines
* Monitor or score Inger-Africa new introductions
* Survey of rice diseases in all rice growing zones of Cameroon

3 2 7 PLANS TO SUSTAIN RESEARCH EFFORT

Variations in disease incidence and severity are apparent in the different rice growing areas of Cameroon It is therefore important that the program to develop cultivars with resistance to the major diseases considering other factors including environmental conditions and cultivation practices in the area of intended cultivation

Of all the rice growing areas of the country, Mbo Plain in the West and Ndop Plain in the north west have the greatest need for disease resistance in cultivars, because the CLIMATIC factors in these regions favor diseases development It is therefor important

a) research program for the west and north-west provinces constantly emphasizes development of cultivars resistant to blast and other diseases

b) All newly imported entries at first be tested for disease resistance at Mbo Plain before they can be grown elsewehre in the country

It has been many times observed that good yielding varieties with very good disease resistance showed susceptibility to leaf scald It is therefore very important to develop varieties resistant to both blast and leaf scald

4 CEREALS AGRONOMY RESEARCH UNIT

4 1 INTRODUCTION

The NCRE Cereals Agronomy Unit during the last three years has conducted research on maize agronomy, on sorghum agronomy and on multipurpose grain legumes species The unit has devoted about 70% of its research efforts to maize agronomy and multipurpose grain legume species The unit has devoted about 70% of its research efforts to maize agronomy, about 20% on sorghum agronomy, about 10% in the study of grain legumes species For research purposes, the area is divided into three main regions The highland plateaus of Adamaoua, the subhumid lowland savanna, and the semi-arid lowland savanna In these regions, the area under traditional and intensive maize cultivation is estimated to be around 70,000 ha while the total area under sorghum production is about 43,000 ha Must of our research work was carried out in the subhumid lowland savanna

4 2 OBJECTIVES

To identify and evaluate the impact of the main agroclimatic and management constraints on the production of maize and sorghum and cereals-based cropping systems in the main zones of North Cameroon (constraint identification and evaluation)

Test different agronomic techniques in order to alleviate these constraints and increase the sustainablility of the cropping systems To develop appropriate packages of improved cultural practices for maize and sorghum farmers in the context of the different cropping systems used in the regions (technology generation)

To participate in the extension of the improved agro-technologies in close cooperation with the agencies in charge of agricultural development (technology transfer) To train national staff in agronomic field research and management (training)

4 3 CONSTRAINTS FOR INCREASED MAIZE AND SORGHUM PRODUCTION

a- Insufficient and/or erratic rainfall in many zones of the lowland savanna
b- lack of adequate cropping systems to maintain long-term sustainable crop and soil productivity
c- Rapid process of soil degradation and erosion The type of intensive and aggressive rainfall is causing serious erosion problems in the fragile soils of the region when cultivated Substantial amounts of rainfall water is lost by run-off
d- Soil fertility problems, deficiency of several nutrient elements (particularly N, P, K, Zn, Mg) and low levels of organic matter in many soils
e- Inadequate knowledge on cultural practices (land preparation, soil and water management and conservation, planting dates, plant densities, weed and Striga management, fertilization intercropping techniques, irrigation, crop rotation, improved fallow management)
f- Weed problems (including)

g- *Striga* problem on maize and sorghum
h- Disease and pest (maize streak virus, blights, insects rots, termites, borers, birds, monkeys)
i- Crop lodging
j- Lack of proper storage facilities
k- Lack of appropriate mechanization and tools
l- Lack of marketing channels and organization

4 4 ACCOMPLISHMENTS

4 4 1 On-farm trials/demonstration with conservation farming technology (farmers' managements

4 4 1 1 On-farm testing and demonstration with minimum tillage (1991) for sustainable cropping systems in the subhumid lowland savanna.

One set of on-farm trials involving N fertilization and minimum tillage was conducted during the 1991 cropping season The main objectives of these experiments were a) to determine the response of maize to different N fertilizer rates under a minimum tillage system in 13 farmers' fields located in the West and South-East Benoue regions, b) to evaluate the performance of the newly available maize variety CMS-8704 in different agroecological zones under farmers' condition, c) to introduce a system of ally cropping with pigeon pea hedgrows in farmers fields

This study show among other things that - Growth of maize variety CMS-8704 was relatively good in most locations This variety seems well adapted in these different agroecological zones Furthermore, this experiment demonstrated once more that a reasonable yield can be obtained in farmers' fields under a minimum tillage systems in the subhumid lowland savanna of North Cameroon Regarding the alley cropping systems used in this experiment, pigeon pea growth was considered satisfactory when planted earlier in June Results are in Table 1

4 4 1 2 On-farm test/Demonstration with interplanted maize/canavalia under minimum tillage system in the subhumid lowland savanna (farmers' management 1992)

Interplanted fallow (legume/cereals) and minimum tillage are two important strategies for sustainable cropping systems The use of interplanted fallow with appropriate legume species has the advantage of producing an abundant mulch which helps in the protection of soil while reducing the intensity of weeds

This experiment has been conducted in 1992 The legume species *Canavalia ensiformis* was used as test crop at an interval of 4 meters between plant on the row It was planted 3 weeks after maize planting, one row of canavalia every two rows of maize Trials were set up on one eigth (1/8) ha in six different farmers fields located at Djalingo, Ouro-Labo and Badjouma There was no land preparation with mechanical implements Only a total herbicide (paraquat 4 l/ha) was applied at planting time in combination with the pre-emergent herbicide (primextra 2 l/ha)

The main objectives were to evaluate at 6 locations under farmers conditions and management a systems of interplanted fallow (maize/canavalia) planted with minimum tillage and to evaluate the performance and acceptance by farmers of the residual effects of interplanted legume species on soil fertility and yield of subsequent maize crop Results are shown in Table 2

The (2 1) interplanting system used seems a satisfactory one as the competition between the legume canavalia and the maize crop was not strong enough to reduce maize yield significantly

4 4 1 3 On-farm test/Demonstration with interplanted fallow with maize/legume species under conventional tillage and hedgerow of pigeon peas. (Farmers management) 1992

This experiment was carried out in 1992 at Ouro-Labo and Badjouma in 6 farmers' fields A RCBD with 2 replications per site was set up using a system of Blocs disperses The same interplanted pattern described above was used The legume species involved in the different treatments were canavalia, Crotalaria, pigeon peas The check plot was mono-crop maize A hedgerow of pigeon peas was planted every 7 meters

The main objectives were to compare under farmers' conditions and management the impact on maize performance of these different interplanting systems (maize/legume) with those of monocrop maize under conventional tillage at several locations, to evaluate the residual effects of the legume species on soil fertility and subsequent yield of maize crop To introduce to selected farmers the system of interplanted fallow as well as allow cropping with hedgerows of pigeon peas

In 1993, the same experiment was carried out at Ouro-labo and Djalingo in 6 farmers fields but cowpea was replaced by *calopogonium mucunoides* Results are shown in table 3 Most of the farmers showed a positive reaction towards interplanted fallow and the hedgerow system with the pigeon peas

4 4 1 4 Effects of interplanted maize/legumes under conventional tillage on maize performance at several farmers' field in the subhumid lowland savanna (1992).

This trial involved 2 treatments with interplanted fallow (in 1992) maize/cowpea plus canavalia and maize/pigeon peas plus canavalia using the 2 1 pattern The trials were carried out in 10 farmers fields located in Sanguere and Djalingo Results are shown in table 4

4 4 2 Research on multipurpose legume species for sustainable cropping systems in the subhumid lowland savanna

A set of 2 experiments on multipurpose legume species for sustainable cropping systems were planted at Djalingo

4 4 2 1 Response of maize and sorghum to interplanted fourrage legume.

This experiment which started in 1991 involved the use of 4 legume forage species *Canavalia ensiformis, Stylosanthes hamata, Calogoponium mucunoides*, and *Cajanus cajan* The legume species were planted at the same time as maize and sorghum using a pattern of 2 rows of cereals for 1 row of legumes The spacing between maize tow was 1 m A moderate amount of fertilizer was used Interplanted cereal-legumes was used in an effort to increase the economic value of the system and kame it more attractive to farmers

The main objectives were to study the performance of maize and sorghum grown in an interplanted fallow system with forage grown in an interplanted fallow system with forage system legume species and to develop sustainable and profitable production systems of cereals and forage (for livestock) while improving soil properties (integration crop/livestock)

Observations made in the maize trial seem to indicate that a better time to plant some legume species (like crotalaria, calopogonium) would be about 3 weeks after planting maize This relay system could reduce plant competition in case of severe dry spells or erratic rainfall patterns

4 4 2 2 Second Cropping Season (1992) residual effects of 3 Legume species (interplanted with maize in 1991) on maize performance in subhumid lowland savanna.

This experiment was started in 1991 The main objective is to evaluate the residual effects of these legume species used in intercropping with maize in 1991 on the maize yield The legume species used were the same in 1991 which regrew in 1992 except pigeon peas The monocrop maize-maize was used as a control Each treatment was divided into two sets of subplots One set of subplots with maize, with two levels of fertilization for each treatmentl, no fertilizer and with fertilizer A system of minimum tillage was used this trial with the legume mulch after killing regowth by herbicides (gramoxone) In the other subplots, the legume species were left with regrowth in an effort to monitor the amount of biomass produced by the regrowth and as well as the ability of these legume species to complete and suppress weed Results are shown in table 6 (a) When no fertilizer was used, the legume treatment produced an extra grain yield of maize of up to 1 08t/ha(+92%) as compared to monocrop maize For Stylosanthes, biomass was, 9 3 t/ha and it gave good weed suppression Canavalia had very little regrowth and weed suppression was poor

In 1993, this experiment was continued

In the third cropping season (1993) there were residual effects of only two legume species, interplanted with maize in 1991, on maize performance The objectives are the same as 1992 The subplots where the legume species were left with regrowth in 1992 received two levels of fertilization, no fertilizer and with fertilizer

Results are in table 6b When no fertilizer was used, the legume treatment gave an increase in grain yield of maize up to 2 21 t/ha (138%) as compared to monocrop maize

4 4 2 3 Effect of different interplanted system (maize) legume species) on maize performance in lowland savanna (1992).

This study which started at Djalingo in 1992 has been conducted with the legume species canavalia, *Crotalaria, cassia* obtubifolia, Stylosanthes, Pigeon peas, Cowpea The legumes were planted 3 weeks after maize planting used a pattern of 2 rows of cereals for 1 row of legumes The spacing between maize rows was 1 m Interplanted cereals/legumes was used in an effort to increase the economic value of the system and make it more attractive to the farmers of the region The objectives were to evaluate the performance of maize grown in an interplanted system with several species of legumes, to evaluate the residual effects of these legumes on soil fertility and subsequent maize yield Results are in table 7a

4 4 2 4 Second cropping season 1993 Residual effects of 8 grain legumes on maize fertilization in the subhumid lowland savanna.

This started at Djalingo in 1992 where grain legume species were planted crotalaria, canavalia, mucuna, pigeon peas, cassia obt Stylosanthes, Calopogonium and cowpea

In 1993, each treatment was divided into two sets of maize subplots, with two levels of fertilizer, no fertilizer and with fertilizer The main objective was to evaluate the residual effect on soil productivity of these legume species Results are shown in table 7 b The observations on this trial confirm that these legume species are well adapted to the agroclimatic conditions of the sudan guinea savanna as well as to interplanted fallow system

4 4 2 5 Response of maize and sorghum to interplanted grain legume species in the subhumid lowland savanna

This experiment which has been conducted at Djalingo involved the use of cowpea, pigeon peas, a mixture of pigeon peas and cowpea crotalaria (improved fallow) and monocrop The planting patterns used were 2 rows of maize (or sorghum) with 1 row of legume species The interrow spacing between maize was 1 m A moderate level fertilizer was used Maize and sorghum were planted at the same time with the legume crop The main objective of this study was to evaluate the performance of maize grown in an interplanted system with grain legume crops Results are shown in table 3 It is interesting to note that the competition due to the food grain legume yield was greater than that of the legume forage crops

4 4 3 Study on Crop Rotation system in the subhumid lowland

4 4 3 1 Effect of different crop rotation system on the performance of maize and sorghum (1991).

This study has been started in 1989 at Djalingo where 7 preceding crops were used Cowpea groundnuts pigeon peas, soybeans, crotalaria, cotton and cereal A rotation system cotton/Cereals (as practiced by many farmers) was used as check All the preceding crops were planted using conventional tillage and harvested in 1990 Following farmers' practices, crop residues were removed from the soil before planting the cereals in 1991 The main objectives were to compare the performance of maize and sorghum after several leguminous and non leguminous crops with their performance after cotton to compare a system of improved fallow management with a crotalaria with different of crop rotation using grain legumes These results confirmed once more the value of Crotalaria as a valuable component in an improved fallow system management for the region In 1992, the same experiment was conducted by rotation cereals/legume

4 4 3 2 Residual effects of different legume crops used in rotation system Nitrogen fertilization of maize in subhumid lowland savanna (1991).

This experiment which was started in 1989 was carried out in 1990 and 1991 on 1 ha at Djalingo Four legume crops were used as preceding crops groundnuts, pigeon peas, cowpeas crotalaria (an improved fallow) and a control treatment consisting of continuous cropping of cereal Four levels of N were applied after each main treatment 0, 45, 90, 135 kgs N/ha (using Urea as N source) The main objectives were, to determine the response of maize to N fertilization as affected by these different legume preceding crops, to compare the improved fallow system with crotalaria In 1992 and 1993, this experiment was carried out in the same conditions as in 1992 Cumulative results for the 3 years are shown in table 9

4 4 4 Effects of different rates of tourteau de coton (cotton seed cake) on maize yield in subhumid lowland savanna of North Cameroon (1991)

The use of locally available organic by-products could contribute significantly to the sustainability of the cropping system in the lowland savanna as mineral (imported) fertilizer has become very expensive The use of tourteau de coton (T C) as a partial substitute deserves careful study This experiment which was started in 1990, was carried out in 1991 The ultimate objective of this study is to determine the most economical and practical combination of T C and fertilizer in order to achieve good and sustainable yields of maize Three rates of T C were used 0, 300, 600 kgs/ha. The T C is an organic by-product with 8% N and 1% K Two fertilizer rates were used the rate recommended by SODECOTON and used by many farmers and half of this rate Both fertilizer and T C were applied banded one week after maize emergence At this rate 1 kg of T C was associated with an increase of 2 83 kg of maize grain

In 1992, the same experiment was carried out in the same conditions and with same objective At this rate, 1 kg of T C was associated with an increase or 2 49 kgs of maize grain Cumulative results are shown in table 10

4 4 5 Effect of cow manure on maize performance in subhumid lowland savanna (1992)

This experiment has been conducted in 1992 at djalingo Previous experiments have shown that cow manure helps increase yield of maize in this region However, the amount of cow manure needed (5 t/ha) to effect a significant impact on yield is an obstacle to its use as collection of manure requires a lot of work and an adequate transport system The main objective was to evaluate the effects of two reduced levels of cow manure without and with fertilizer on grain yield of maize Cow manure (1 and 2 t/ha as well as fertilizer) were applied banded Results are shown in table 11

Using cow manure in band application at a reduced rate (1 or 2 t/ha) seems an effective, practical practice for the farmers of the region

4 4 6 Agronomic Research on Integrated Striga management in the subhumid lowland Savanna of North Cameroon

Performance of Maize and Sorghum after different Trap Crops grown in rotation on an Alfisol severely infested with Striga in the subhumid Lowland Savanna of North Cameroon

This study started in 1989 in a farmers' field at Karité In 1990, several crops were planted as preceding crops groundnuts, cowpea, soybean, pigeon peas, cotton, crotalaria and cereal (maize-sorghum) They were harvested in the same season

In 1991, maize and sorghum were planted (using a split plot design) after these different preceding crops A farmers rate of fertilizer was used Crops were planted at the end of June for the next experiment (1992) and harvested Striga counts were made at 3 times, 9, 12, 14 WAP (weeks after planting) in the 4 central rows

The main objectives of this experiment were, to evaluate at short and medium term the differential response of maize and sorghum to several trap crops grown in rotation on an Alfisol severely infested with *Striga hermontica* and to evaluate the dynamics of the Striga population in the treatments

Results showed that the best preceding crop for maize was Crotalaria, followed by cowpea and cotton, and for sorghum was it crotalaria, followed by cowpea and groundnuts

In 1992, this study was carried out with the same preceding crops which were planted in 1991 (soybean was replaced by *Cassia obtusifolia* and cowpea for sorghum) The best was crotalaria, followed by *Cassia obtusifolia*, Cowpea and groundnuts In 1993, this experiment was carried out in the same conditions Cumulative results are shown in table 12

4 4 7 Effect of different intercroping of cereals/legume species on cereal yields on an Alfisol infested with Striga in the subhumid Lowland Savanna

This study which started in 1989, was conducted at karité (Djalingo) in 1991, Maize and sorghum were used as test crops The legume species used were *Crotalaria cancea, Cassia Obtusifolia* These legumes were planted with different patterns

Treatments 2, 3, 4, were planted in the same hill and removed 20 days after crop emergence

The main objectives were, to determine the effects of intercropping patterns on maize and sorghum performance in an Alfisol severely infested with *Striga hermonthica*, To compare the impact of the monocropping with intercropping patterns on maize yield and striga population in this Alfisol severely infested with *striga hermonthica*

In 1992, the same study was conducted but with *Crotalaria, Cassia obtusifolia, Cassia occidentalis* used as a test legume species Regarding intercropping patterns, the most effective one seems to be the treatment which involved planting one legumes species (*cassia obtusifolia, Cassia Occidentalis, Crotalaria*) one month before planting cereals and then removed the legume 3 weeks after maize emergence Results are shown in table 13

4 5 IN-SERVICE TRAINING

1991 - 1993

1- Six different training - field days were organized "on maize and cowpea production and utilization, conservation farming technologies, improved fallow management and alley cropping" from September to December 1991 for different groups of farmers and extension agents of SODECOTON and Projet Nord Est Benoue

2- One field day and one "maize and cowpea utilization day" were organized for IRA/North researchers

3- In January 1992, there was a 3 day workshop at IRA/Garoua on laboratory methods for the determination of Striga seeds in soil samples and in vitro study of Striga A group of 8 IRA researchers and technicians participated in this workshop sponsored by IITA Maize research program

4- We helped organized a short course related to computer use, maintenance, use of software SYSTAT, Harvard graphics, Wordperfect 5 1 and Lotus 1-2-3 The training activity (which was held at IRA/Garoua in March 1992) was organized by NCRE Project and the IRA Biometries Section

5- We organized 4 field training days for researchers, extension and farmers Emphasis was put on legume-based technologies and conservation farming technologies

6- We organized 5 meetings (dialogue research/development) for IRA researchers and development agencies

7- We were very actively involved in the organization of the 4th IITA/COMBS Workshop - held at IRA/Garoua from 30 August to September 1992 and spent considerable of time and energy for the success of this workshop

4 6 PRIORITIES FOR FUTURE RESEARCH

1- Research on multipurpose legume species for sustainable cropping system in the subhumid lowland savanna

2- On-farm test-demonstration with interplanted fallow with cereals/legume species under conventional tillage and hedgerow of pigeon peas (farmers' management)

3- Effect of different intercropping patterns of cereals/legume species on cereals yields on an alfisol infested with Striga in the subhumid lowland savanna

Table 1 On-farm Testing Response of Maize CMS-8704 to Different Rates - a Minimum Tillage System in 12 Farmers Fields Located in the Sub-humid Lowland Savanna of Northern Cameroon 1991 (Maize Grain Yield T/ha)

Treat	Djal I	Djal II	Djal. III	Djal. IV	Sang. I	Sang II	Winde	Ngong	Zouye	Laboum	Raina I	Ra II
- Fert	3 30	1 15	0 99	1 37	1 01	1 12	1 59	3 56	0 79	0 32	0 58'	1 21
+ Fert	4 54	2 74	3 09	4 42	1 93	1 69	3 52	4 71	2 51	0 89	2 33	2 51
+ Fert 11kg N/ha	3 55	4 13	5 03	2 27	2 27	2 21	4 11	5 86	3 16	1 28	2 96	2 89
F + 22kgs N/ha	3 75	3 75	4 24	5 98	2 66	2 64	4 60	6 38	4 18	1 95	3 47	3 11
F + 44kgs N/ha	5 75	3 84	5 22	6 48	3 17	3 56	5 19	7 0	5 56	2 43	4 51	3 90
-	4 82	3 0	3 53	4 65	2 21	2 24	3 8	5 5	3 26	1 38	2 77	2 72
Average		142		291		356		404		473		332

Table 2

On-farm Tests/desmonstration
Interplanted Fallow under Minimum Tillage on Maize Performance 1992

Treatments	Farmers' Field I	II	III	IV	V	VI	AVERAGE	RGY %
T-1	2 50	2 23	3 28	4 52	2 53	3 46	3 06	92
T-2	2 45	2 33	4 35	4 50	1 82	4 36	3 30	100
Average	2 47	2 28	3 81	4 51	2 17	3 91		

F_{trt} = N S , C V 10% $F_{Farmers\ fields}$ = H S
T - 1 = Maize + P P Canavalia , T - Monocrop Maize

Table 3

Interplanted Fallow under Conventional Tillage
Performane in Farmers' Fields at Ouro-labo, Bajouma and Djalingo (1992-1993)

Treatments	Farmers' Field I	II	III	IV	V	VI	VIAVERAGE RGY		
T-1	4 01	4 39	3 59	3 28	4 21	3 68	3 68	93	
T-2	3 12	3 19	3 51	2 96	5 42	3 97	3 97	96	
T-3	3 98	4 35	3 39	2 90	4 79	4 47	3 97	96	
T-4	3 33	3 92	4 02	3 07	5 08	5 48	4 15	100	
T-5	4 27	3 62	3 29	3 51	5 37	4 71	4 12	100	
								Average	3 74
3 89	3 55	3 14	5 02	4 75					

T-1 = Maize + Canavalia , T-2 = Maize + Crotalaria , T-3 = Maize + Pigeon Peas , T-4 = Maize + Cowpea

F_{trt} = N S , C V $F_{Farmers\ fields}$ = H S

Table 4

Interplanted Fallow under Conventional Tillage with Maize

Treatments	Farmers' Field I	II	III	IV	V	VI	VII	VIII	IX	VIAVERAGE RGY	
T-1	3 30	1 96	2 15	2 98	2 70	3 87	3 57	4 10	3 93	3 17	91
T-2	2 90	3 06	3 38	2 63	2 97	4 24	4 50	4 68	3 08	3 48	100
T-3	2 50	2 04	3 60	2 38	2 99	3 82	3 60	4 70	3 83	3 26	93
										Average	
2.90	2 35	3 03	2 66	2 87	3 87	3 89	4 47	3 61			

T_{trt} = N S C V = 13% , $F_{Farmers\ field}$ = H S

T-1 = Maize + coewpea + Canavalia , T-2 = Monocrop maize , T-3 = Maize + pigeon peas

Table 5 — Response of Maize and Sorghum to Interplanted Forage Legume On Yield of Maize and Sorghum (1991)

Treatments	Maize (CMS-8704)	RGY %	Sorghum (CS-95)	RGY%
T-1	5 33	95	0 79	90
T-2	5 50	98	1 85	93
T-3	5 27	99	1 69	85
T-4	5-29	99	1,87	99
T-5	5 63	100	2 01	100
Average	5 40		1 84	

T-1 Maize + Calopogonium , T-2 = Maize + Stylosanthes , T-3 = Maize + Canavalia , T-4 = Maize + Pigeon peas
For maize -F_{trt} = N S , C V = 6% , For Sorghum F_{trt} = N S , C V = 17%

Table 6a — Residual Effects Of Interplanted Legume Species with Maize on Subsequent Maize Yield under Two Fertilization Levels, Djalingo 1992 (2nd Cropping Season), Grain Yield of Maize Cms-8704

TREATMENT PRECEDING CROPS	NO FERTILIZER	T/HA	RGY%	WITH FERTILIZER	T/HA	RGY%	AVERAGE	T/HA	(RGY%
I Maize	1 17 A	100		5 20 A	100		3 18 A	100	
II Canavalia Ens	2 14 B	182		6 44 B	125		4 29 B	134	
III Calopogonium	2 17 B	185		6 00 B	115		6 40 B	128	
IV Stylosanthes	2 25 B	192		6 40 B	123		4 32 B	135	

F_{Trt} = H S , C V 9 7 % , $F_{Test\ crops}$ = H S , F_{Int} = N S
LSD_{Trt} = 0 48 t/ha

Table 6b — Residual Efeects of Interplanted Legume Species with Maize on Subsequent Maize Yield under Two Fertilization Levels, Djalingo 1993 (3rd Cropping Season) Grain Yield of Maize Cms-8704 (2nd Cropping Season), Grain Yield of Maize Cms-8704.

TREATMENT PRECEDING CROPS	NO FERTILIZER	T/HA	RGY%	WITH FERTILIZER	T/HA	RGY%	AVERAGE	T/HA	(RGY%
I Maize		1 59 B	100		4 08 B	100		2 84 B	100
II *Calopogonium mucunoides*	3 80 A	238		5 51 A	135		2 84 A	163	
III *Stylosanthes hamata*	3 42 A	215		5 13 A	125		4 28 A	150	

F_{Trt} = S , C V = 18 04% , $F_{Test\ crops}$ = H S , F_{Int} = H S , $LSD_{05\%}$

Table 7a — Effect of Interplanted Maize/legume Species on Grain Yield (1993)

Treatment	Average Grain Yield	RGY%
T-1	5 69	93
T-2	5 84	96
T-3	5 62	92
T-4	5 45	89
T-5	5 52	90
T-6	5 82	95
T-7	6 08	100

T-1 = Maize + Cassia Obt , T-2 = Maize + Stylosanthes , T-3 = Maize + Crotalaria ,
T-4 = Maize + Pigeon peas, T-5 = Maize + Cowpeas , T-6 = Maize + Canavalia , T-7 = Monocrop Maize

F_{Trt} = N S , C V 12%

Table 7b — Effects Of Grain Legumes On Maize Fertilization with 2 Fertilization Levels, Djalingo 1993

TREATMENT PRECEDING CROPS	NO FERTILIZER T/HA	RGY%	WITH FERTILIZER T/HA	RGY%	AVERAGE T/HA	(RGY%
1 Natural fallow	1 22 B	100	3 67 B	100	2 45 B	100
2 Crotalaria	1 42 AB	116	4 49 AB	122	2 96 AB	120
3 Canavalia	1 98 AB	121	4 28 AB	116	2 88 AB	117
4 Mucuna	1 67 AB	136	3 71 B	101	2 69 AB	109
5 Pigeon peas	1 52 AB	124	3 70 B	108	2 61 AB	106
6 Cassia Obt	1 42 AB	116	4 27 AB	116	2 84 AB	115
7 Stylosanthes	2 30 A	188	5 07 A	138	3 68 A	150
8 Calopogonium	1 52 AB	124	3 93 B	107	2 73 AB	111
9 Cowpea	1 69 AB	138	4 55 AB	128	3 12 AB	127

T_{Trt} = H S , C V 21 19 % , $LSD_{Trt\ 05\%}$ = 08 t/ha , $F_{Test\ crop}$ = H S , $LSD_{Test\ crop}$ = - 1 0 t/ha

Table 8 — Effects of Different Crops Rotation on System on the Grain Yield of Maize and Sorghum (Djalingo 1991 - 1992)

Treatment	Maize TZPG-SR Av Grain Yield (t/ha)	Yield Increase (t/ha)	Damougari Av Grain Yield (t/ha)	Yield Increase (t/ha)
Cowpea	6 63	0 77	2 53	0 60
Groundnuts	6 16	0 21	2 16	0 23
Cotton (control)	5 94	-	1 93	-
Pigeon peas	6 23	0 29	2 20	0 33
Soybean	6 06	0 12	1 99	0 06
Cereals	4 78	(-1 16)	1 64	(-0 28)
Crotalaria	7 18	1 24	3 18	1 25
Average	6 13		2 85	

Table 9 Response of Maize to N Fertilization, Djalingo (1991-1993)

N Rate (kg/ha)	PRECEDING CROPS Crotalaria (t/ha)	(t/ha)	Pigeon Peas (t/ha)	Cowpeas (t/ha	(t/ha)	Groundnuts (t/ha)	Maize	Average
0	5 16		4 01	4 37		3 97	3 01	4 11
45	5 93		5 16	5 47		5 28	3 90	4 81
90	6 98		5 84	6 19		1 93	4 84	5 96
135	7 25		6 57	6 58		6 24	5 36	6 40
Average	6 28 A	5 39 B	5 63 B	5 41 B	4 28 C	5 40		

F_{Trt} = H S

Table 10 Effect of Tourteau De Coton (T c) on Yield of Maize, Djalingo 1991- 1992

Treatment	Grain Yield (t/ha)	Yield Increase (t/ha)	RGY%
1) - F, - T C (control)	2 87	-	100
2) + F,	5 02	2 42	199
3) + F, + 300 kgs/ha T C	5 44	2 84	214
4) + F, + 600 kgs/ha T C	6 18	3 58	245
5) + 1/2 F	4 14	1 54	162
6) + 1/2 F + 300 kgs/ha T C	4 93	2 33	195
7) + 1/2 F + 600 kgs/ha T C	5 52	2 92	221
8) + 300 kgs/ha T C	3 93	1 35	157
9) + 600 kgs/ha T C	4 73	2 13	189
Average	4 72		

Table 11 Response of Cms-8501 to Different Rates of Manure and Fertilzer in a Representative Alfisol of the Lowland Savanna Djalingo (192)

Treatments	Grain Yield (t/ha)	Yield Increase (t/ha)	RGY%
I Control (no Fert no Man	2 35	-	100
II Cow manure (1 t/ha)	4 45	2 10	189
III Cow manure (2 t/ha)	5 67	3 32	241
IV Fertilizer	6 31	3 96	268
V Fertilizer + manure (2 t/ha)	7 89	5 54	335
Average	5 33		

Note F H S , C V = 7% , LSD = 0 58 T/ha
Fert = Fertilizer rate used 120 N + 60 P_2O_5 + 60 K_2O + 6S + $2B_2O_3$ kgs/ha
RGY% = Relative grain Yield

Table 12 Effect of Different Trap Crops Grown in Rotation On Grain Yield of Maize and Sorghum with Striga (Karite 1991)

Treatments	Maize Yield (t/ha)	Av Striga Plt /m2 9 WAP	12 WAP	Sorghum Yield (t/ha)	Av Striga Plt /m2 9W	12 WAP
1 Cowpea	2 63	1 21	3 4	1 04	1 10	8 50
2 Grounduts	2 01	2 00	6 1	0 89	8 40	11 30
3 Cotton	2 23	1 9	5 2	0 93	8 45	10 70
4. Pigeon peas	2 35	2 35	1 4	0 87	7 60	13 30
5. Cassia obt	2 44	1 1	3 1	1 36	5 90	10 0
6 Maize (cont)	1 77	5 5	9 3	0 61	13 60	16 55
7 Crotalaria	2 98	0 9	1 7	1 30	3 15	4 3
Average	2 31			0 94		

Table 13 Effects of Different Intercropping Partterns - Maize and Sorghum Legume Species on the Yield of Maize and Sorghum (Karite 1991)

Treatments	Maize Yield (t/ha)	Av Striga Plt /m2 10 WAP	14 WAP	Sorghum Yield (t/ha)	Av Striga Plt /m2 D W	14 WAP
1 Cowpea (2 1 on same row)	1 56	0 43	1 15	0 60	2 0	2 4
2 Cowpea (same hill)	1 52	0 83	1 35	0 62	1 4	1 8
3 Crotalaria (same hill)	1 82	0 40	1 20	0 70	1 3	2 0
4 Cassia obt (same hill)	2 07	0 20	0 81	0 79	1 1	1 5
5 Cereal mono-crop	1 28	1 46	3 5	0 47	4 5	5 1
Average	1 65			0 63		

5 SORGHUM AND MILLET RESEARCH UNIT

5 1 SORGHUM BREEDING

5 1 1 INTRODUCTION

Sorghum and millet are the major cereal crops grown in semi-arid areas of northern Cameroon They are the staple food for the population of this zone They are also used for making local drinks Sorghum stalks are used as building material, for animal feed and fuel

Two types of sorghum are grown, the rainy-season sorghum and the post-rainy season crop known as Muskwari Muskwari is transplanted in vertisols and grows on residual soil moisture Pearl millet is also grown during the rainy-season Its production has been decreasing these years and now accounts for about ten percent of the total production of sorghum and millet in the Far North Province

The current combined annual production of these two cereals is about 418,000 metric tons in the three northern provinces Rainy season sorghum contributes for more than half of the total production Muskwari accounts for about the third of the sorghum and millet production

5 1 2 OBJECTIVES

The main objective of the Sorghum and Millet Research Program is to increase the sorghum and millet production through development of high yielding cultivars resistant to various stress factors During the past three years (1991-1993), priorities were given to

* Breed sorghum for striga and drought tolerance
* Evaluate advanced breeding lines
* Generate segregating progenies
* Select and test varieties
* Improve local cultivars in terms of grain quality, maturity cycle and resistance to various stresses
* Identify short cycle and photoinsensitive pearl millet varieties

5 1 3 CONSTRAINTS

Sorghum and millet production is limited by a lack of suitable varieties with desirable agronomic and grain quality traits and the very long cycle of most local cultivars Stress-related constraints include erratic rainfall, striga, pests and diseases Limited soil moisture, laborious manual land clearing and transplanting are the major constraints for Muskwari sorghum Other constraints are socio-economic related and limited facilities for small farmers to get fertilizers

5 1 4 ACCOMPLISHMENTS

Keeping with the four-year work plan of 1991 that was sometimes slightly modified and approved annually, work has been carried out on the improvement of sorghum and millet in the North and Far North provinces These two zones are ecologically different and as such, materials and selection criteria varied accordingly

In the Extreme-North Province termed zone I, rainfall ranges from 300 mm to 800mm Sorghum and pearl millet are the main cereals in this zone North Province is known as zone II and has rainfall up to 1200mm

During the last phase of NCRE project, 636 rainy season sorghum accessions and 440 millet accessions were introduced to the breeding program from various international research institutions and regional research agencies In addition, 210 Muskwari accessions were collected and brought to the station for classification and evaluation

During the three campaigns, 95 sorghum crosses from all possible combinations with local and exotic materials have been made and selection has been going with the advanced segregating progenies Seventy five sorghum and millet trials have been carried out in the two ecological zones Advanced sorghum breeding lines, local cultivars and introductions that performed satisfactorily in preliminary yield trials were advanced to multilocation tests Results of these trials at different research stations and sub-stations located in each of the two ecological areas have helped to identify some promising varieties

In the low rainfall zone, varieties such as ICSV-111, ICSV-1079 and CS-130 gave good results over locations (tables 1, 2 and 3) Furthermore, it appeared that varieties which performed well under limited rain fall and other stress factors in zone I are early maturing cultivars These cultivars escape the drought that occurs during to the rainy-season by completing their cycle before the rain stops

A second group of varieties, namely CS-233, CS-244 and ICSV-1063 showed satisfactory results for the zone of higher rainfall over two years in multilocation trials (tables 4 and 5) These varieties as well as the first three mentioned for zone I should be tested in farmers' field conditions

Among the rainy season local sorghums that were collected since 1988, purified and made uniform, some cultivars like Boulbassiri, Gueden-Gueling, Wongtosho and Zouaye gave encouraging results in various locations in Far North Province These local varieties have been found agronomically performant, with good yield potential Therefore, they will be used to increase the number of the parental materials which constitute the base of our long term breeding program

The Sorghum and Millet Research Unit has conducted striga trials during the last three years Results showed that in addition to genotypes like S-35, CS-54 and CS-95, ICSV-111, CS-130 and ICSV-1079 are less susceptible to *Striga hermonthica* Therefore, these lines are likely to be introduced in the pipeline and serve as parents in the crossing program

Although hybrid development is not a major concern of the Sorghum Breeding Unit, the maintenance of some germplasm and the identification of a number of female parents and restorers for future breeding strategies have been our objectives

Table 1 Trial Multilocation Sorghum Variety Adaptation Trial-1991 (Early Duration) Combined Means over Three Locations

Entries	Grain yield kg/ha	Rank	Days to 50% flow	Plant height (cm)	Panicle length (cm)	Plant count after thinn /ha		Panicle count after harv /ha	1000 grain weight (grs)	
ICSV-111	3 037	2	63	183		59 166	58 194	24	26 55	
ICSV-247	2 530	8	66	165		59 305	57 777	30	22 11	
CS-181	2 405	9	69	239		59 583	57 638	25	26 77	
CS-210	2 633	5	66	200		65 694	62 083	26	27 44	
CS-54	2 691	3	62	178		58 611	60 694	23	28 00	
S-35	2 538	7	64	178		64 444	59 444	21	27 33	
Nagawhite	3 258	1	62	174		65 833	65 000	29	25 55	
Barlang	2 647	4	67	255		67 916	60 833	24	28 11	
Gueden-Gueling	2 600	6	66	230		60 833	57 916	19	29 88	
Gueling	2 377	10	69	273		68 888	62 916	25	26 33	
Overall Mean	2 263		68	212		61 344	58 977	26	24 84	
L S D	1051 36		5	36 78		12 447	14 539	5 19	24 84	
CV%	28 73		4 55	10 69		12 55		15 25	11 97	10 40

Table 2 Trial Multilocation Sorghum Variety Adaptation Trial-early-1992 Combined Means over Four Locations

Entries	Grain yield kg/ha	Rank	Days to* 50% flow	Plant height (cm)	Panicle** length (cm)	Plant** count after thinn /ha	Panicle** count after harv /ha	1000 grain** weight (grs)
CS-61	2 379	9	64	197 8	22 00	57 110	49 920	30 83
ICSV-1079	2 589	2	64	190 0	24 75	63 440	47 110	26 01
CS-141	2 446	7	69	245 9	23 63	61 250	49 770	30 39
ICSV-1083	2 475	5	69	202 2	20 25	64 300	48 360	27 76
CS-63	2 448	6	69	186 3	27 00	64 140	54 530	27 99
CS-233	2 958	1	65	296 6	24 81	64 530	57 190	35 16
CS-54	2 396	8	63	205 3	22 44	55 860	46 950	30 69
S-35	2 541	4	63	202 5	22 63	57 810	48 910	31 99
CS-130	2 318	10	64	205 9	22 56	59 450	46 640	31 72
Damougari	2 564	3	65	173 8	13 19	63 830	53 440	32 03
Overall Mean	2 206		66	210 92	22 28	59 840	48 450	28 90
L S D	199 9		0 6	6 4	0 6	2153 8	2651 8	0 6
CV%	36 24		3 44	12 15	11 02	14 40	21 89	8 73

** **Significant at 0 01 probability level**

Table 3 Trial Multilocation Sorghum Variety Adaptation Trial-early-1993 Combined Means over Two Locations

Entries	Grain** yield kg/ha	Rank	Days to** 50% flow	Plant height (cm)	Panicle** length (cm)	Plant** count after thinn /ha	Panicle** count after harv /ha	1000 grain** weight (grs)
ICSV-1079	4 123	4	62	200 0	29 88	59 530	61 410	26 44
ICSV-1089	3 811	10	68	214 4	26 00	57 190	62 340	25 77
ICSV-1083	4 188	3	68	223 1	24 50	53 280	57 030	29 69
CS-54	4 080	5	63	216 9	26 50	53 130	48 590	32 40
CS-61	3 841	9	64	211 3	29 63	57 030	54 690	31 93
CS-130	4 256	2	64	216 9	27 00	54 060	58 280	34 33
ICSV-111	4 319	1	64	214 4	26 50	54 060	61 090	34 24
S-35	3 969	7	62	211 9	27 88	46 720	49 380	34 85
CS-251	3 913	8	66	230 6	27 25	54 060	54 530	31 05
Damougari	3 991	6	69	184 4	14 63	60 310	70 470	32 31
Overall Mean	3 632 03		67	228 32	26 47	56 699	59 180	30 09
L S D	662		3	17 9	2 1	3661 44	8307	2 1
CV%	18 34		4 12	7 98	7 97	18 27	14 13	7 25

** Significant at 0 01 probability level

Table 4 Trial Multilocation Sorghum Variety Adaptation Trial-medium-1992 Combined Means over Three Locations

Entries	Grain** yield kg/ha	Rank	Days to** 50% flow	Plant height (cm)	Panicle** length (cm)	Plant** count after thinn /ha	Panicle** count after harv /ha	1000 grain** weight (grs)
CS-144	2 450	8	69	265 4	24 67	56 350	45 630	27 00
CS-233	2 452	7	63	288 3	26 58	55 520	47 290	33 00
ICSV-1083	2 388	10	67	205 4	23 33	58 540	46 040	25 41
CS-159	2 395	9	71	225 8	20.50	53 850	47 500	26 99
CS-169	2 522	6	66	227 5	23 08	50 730	43 440	29 94
CS-244	2 702	3	65	228 3	22.67	57 600	48 330	28.63
ICSV-1069	3 073	1	66	211 3	19 92	57 400	54 060	27 89
CS-61	2 809	2	63	222 1	22 92	53 130	49 580	29 45
CS-95	2 591	5	62	208 3	23 25	54 790	46 980	29 66
ICSV-210	2 647	4	64	225 4	24 75	56 040	47 400	30 82
Overall Mean	2 341 79		67	241 45	22 60	54 715	46 349	28 20
L S D	183 4		0 6	7 2	0 8	2299 2	2367 5	0 6
CV%	27 12		3 44	10 27	11 93	14 56	17 69	7 03

** Significant at 0.01 probability level

Table 5 Trial Multilocation Sorghum Variety Adaptation Trial-medium-1993 Combined Means over Two Locations

Entries	Grain** yield kg/ha	Rank	Days to** 50% flow	Plant height (cm)	Panicle** length (cm)	Plant** count after thinn /ha	Panicle** count after harv /ha	1000 grain** weight (grs)
CS-233	3 131	10	70	343 8	27.38	69 840	63 440	32 17
ICSV-1083	5 033	1	67	235 0	24 00	63 440	61 410	31 30
CS-159	3 306	7	74	263 9	23 13	59 530	56 720	29 15
CS-210	3 227	8	68	211 3	26 38	64 380	58 440	32 80
CS-244	3 663	5	69	255 0	26 63	70 940	60 940	29 95
CS-130	4 331	2	64	223 1	26 75	62 810	57 190	33 31
ICSV-210	3 542	6	64	225 6	24 00	69 380	65 470	24 30
ICSV-1063	3 998	4	68	240 0	27 88	55 940	53 280	30 27
CS-278	3 192	9	70	337 5	25 00	67 190	51 090	33 33
CS-61	4 181	3	64	215 0	26 00	69 910	51 090	33 45
Overall Mean	3228 68		69	262 14	24 96	63 189	55 129	29 97
L S D	765 5		0 94	33 6	1 9	9280	2938 45	2 209
CV%	23 89		3 82	12 93	7 77	14 80	15 08	7 43

** Significant at 0 01 probability level

The Sorghum and Millet team has been collaborating with international and regional research institutions and agencies like ICRISAT, PASCON, ROCAFREMI and WASIP Various variety trials, disease and pest experiments have been carried out Collaborative work has also been done on striga

As pearl millet is concerned, emphasis was put on developing suitable high yielding cultivars that are resistant to downy mildew and other millet diseases such as ergot and smut Attention has equally been given to cultivars that are photoinsensitive In fact efforts devoted to millet research during this final phase of NCRE Project have helped to identify two varieties of pearl millet, Gouzouma and IKMV-8201 with high yielding potential They are also early maturing and mold resistant On-station and farmers' field trials revealed a yield increase of about 22 percent for Gouzouma and near 10 percent for IKMV-8201 over the best local check

5 1 5 IN-SERVICE TRAINING

In-service-training took place during this last phase of the project Mr Bailangsou Gamdandji, the technician attached to the Sorghum and Millet Research Unit spent six months in training in ICRISAT, India in 1991 In December 1991, Mr Andre Djonnewa joined the team after his M Sc training in sorghum breeding in the United States From 1992 to 1993, Mr Richard Kenga assisted to several workshops from Mali, Nigeria, Zimbabwe and Burkina Faso

Although not financially supported by NCRE Project, Mr Jacques Beyo, the entomologist of the Sorghum and Millet Unit left in October 1993 for his M Sc training in Ahmadu Bello University in Nigeria

5 1 6 PRIORITIES FOR FUTURE RESEARCH

Insufficient number of technicians and other qualified support staff constitutes a major problem for to the Unit The Sorghum and Millet Program is a big program run by two M Sc , one B Sc and one technician A senior scientist (Ph D) is very necessary Other job-related problems are lack of short-term training for the researchers, lack of backstopping to the program and inadequate research equipment such as non functional cold room for keeping breeding materials

As research activities are concerned, emphasis should be put on breeding for Muskwari sorghum Pluridisciplinary research may be very essential on this crop which is of great importance in the vertisols of North Cameroon where it is grown in dry season with residual soil moisture Work should continue on developing materials more resistant to drought and striga which are very limiting factors to sorghum production Research should emphasize improving local cultivars which are more adapted and acceptable by farmers However, undesirable characters of these local varieties should be corrected using improved exotic lines

Areas planted to pearl millet and its production are now decreasing due to lack of suitable varieties Unfortunatly, research still devotes time to it More effort should be directed to develop high yielding and adaptable varieties of pearl millet for its zone of interest

5 1 7 PLANS TO SUSTAIN RESEARCH EFFORT

Research should generate resources to support itself or part of its work Thus, there is a necessity to valorize the research products Regional research activities could give more strength to national research institutions Therefore priorities should be given to regional research projects Direct more efforts to pluridisciplinary research which seems to fit more to the present situation

5 2 SORGHUM AGRONOMY UNIT

5 2 1 INTRODUCTION

This is a 1991 -1993 summary report of sorghum agronomy program of IRA /NCRE Maroua While in phases I and II of the NCRE Project, the technical assistance (TA) was full time sorghum agronomist, in phase III the position was turned into system agronomist in order to play an important role in TLU pre-extension activities and training while continuing technology development on-station This report however deals mainly with on-station activities

5 2 2 OBJECTIVES

1 Identify viable practices to conserve soil moisture and fertility in rainfed and dry season sorghum,
2 Identify practices to reduce *Striga hermonthica* populations in rainfed sorghum

SPECIFIC GOALS

1 Identify one or more candidate systems of both cover cropping and alley cropping,
2 Identify improved practices for moisture conservation in dry season sorghum
3 Study the long term effect of *Striga* control components on subsequent striga populations and seedbank

5 2 3 CONSTRAINTS

1 Short growing season characterized by limited and very erratic rainfall
2 Poor and decreasing soil productivity, aggravated by appreciable erosion limits production and threatens the sustainability of the systems
3 *Striga*, a parasitic weed of cereals causes serious damage to sorghum
4 Birds cause considerable loss to short cycle improved sorghum varieties
5 Insect pests and diseases

5 2 4 ACCOMPLISHMENTS

COVER CROPPING AND ALLEY CROPPING

Screening of cover crop for soil protection

Vegetative cover is necessary to protect the soil surface from rain drop impact and consequent surface compaction and runoff Leguminous cover crops would have the additional benefit of contributing some N to the soil for subsequent crops The first question to be answered was whether there are some adapted species which grow rapidly during the rainy season Thus screening of candidate legumes began in 1991 at Mouda on a gravelly ferruginous Alfisol and continued in 1992 at three additional sites (Ndonkole on Vertisols, Guiring on alluvial in plains soil and Guetale on alluvial soil near mountains) to evaluate the adaptability on different soil types Species which did not establish or grow well such as *Stylosantes hamata* and *S guyanensis* , *Centrosema pascuorum* and *C brasilianum* 1991 and 1992 were discarded in 1993 In 1993 ten promising species out of twenty were tested for the the third time at the same sites except Guiring Legumes species screened were mostly from ILCA /Kaduna, IRZV Garoua and local collection They were planted in pure stand in small plots in RCBD every year Groundcover, biomass and soil temperature were measured Nodule formation was also observed

From 1991 to 1993, *Mucuna pruriens* provided the earliest and most complete cover (60 days after planting) *Mucuna* and *Canavalia* species accumulated the highest biomass Late pigeon pea and *Canavalia* stayed green the longest Soil temperature was often negatively correlated with cover crops i e lower when biomass was higher Nodules were found in all species tested except *Canavalia* and *Cajanus cajan* Most of the nodules were pink inside (except cowpea) indicating that they were actively fixing nitrogen Seed production was influenced by the genotype and environment

Observation of Pigeon Pea and Cassia siamea Hedgerows and Associated Crops

While alley cropping is considered to be a biologically sustainable cropping system in the humid and subhumid zones, it may not be appropriate in semi-arid areas The tree species which are most adapted to dry conditions may be those which most compete with an associated crop for soil moisture Thus, from 1991 to 1993, trials were conducted to observe the growth and response to pruning of pigeon pea *Cajanus cajan* and *Cassia siamea* and the yield of associated crops The trees were established in 1990 Pigeon pea was planted at the onset of the rains every year In 1991, associated peanut yields were lower in the two rows next to the *Cassia siamea* hedgerow than in the central rows which were one meter or more from the hedgerow (table 1) Pigeon pea depleted soil moisture and reduced yield of associated peanut In 1992, grain yield in the central rows of the Cs plots was equal to that of the unplowed control Yields in plowed plots were 25% higher, possibly reflecting improved moisture or fertility status due to incorporated residues (table 2) *Cassia siamea* hedgerows also produced substantial amounts of firewood and did not compete with an associated sorghum crop (FIG 1)

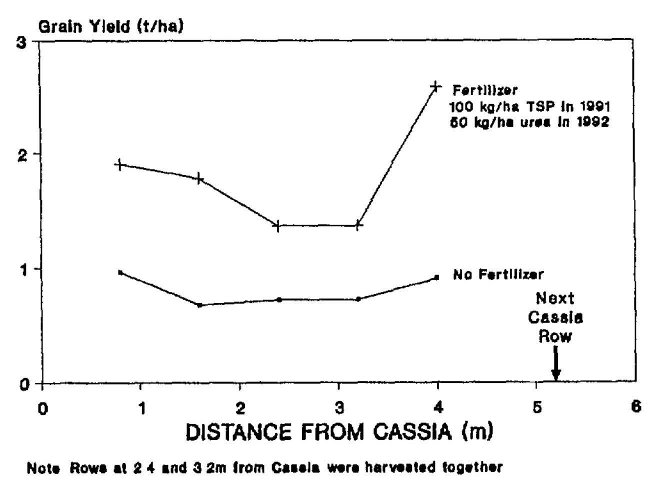


Figure 1 Sorghum grain yield as function of distance from *Cassia siamea* hedgerow at Mouda, 1992

Cotton was planted in 1993 in *Cassia siamea* and *Cajanus cajan* hedgerows Although there was no competition for moisture, *Cassia siamea* significantly reduced cotton yield because of shading *Cajanus cajan* was also depressive on cotton yield but to a lesser extent (table 3)

Table 1 Pod and hay yield of peanut in central and border rows of plots with Cassia siamea or no hedgerows, 1991

Treatment	-- Peanut Pod Yield -- Central Rows	Border Rows	-- Peanut Hay Yield -- Central Rows	Border Rows
	kg ha^{-1}			
No tree	1620	1660	2580	2560
C siamea	1610	1430	2390	2460
SE	n s	n s	n s	n s.

Table 2 Grain and stover yield of sorghum in central and border rows of plots with Cassia siamea or no hedgerows, 1992

Treatment	---- Grain Yield ---- Central Rows	Border Rows	--- Stover Yield --- Central Rows	Border Rows
	kg ha^{-1}			
No tree, Not Plowed	1070	1360	3890	4350
C siamea, Not Plowed	1050	1440	4680	5170
No Tree, Plowed	1330	1710	5540	5570
SE	n s	n s	n s	n s

Table 3 Cotton yield (kg/ha) in central and border rows in different treatments at Mouda, 1993

Treatments	Central rows	Borders rows
Tree, plowed	510 ab	590 a
Cassia siamea	333 c	375 bc
Cajanus cajan	496 ab	503 ab
No tree not plowed	396 bc	451 abc
Means	434	480
LSD (5%)	139	

Striga Research

Technology generation for control of *S hermonthica* usually focuses on current year control to protect the sorghum crop A successful technology must also reduce *Striga* seed populations, thereby reducing *Striga* pressure in subsequent years

In 1991 two trials were conducted to evaluate the effect of *Striga* control with herbicides for two cropping seasons (1989 and 1990) on densities of emerged *Striga* in control years and of *Striga* seed and plants in subsequent years The herbicides 2,4-D, Garlon, Paraquat, and Buctril and Urea solution (20%) were compared to handweeding of *Striga* and a control treatment Reduction of emerged *Striga* density during the two years of treatment was greatest with 2,4-D and Garlon Sorghum grain yield was greatest with Urea solution Subsequent *Striga* seed densities were not significantly different although substantially lower in the 2,4-D treated plots (table 4) Emerged *Striga* densities in subsequent years were generally not significantly related to previous herbicide treatments

In 1991 and 1992 an important researchable issue was also the appropriate distance between sorghum and cowpea plants seed at planting Sorghum/Cowpea intercrop did not significantly reduce *Striga* emergence However, the number of *Striga* carrying mature capsules at sorghum harvest was significantly lowest in cowpea/sorghum intercrop The lowest density of mature capsule-bearing *Striga* plants was obtained with one hole of cowpea containing two plants between two pair of sorghum holes while the highest was in the pure sorghum treatment However the highest yield of the intercrop was when two holes of cowpea (each containing one plant) were placed at 5 cm from each pair sorghum holes (table 5)

In 1992 and 1993 the initial *Striga* seedbank was determined before surperimposing our "best bet technologies" to reduce *Striga* seed in the soil Previous treatment was again a non significant factor in *Striga* seed density (table 6)

Table 4 Striga seed density (kg^{-1} soil) in 1991 and 1992 following Striga suppression for two years with herbicides or handweeding, Experiment 1 Separation of Striga seed from soil with sucrose solution in 1991 and K_2CO_3 solution in 1992

Treatments	1991	1992
Control	1375	280
Handweeding	567	367
2,4-D	508	173
Urea Solution	1125	347
Buctril	1092	283
Paraquat	767	313
SE	256	n s

Table 5 Sorghum (S-35) and cowpea (Vya) yields in trial of sorghum/cowpea intercropping, 1991

Treatment†	Cowpea Planting Density ha^{-1}	----Sorghum---- Grain kg ha^{-1}	Stover t ha^{-1}	-------Cowpea----- Cover %	Grain kg ha^{-1}	Hay t ha^{-1}	Striga w/ Capsules_ ha^{-1}
T1	----	740	1 55	--	---	----	10,400
T2	42,000	950	1 55	58	300	1 55	1,600
T3	42,000	730	1 64	79	360	2 85	2,300
T4	42,000	690	1 54	64	320	1 85	2,100
T5	42,000	860	1 35	67	360	1 81	4,300
T6	42,000	1180	2 14	66	320	2 24	2,300
T7	21,000	910	1 66	22	200	0 78	7,400
T8	42,000	910	1 58	49	310	1 32	7,800
SE		220	0 23	7	61	0 32	2,500

Table 6 Initial Striga seedbank and fraction of seed emerged, Mouda,1993

Treatments	Striga seed/m2	Striga emerged /m2
Djigari	170800 a	73 a
S35	126000 b	66 a
Djigari/Vya	84000 c	60 a
S35/ Vya	75000 c	56 ab
Djigari/2,4-D	61000 c	29 b
S35/2,4-D	162000 ab	56 ab
SE	10832	8

Study of Moisture Management in Muskwari Sorghum

The major limiting factor in Muskwari sorghum is the amount of moisture which is present in the soil at the time of transplanting (beginning of the dry season) A study was conducted to quantify moisture depletion by the crop at two sites through intensive soil sampling Total moisture loss from 0 to 80 cm depth was 105 cm at Mouda and 130 cm at Salak Soil surface treatments (native grass mulch or superficial plowing) did not decrease soil moisture loss in 1991 and 1992

5 2 5 IN-SERVICE TRAINING

The TA, Dr R J Carsky helped sorghum Agronomy Unit for transition to independent functioning without a TA This by giving more responsibility to counterparts in planning, desining and budgeting experiments Another area of training was computer use knowledge especially for statistics, word processing and graphics and the preparation of reseach results for publications A technician was fully trained to record data in various field experiments The TA coordinated training of PNVFA subject matter specialists and divisional supervisors in about 10 sessions per year

5 2 6 PRIORITIES FOR FUTURE RESEARCH

a) Quantification of *Striga hermonthica* seed bank with best technologies
b) Laboratory screening of false hosts of *Striga hermonthica* which might then be incorporated into sorghum-based rotations or intercropped with sorghum
c) Quantification of N contribution to second year cereal crop of first year improved fallows left as mulch during dry seasons
d) Continued search for appropriate fallow species

5 2 7 PLANS TO SUSTAIN RESEARCH EFFORT

Despite the economic hardship, we count on the Government of Cameroon to provide funds for research Minimum activities can be maintained through bilateral assistance such as Projet Garoua II Another possibility is to write a grant appplication for research proposal

6 0 TESTING AND LIAISON RESEARCH UNIT

6 1 TLU BAMBUI

6 1 1 INTRODUCTION

The TLU-Bambui is the original Testing and Liaison Unit Established in 1981, it is based at the IRA Bambui Station (1500 m a s l) in the N W Province and is responsible for farming systems research in the Western Highland Zone of Cameroon (i e NW and W Provinces), with an emphasis on maize and rice-based cropping systems Within this period, it functioned with 2 expatriates (1 Agric Economist and 1 Soil systems Agronomist), 3 national counterpart researchers and 4 agricultural technicians reduced to two the last year

6 1 2 OBJECTIVES

The TLU was designed to serve as a linkage between research and extension/farmers The original objectives of the TLU, listed in the Project contract are

- to train extension personnel and agricultural technicians,
- to design the methodology of on-farm trials/demonstrations,
- to coordinate the on-farm testing program,
- to study the results including the socio-economic impact of proposed recommendations,
- to feed back on-farm research results and information on researchers,
- to translate research results into recommendations to be extended to farmers,
- to develop, release and ease the adoption by farmers of appropriate agronomic packages

6 1 3 CONSTRAINTS

The constraints most limiting on the work of the TLU Bambui during the last 3 years included

- lack of adequate field lab facilities,
- non departure of national counterparts for Ph D training,
- continued IRA workers' strike over unpaid salaries,
- a volatile political situation that prevented TLU staff from going out to their on-farm research sites,
- the lay-off of many MIDENO VEW's that constituted the main technical labour force of the agricultural Extension service in the NW Province
- difficulties at the end of 1993 in getting financial support because of the announcement of the anticipated phasing of the project out by April 1994

6 1 4 ACCOMPLISHMENTS

A second generation of varieties (e g maize varieties ATP, Synthetic 3 and 4, Early White and HAP, and the TOX rice varieties), that entered on-farm testing in 1989, incorporated additional characteristics desired by farmers, a result of TLU feedback to the breeders These included harder (flinty) grain for longer storage life, earliness, shorter plants, tolerance to low pH soils, and adaptation to the high altitude zone for maize, and, enhanced grain quality (long, narrow, translucent, slender grains) for rice, to make it more competitive in the market with imported rice from Asia These varieties of maize and rice are being extended to farmers

The on-farm trials program was complemented (and motivated in later years) by farmers surveys single visit descriptive, resource monitoring (descriptive), and rapid rural appraisals, (RRAs), retention and diffusion studies RRAs (diagnostics) helped identify research topics important to solving farmers' problems (e g , assessing storage losses, erosion and soil fertility problems)

The TLU also initiated a program of joint researcher-farmer managed on-farm soil conservation (mainly use of contour bunds for erosion control) and soil fertility improvement (Tephrosia fallow) trials in 1991-93, in collaboration with the Provincial Delegation of Agriculture Adaptive Research Service and U S Peace Corps 10-year Agroforestry Project

Efforts were made to come up with a completed soil map for the North West Province initiated by MIDENO now available and produced in colour, the characterization of the NW Province and Upper Noun River soil fertility based upon parent materials

It also finalized the research on lime study, the adequate phosphorus maintenance on the group 1 and 2 soils and the adaptability of the 2nd generation of maize varieties on the defined soil groups

Screening of 3 soyabean lines for grain yield, severity of leaf spot diseases incidence and seed viability was made with the collaboration of IITA and PDA, NW Province They are ready for on-farm testing

The first two IRA/NCRE maize hybrids were tested on-farm and significantly yielded higher than the commercial ones from the Pioneer Seed Company, at the recommended input level in the large maize producing areas (Ndop & Noun Plains)

The TLU was also actively participating in training activities in line with the start up of the National Training and Extension Project (NTEP) in the West Province This new engagement in the W P should presage an impact in terms of significant farmer adoption of IRA/NCRE improved maize varieties in the West similar to that already experienced in the NWP

The TLU trial program comprised 3 major themes Varietal testing, soil fertility management/characterization and cropping patterns

1991

Survey of Farmers Traditional Maize Stores. A survey of farmers maize stores, initiated in 1990, was completed in 1991 The objective was to obtain accurate estimates within zones Losses were of 2 kinds quantitative (% weight loss), and qualitative (% damaged weeviled or moldy grains) The study was carried out collaboratively by TLU and the FAO Postharvest Food Loss Reduction Project It entailed sampling maize ears from 40 stores at regular intervals, followed by laboratory assessments of loss Farmers were interviewed about household characteristics, storage practices and maize use patterns Potential quantitative losses in the Mid-altitude zone (Ndop 1200m) were assessed at between 0 1 and 35% (mean=7%) Assessed qualitative losses ranged from 2% to 64% (mean=23%) damaged grains (by weight) in the last storage period (August) The average value of storage losses to the Ndop Plain farmer storing 2 5 tons of maize (shelled equivalent) was estimated at 15% (23,000 CFA)

On-Farm Mid-altitude Maize Variety. In the 3rd year of on-farm testing of 2nd generation maize varieties, 3 new varieties were compared with an already released variety (COCA or KASAI) and the farmer's LOCAL variety The single replication trial was set out on 56 farms in the NWP and WP in the first season (Mar-Sept) A slightly modified version of the trial was planted during the 2nd season (Aug-Dec) on 25 farms in 2 zones in the NWP where maize is double-cropped (Bali and Mbingo-Fundong axis) New varieties tested included ATP, SYNTHETIC-3, EARLY WHITE and MSR (end season trial) Fertilizer was applied at a low level (100kg 20-10-10) and most management decisions left to the farmer The maize was intercropped with soybeans In the 1st season, the new varieties outyielded the farmers' LOCAL varieties by a mean 0 5 t/ha (24%), but did not outyield the released varieties With the exception of Early White, farmers assessed the new varieties as being superior to their LOCAL varieties Specific characteristics of the new varieties (e g , yellow color and flinty grains for the ATP variety) were of special interest to subsets of farmers, demonstrating the differences in preferred maize characteristics among farmers in the area In the 2nd season trial, no new varieties yielded more than the LOCAL variety

On-farm High-altitude Maize Variety. New high altitude maize varieties were tested on-farm for the third year in the Western Highlands of the NWP The trial design was identical to that used in the mid-altitude maize variety trial (See above), with phaseolus beans replacing soybeans as the intercrop Varieties tested included HAP, POOL 9 and IMPROVED-NDU-LOCAL, with a LOCAL variety check The trial was set out on 27 farms After 2 years of promising results for the HAP variety, results that gave the TLU reason to hope that the 1st improved high altitude maize variety would be released in 1993, HAP performed poorly in 1991, yielding no better than the LOCAL variety Moreover, most farmers ranked their LOCAL variety first in overall performance A new maize disease in the area, Phaeasophora leaf spot, widely attacked all varieties in the trial, including the LOCAL

1992

<u>On-Farm Trials Maize Variety</u> The overall objectives of the on-farm trials were

- Evaluate adaptability of new improved varieties to the different environments in the area
- Provide an opportunity to the farmers to assess the new varieties within their various cropping systems,
- Use the feedback from farmers as basis for improving technology and future research plans

Four 2nd generation open pollinated mid-altitude maize varieties (ATP, Synthetic, Kasai and Early White) were tested for adaptability to farmer cropping conditions for 2 years In the second year, sites selection covered the major soil groups (Table 1) on the soil map including the high-altitude zone where HAP variety was tested on group 4

<u>Table 1</u> Grain yield (kg/ha) performance of improved mid-altitude maize varieties on different soil groups in the Western Highlands

Soil Group Description	Early White	Syn 4 High Fert	Syn 4 Low Fert	Local	Kasai	ATP	Soil Group Mean
1 Basalt with ash influence	1448	2651	2097	1448	1577	1756	1837
2 Old basalt No ash	2706	2944	2889	2592	2904	3108	2857
3 Granites	2891	3415	3461	2684	2869	2947	3045
S E Soil Group	271						
Varieties	119						
Zone x variety	206						
CV	28%						

<u>Table 2</u> Chemical Characteristics of Surface soil samples from three different soil groups in the Mid-altitude zone

Soil Group Description	OC ------	Tot N %----	Avail P* mg/kg	pH H_2O	pH Kcl	K ----	Mg -meq	Ca /100g	ECEC ----	CECC pH7 ----	Base Sat ----%	Base Al. ----
Basalt with ash influence	5 95	0 406	12 0	5 15	4 48	0 39	1 82	2 90	6 46	24 20	22 25	13 75
Old basalt with no ash	7 23	0 463	11 5	5 37	4 83	0 45	2 49	7 59	10 22	26 27	38 67	2 81
Granites /gneis	5 23	0 338	14 5	5 15	4 56	0 72	2 48	5 39	9 58	23 47	33 67	8 42

* Bray 2 Available P

Conclusion

Under poor environment (soil fertility, Table 2) conditions generally encountered on farmers' fields variety ATP is the least affected (most stable) by changes in soil acidity This is especially so in soil groups 2-3 Synthetic 4 showed about the same tolerance to low soil pH as ATP The farmer however, gave greater yield response to soil acidity amendments and ATP appears more tolerant to high Al Saturation

The following recommendations summarize the 4 years on-farm maize variety trials In the mid-altitude zone (1000-1500 m a s l) synth 4 is recommended for acid soils with strong volcanic ash influence (soil group 1) and acid soils derived from granites (group 3) On soils formed on older basalts where volcanic ash influence is now to minimal, ATP is recommended for both resource poor and medium farmers Farmers who can afford up to 300kg/ha 20-10-10 compound fertilizer should continue with kasai in this zone ATP is equally recommended for resource poor farmers whose preference is for the yellow maize in soil groups 1 & 3

For the high altitude zone, HAP appears to be a viable alternative for farmers who can afford a higher dose of fertilizer for their maize crop

Finally, seed multiplication for ATP, Synth 4, Kasai and HAP on a large scale is recommended

Maize Minikit Trials Since 1991, the objective of the minikit program has been redefined so that farmers and extension workers' assessments become a major concern Evaluation questionnaires comprise 3 sheets instead of one Forms 2 and 3 deal with post harvest operations and extension feed back respectively

The approach has been improved and benefited from the NAET program implemented in West Province with well trained and qualified extension agents, on the contrary of the NW Province where agricultural extension services are getting loose because of MIDENO workers' salary strike and the lay off of most of them Much more reliable information was obtained and will help the TLU Zone areas in recommendation domains with respect to major constraints, opportunities and farmers' aspirations Up to date, 3264 minikits have been distributed to extension staff in the Western Highlands

Hybrid Maize Population x Fertilizer. The Western Highlands Maize Breeding Unit has to date developed two hybrid maize varieties adapted to the mid-altitude zone of the area The objective of this trial was to develop an on-the-shelf technology for hybrid maize production in the mid-altitude zone of the Western Highlands

Results showed that plant density (40,000, 52,000 and 60,000 plants/ha) and N rate (40,80 and 120 kg N/ha) significantly affected grain yields at IRA sub-station Babungo While the only significant treatment effect was plant density in Mban Birni (Ngaoundere IRA sub-station) Lack of response to P (50, 100 and 150 kg P_2O_5/ha) was due largely to previous P applications at both sides There were no interactions between density and fertilizer rates at both sites even though average ear weight per plant decreased significantly with increasing plant density and tended to rise with increasing N rates

The conclusion from both sites is that optimum plant density for the hybrid maize in the mid-altitude is about 50,000 plants/ha A nitrogen fertilizer rate of 80 kg/ha and the P recommendation for open pollinated variety in an environment should be sufficient for hybrid maize in the zone

Maize/Legume Intercropping Adaptability of new NCRE mid-altitude maize varieties (Synth 3, Early White (EW) and ATP) to intercropping with food legumes- (bean *phaseolus sp* and soyabean *Glyxine max*) were tested for 2 years at full recommended densities (40,000 plants/ha for maize, 267,000/ha for soyabean and beans) and fertilizer rate (80-20-20/ha) at Mfonta and Babungo

The results (Table 3) showed that bean or soyabean intercrop consistently reduced grain yields compared to that of sole maize crop The severity of yield reduction was in the order of magnitude Synth 3 > EW > ATP > Local The differences among the varieties were significant ($P < 05$)

The 3 improved maize varieties were higher yielding than the local ones at both locations Although maize followed the same trend under bean or soyabean intercropping, the interaction between maize and legume was not significant Beans intercropping affected maize yield more than soyabean The inference of the lack of significant interaction between the maize varieties and the legumes is that there is no need to select separate maize varieties for adaptability to bean or soyabean intercropping without modifying their vegetative architecture

Table 3 Maize variety/Food Legume Intercropping over 2 locations' maize grain yields, kg/ha (1991-92 pooled data)

Maize* Variety	Sole Crop		Intercropped with Beans		Intercropped with soya		Means (maize var)	
	Bab	Mf	Bab	Mf	Bab	Mf	Bab	Mf
Local	6522	2435	4588	1539	4492	1921	5201	1965
Syn 3	8572	2601	5877	2481	6143	1851	6844	2311
ATP	7325	2250	4935	2068	5627	1915	5962	2077
E White	7144	2647	4913	2270	5822	2132	5960	2356
Mean	7391	2483	5078	2089	5521	1955		
CV%	18 4	23 5						
LSD V	751	348						
LI	651	302						
VxLI	NS	NS						

* V = maize variety Bab = Babungo
LI = Legume intercropping Mf = Mfonta

When a separate study was set up at Babungo to study the effect of N fertilizer (0, 40, 80 and 120 kg N/ha) on the productivity of maize/food legume intercropping, results showed that competition between maize and the intercropped legumes for N was offset only after application of 120kg N/ha, confirming that maize grain yield reduction observed is due mostly to strong N competition from the legumes These results don't indicate any direct benefit by maize from N fixed by the legumes growing concurrently with maize

Soyabean International Observation, Babungo In 1991-92, Soyabean International observation trial organized by the IITA was planted at Babungo The objectives were

- test the adaptation of soyabean cultivars under a wide range of environmental conditions,
- provide research workers an opportunity to compare local and introduced cultivars,
- provide a source of new germplasm which the cooperator may use directly or incorporate into his or her breeding program

Frog-eye leaf spot (*Cercospora sojina*) was the most important disease encountered at the experimental site There was no relationship between maturing date and seed viability (% germination), but the early maturity lines appear to be higher nodulating than the late and medium maturing lines

Based on grain yield, severity of leaf spot disease incidence and seed viability, the 3 top ranking lines were TGX 1448-ZE(M) > TGX 1440-IE(M) > TGX 1447-3D(M) The seeds of these 3 lines were multiplied for further tests of adaptation to Western Highland environments

Soil Amendment and Fertilizer Effect on Maize. The trial was initiated in 1989 to compare the effect of three levels of fertilizer (0-0-0, 50-60-50, 100-120-100 kg/ha of N, P_2O_5 and K_2O respectively), manure (compost), organic matter (plant residues) and 5 tons of dolomite on maize yield The amendment treatments were applied once in 1989 and fertilizer treatments to maize every year The residual effect of amendments were assessed for 5 years

The 1992 results showed that only fertilizer application significantly ($P<0\ 5$) increased maize grain yield at all levels As in years 1990-91, the liming treatment increased maize yield (not significantly) when compare to other amendment sources, including the check (4 93 tons/ha vs 4 15, 4 25 and 4 73 tons/ha) There was no fertilizer x amendment interaction indicating that the response was not influenced by the type of amendment and that yield increase was only due to the fertilizer effect The lime and highest fertilizer level significantly increased the plant height

Rapid Rural Appraisal Survey of Ngie During the week of July 12-18, 1992, two TLU researchers joined a multidisplinary team of 11 agricultural researchers from different institutions and an Agroforestry Peace Corps Volunteer to carry out a RRAS (Rapid Rural Appraisal Survey) of Ngie (a single clan enclave in Momo Division in the NW Province) The survey indicated that the most important factors limiting farmers' efforts in the area of crop production, soil conservation and agroforestry were the following in the order of importance

1) Soil degradation (severe erosion and fertility decline),
2) Tree/crop damages by cattle and small livestock,
3) Unclear demarcation between grazing and crop lands,
4) Deforestation and overcropping of land,
5) tree planting will be hampered by a land tenure system,
6) Uncontrolled bush fires that destroy trees and the microflora,
7) Lack of extension staff trained in proven soil conservation methods

1993

<u>Production of Soil Map of North West Province.</u> In collaboration with IRA Ekona and the Adaptive Research Unit of the NW P D A, Bamenda, the stalled soil map of the NW Province initiated by MIDENO was completed and produced in colour The map, on a scale of 1 200,000, provides adequate detail for planning soils resource management

<u>Soil Fertility characterization of the NW Province and Upper Noun River of the West Province.</u> The objectives of the exercise were to provide soil fertility data for the various soil groups in the Western Highlands and identify researchable soil fertility constraints for future research planning purposes in the Western Highlands Five soil groups were established based upon parental materials and supported by soil (0-15cm) and maize earleaf analysis data (see annual report 1993)

<u>Group 1</u> Soils on low lava basalt with more volcanic ash influence (Bamenda-Bafut axis, Mfonta Plain, Babanki-Belo axis, Batibo-Ashong-Bali crescent)

<u>Group 2</u> Highly weathered soils on ancient basalt without recent volcanic ash influence (Upper Noun River area, Babungo in Ndop Plain)

<u>Group 3</u> Soils on granites and other basement complex rocks (Misaje, Mbengwi, Babessi, Nwa, Tabenken)

<u>Group 4</u> Soils formed on high lava basalt (Bui and Ndonga Matung divisions)

<u>Group 5</u> Soils formed on trachytes/Basalt (Fundong Plateau)

<u>"Ankara" land preparation System</u> Ankara is the art of slow burning grass buried under ridges The practice has been found highly rewarding in the year of preparation Crop yields decline sharply in subsequent years

Soil analysis before and after ankara (Table 4) showed that the practice has the following attributes

(a) Slight amelioration of soil acidity
(b) Massive release of available P
(c) Increase in soil exchangeable K

(d) Enhancement of soil N release
(e) Complete control of the noxious elephant grass weed
(f) 30-40% loss in soil organic matter
(g) Effects of N released through ankara lasted only one cropping season, making the system non-sustainable

Table 4 Soil properties under ankara and surface burning trash
Mfonta 1992 Chemical Characteristics

Treatment Physical Characteristics

	< 2m	2-20m	20-50m	250-500m	pH	OC %	Tot N %	Avail P ppm
Control	36 7	40 5	10 1	12 7	5 3	10 1	0 69	12 0
Ankara	19 0	52 9	15 1	13 0	5 6	6 1	0 46	36 5
Surface burn	36 0	40 9	12 0	11 1	5 5	10 1	0 67	15

	Na	K	Mq	Ca	TEB - meq/	Al^{3+} 100g--	H+	ECEC	CEC	Base sat
Control	0 20	0 46	2 38	4 36	7 35	0 10	0 27	7 86	32 05	22 5
Ankara	0 26	0 98	2 65	4 53	8 36	0 00	0 33	8 68	20 20	41 0
Surface burn	0 11	0 88	2 47	4 95	8 40	0 12	0 20	8 72	32 58	25 0

The studies on the residual effects of ankara showed that the following year 1993, the control plot + fertilizer (200kg/ha 20-10-10 compound fertilizer) outyielded the ankara plots (Table 5), showing the short life of the practice

Table 5 Effect of Ankara and fertilizer on maize yield (kg/ha), Mfonta 1992-93

LAND PREPARATION	1992	1993
Control	1005	817
Control + Fertilizer	2342	3945
Ankara	6899	2018
Ankara + Fertilizer	5802	4906
Surface burning	1457	834
Surface burning + Fertilizer	2179	3292
Mean	3281	3635
LSD (0 05)	429	978
SE	244	558
CV (%)	10	30

Fertilizer = 200kg/ha 20-10-10 compound

Maize Retention Survey. The TLU began observing farmer's technology retention as early as 1987, during a survey on participating farmers in the "minikit" trials in all previous years (1983-1986)

In 1991, 86 farmers in the mid-altitude zone who had maize variety trials on their farms in 1989 or 1990 were regularly visited and interviewed Results of these interviews revealed that mean retention rates for the improved maize varieties (i e % of farmers still growing at least 1 improved variety on a part of their farm in subsequent years) was 91% By variety, Kasai I, Coca and ATP had the highest retention rate with 83%, 44% and 28% respectively Sixty nine percent (69%) of the respondents retained only 1 improved variety, while 23% retained 2 varieties Although 4 to 8 varieties had been tested on each farm, farmers were encouraged to keep seed and plant more than 1 or 2 new varieties the next year Preservation of seed was apparently the key problem Farmers retaining at least 1 improved variety planted it on an average 51% of their maize land, which means that the improved varieties were established on 46% of the total land area planted to maize Eighty-three percent (83%) of the trial farmers who had tested KASAI planted it on 43% of their maize-cropped land, or 36% of total maize land For COCA the figures were 44%, 36% and 16%, and for ATP, 28%, 37% and 10% respectively

In 1992, the TLU team repeated the retention survey on the farmers participated in the "minikit" Trials of the previous years (1983-1990) Questionnaires were sent out to the West and North West Provinces to be conducted by the AVV and VEW's from the DDA or Agricultural posts The continuous cropping of the improved maize varieties was achieved despite various problems The participating farmers (50%) said the maize usually weeviled in their stores Some reported bird destruction (16%) and animal damages (11%) with cattle and goats contributing for 4% For the characteristics they sought for producing maize, yield came first, taste second, earliness third with the mean rank being 2,3, and 4 respectively Here COCA and KASAI one more time gave their proofs with 41% retention rate of each

In 1993, the retention survey was repeated on the participating farmers with the minikit trials from 1990 to 1992 The objectives were to assess the impact of on-farm maize variety test on farmers'field and the tested varieties of retention rate The list of 379 farmers, taken from 1990-92 minikit trials was our reference 114 farmers were randomly selected The sample size for each variety was proportional to the number of participants receiving that variety The results of 1993 survey are presented in Tables 6, 7, 8, 9 and 10 It appears that 53% of farmers still grow the improved maize on an average of 24% of their maize land The IRA varieties were established on 13% of the total land area planted to maize By variety, Synth 3 and MSR were highly retained, 75% and 71% respectively

When assessing specific characteristics of new varieties, in comparison with the local (farmer's variety), the respondents found that, on average, the new varieties do not store as well but taste better and have better cooking quality and color (Table 9) For the contribution of improved varieties to the utilization of the maize harvested, some of the participating farmers said that the new varieties increased their rate of consuming maize, quantity of maize sold, production of corn beer and the quantity of feed for chickens, and brought them to think about the production of feed for chickens

Table 6 Maize Minikit retention rate per variety (%) and its influence on the land use

	BACOA	CMS 8704	ATP	KASAI	MSR	EK WHITE	COCA	EARLY WHITE	EK YELLOW	SYN 3	CMS 8501	ALL
N_1	4	5	17	23	21	4	4	5	6	12	6	107
RR (%)	50	40	47	52	71	25	25	20	50	75	50	53
LPIMV/F (%)	23	10	19	28	33	19	13	15	21	27	18	24
TL(%)	12	4	9	15	23	5	3	3	11	20	9	13

RR = Retention Rate
LPIMV/F = Land planted with improved maize variety per farmer
TL = Total land (%) = Retention rate (%) X (Aver land planted with improved maize variety by each retaining farmer)

Table 7 Elements of technology diffusion

	BACOA	CMS 8704	ATP	KASAI	MSR	EK WHITE	COCA	EARLY WHITE	EK YELLOW	SYN 3	CMS 8501	ALL
N_1	4	5	17	23	21	4	4	5	6	12	6	107
RR (%)	50	40	47	52	71	25	25	20	50	75	50	53
N_2	4	5	17	20	21	4	4	4	6	12	6	103
GM(%)	50	60	47	55	67	25	50	50	67	75	67	58
% MS	20	13	19	19	15	21	30	7	21	11	6	16

MS = Maize sold
GM = Gave maize
N_1 = No of farmers who received maize varieties
N_2 = No of farmers who responded to the question of giving maize to others

Table 8 Degree of Utilization of the new technology

	BACOA	CMS 8704	ATP	KASAI	MSR	EK WHITE	COCA	EARLY WHITE	EK YELLOW	SYN 3	CMS 8501	ALL
N_3	4	4	15	20	19	3	4	3	6	12	6	96
IV+F	50	50	27	20	42	33	0	33	0	33	0	27
IV-F	0	0	27	40	37	0	25	0	50	42	50	3
F-IV	50	25	13	20	21	33	0	0	17	8	17	18
None of them	0	25	33	20	0	33	75	67	33	17	33	23

IV+F = Improved variety with fertilizer
IV-F = Improved variety without fertilizer
F-IV = Utilize the fertilizer without using the improved variety
N_3 = No of farmers who responded to the question of applying fertilizer

Table 9 Assessment of Specific Characteristics of IRA Maize in Comparison with local (%)

	Storage quality	Cooking quality	Taste quality	Grain color
N4	91	96	92	93
Better	21	78	75	80
The same	16	13	15	5
Poorer than local	63	9	10	15

N4 = Number of respondents

Table 10 The contribution of improved varieties in the utilization of maize harvested (%)

	CMS 8501	EK YELLOW	CMS 8704	COCA	BACOA	EK WHITE	ATP	MSR	SYN 3	KASAI	EARLY WHITE	ALL
N5	6	5	5	3	3	3	15	18	11	21	5	95
No contrib	50	40	80	100	33	100	80	72	73	62	80	69
contrib for one aspect	50	60	0	0	33	0	7	6	27	33	20	19
more than one aspect	0	0	20	0	33	0	13	22	0	5	0	12

N5 = Number of respondent

Rice Minikit in Menchum Valley

Since 1989, the TLU has been testing the 2nd generation of rice varieties (2 TOX lines, IR 7167-33-2-4) that have the characteristics of having long, slender and translucent grains that make them more competitive in the market than the bold grain types (ITA 222, CICA8, CISADANE, etc) All of them yielded at least 7% more than the local variety which is an old improved variety (ITA 222), and were preferred by all 17 participating farmers

Hybrid Maize Stepwise Trial.

This was a follow-up of an on-station trial started in 1992 and examined farmer's reactions to hybrid maize in larger maize production centers of the Ndop Plain and W Province It consisted of 6 treatments 1) local variety + farmers' input level, 2) Improved O P variety + farmer's input level, 3) improved O P + 300kg/ha 20-10-10, 4) IRA hybrid + 300kg/ha 20-10-10, 5) IRA hybrid + 300kg/ha + 40kg N/ha and 6) Pioneer Hybrid + 300kg/ha + 40kg N/ha, arranged in a RCB design with 2 replications/farm planted on a farms in the mid-altitude zone divided into 2 site, based on soil grouping and 2 farms on low-altitude zone (Santchou and Bamtoum III) The maize yield results are presented in Table 11

Table 11 Hybrid technology on-farm Evaluation over different sites

Treatments[a]	Site I* (N=11)	Site II+ (N=7)	Site III[b] (N=6)
Local + F_1	5 5	4 4	4 4
Kasai/Synth 4 / CMS 8704 + F_1	7 3	5 6	6 0
Kasai/Synth 4 / CMS 8704 + F_2	7 7	5 8	6 7
IRA Hb-MA/Hb-LA + F_2	9 4	8 2	8 1
IRA Hb-MA/Hb-LA + F_3	8 7	8 0	7 4
Pioneer Hb-MA/Hb-LA + F_3	7 3	8 7	5 1
Mean	7 7	6 8	6 3
LSD (0 05)	1 1	NS	1 3
SE	0 6	1 7	0 7
CV %	14 3	25 5	20 5

a F_1 = 40-20-20

F_2 = 60-30-30

F_3 = 100-30-30

* Kasai, IRA Hb-MA & Pioneer Hb-MA were planted at Galim, Fbot and Babungo

\+ Synth 4, IRA Hb-MA & Pioneer Hb-MA were planted at Bafole, Bansoa and Bamendou I

b CMS 8704, IRA Hb-LA and Pioneer Hb-LA were planted at Santchou and Bantoum III

At the highest fertilizer level F_3, the IRA maize hybrids significantly ($p<0$ 05) out-yielded those of Pioneer Seed company both at site I and III respectively that couldn't even do better than O P varieties at the F_2 level (except at the Site II) Also at the F_3 level, all IRA hybrids yielded higher than the O P 's At this modest investment an average of 28 5% yield increase was realized An additional 40kg N/ha to F_2 caused a general decrease in IRA Hybrid yields at all sites, indicating that the optimum level should be between F_2 and F_3 Medium and large scale maize producers capable of investing a little more on fertilizer and seeds can make good profit on hybrid maize production

Field calibration for maize P requirement

This trial was established in 1991 at IRA Mfonta and Babungo to determine the pattern of maize response to P levels for maize in 2 different soil groups In 1992, the plots (main plots) were split in three 6m x 5m small plots (split plot) and additional treatments of 0, 100, and 200kg P_2O_5 were super imposed on the original plots turning the design to a split plot in a RCBD with 4 replications Soil and plant analyses along with grain yield will be used to calibrate optimum levels of available P for maize in both soils

Preliminary data on the relationship between soil tests for available P and maize grain yield showed that Bray 1 and 2 tests were strongly correlated with grain yield at Babungo The contrary was the case of Mfonta There appears to be a need for a new soil test method for assessing available P in those soils formed on low lava typified by Mfonta The results of 1993 soil analysis will be used for calibration

Maize yield responses to fresh P application in 1991 and to the residual effects of applied P in 1992 are shown in Table 12. In the year of application, 50kg P_2O_5/ha appeared adequate at Babungo. On the contrary small increases in yield were obtained with increasing P rates at Mfonta. The response pattern was however, clearer for the residual effects. Except for the control and the 2nd year's 50kg/ha treatments where there was reduction in yield, maize yields in the 2nd and 3rd years after P application were generally higher than in the 1st year. Maize yield increased with increasing rates of previous P application. These increases were significant up to 100kg P_2O_5/ha at Babungo and 200kg P_2O_5/ha at Mfonta.

Table 12. Grain yield response of Maize to Phosphorus application

	Grain Yield, kg ha^{-1}					
	Babungo			Mfonta		
P rate kg ha^{-1}	1991	1992	1993	1991	1992	1993
		Residual effect			Residual effect	
0	5774	4664	6261	2176	1262	3948
50	7061	7557	6839	2521	2496	3257
100	6155	8332	6795	2629	3141	3719
200	5666	8907	6500	3085	5372	4453
300	5852	9237	6714	2837	5708	4191
S E of Mean	455	684	466	190	615	503
C V (%)	15	11	7	14	18	13

On-Farm Evaluation of low farmer's fertilizer rate for maize grain yield

This was the evaluation of farmer's fertilizer rate for maize in different soil groups (parental material difference) in the mid-altitude zone of the Western Highlands The objective was to evaluate the return from a small N top dressing over the base application of 100kg/ha 20-10-10 compound fertilizer (farmer's level)

Results in Table 13 showed that except for sites I and III (Ferralitic soils of the WP and soils on low lava basalt with more volcanic ash influence, respectively), there were significant differences among treatments for grain yield means The effect of fertilizer was not apparent until 20kg N/ha was top dressed mostly for sites III (soils on granites and other basement complex rocks) and combined analysis

In general, top dressing maize with 20kg N/ha in the mid altitude zone could produce profitable grain yield increases for small scale farmers

Table 13 Effect of nitrogen top-dressing of low farmer's fertilizer rate on maize grain yield (kg/ha)

Treatment*	Site I (N=16)	Site II (N=14)	Site III (N=5)	Site IV (N=18)	Across Site (N=53)
Control	2115	1211	2771	1717	1805
FF at P	2512	1597	2797	2041	2137
FF at 5 WAP	2343	1998	3386	2024	2242
FF at P + 20kg N TD	2900	2032	3367	2392	2508
Mean	2412	1709	3080	2043	2173
LSD (0 05)	NS	383	NS	221	203
S E	239	190	331	110	101
CV (%)	28	30	17	7	24

NS Not significantly different
FF Farmer's fertilizer
P Planting
WAP = Week after planting
TD = Top dressing

6 1 5 IN-SERVICE TRAINING

A list of formal in-service training courses attended by IRA personnel attached to the TLU follows Formal courses were supplemented by continuing on-the-job training

Individual	Course	Venue
Enam Jean	Sustainable Agricultural Systems	IITA Ibadan
Meppe Francois	Sustainable Agricultural Systems	IITA Ibadan
	Resource Management training workshop	NCRE Nkolbisson
Samatana Marc	Resource Management training	NCRE Nkolbisson
Malaa Dorothy (Technician)	Agroforestry Research Methodology Training course	ICRAF, Yaounde

Priorities for Future

Prior to 1991, the TLU concentrated on straight-forward yield enhancing technologies (improved varieties and agronomic practices requiring significant investment in external inputs, mainly fertilizer) to maximize the probability of rapid and measurable project impact Future research needs to address longer term agricultural development goals in the region

In the future, the emphasis of the TLU work will be on developing low input, farm resource conserving, yield sustaining technologies Agronomic themes will assume greater importance, including studies on 1) release of plant nutrients tied up in soil organic matter which is sometimes as high as 15% (a particular problem in cool high altitude zone), 2) field calibration for P for groups 3-5 as is currently being done for soil group 1 and 2 at Mfonta and Babungo, taking into consideration the variable P sorption capacities, and 3) farmer evaluation of leguminous planted fallow crops- crotalaria, mucuna and carnavalia

On-farm varietal testing (expanded to include foodcrops other than maize and rice, e g , potatoes, soyabean) will continue, with greater attention to crop characteristics desired by farmers

The greatest strength of the TLU has been its close and effective collaboration with the extension service and other development projects and institutions This will undoubtedly be the biggest key to continued success in the future Cost efficient on-farm research methodologies will be the norm (e g , the minikit trial) and these will depend on good linkages with extension

Adoption and impact studies will also be an important element of the future research program

<u>Plans to Sustain Research Effort</u>

- writing research proposals and submitting them to local and foreign funding agencies
- strengthening linkages between TLU and other institutions (e g , MINAGRI, NGO'S etc)
- taking good care of research equipment,
- raising research funds by producing foundation maize seed for sale with the breeding unit,
- persuading the IRA administration not to sell good project vehicles that NCRE will hand over

6 2 TLU EKONA

6 2 1 INTRODUCTION

Ekona TLU is responsible for the Coastal Humid Forest Region of Cameroon It functions as a link between IRA and the extension service of the Ministry of Agriculture by channeling information and resources in both directions Since its introduction at Ekona in 1986, TLU had focussed on (a) provision of baseline data on smallholder agriculture, (b) on-farm testing of the National Cereals Research and Extension Project's (NCRE) maize and IRA/IITA cassava varieties, (c) soil and weed management studies and (d) post-harvest problems of maize (storage) and other food crops (marketing) Liaison with extension has been effected through annual training-and-planning workshops, collaborative research and minikit distributions The basic approach of the TLU involving a combination of on-station trials, researcher and farmer managed trials in focus villages, and minikit distributions is continuing However, increased emphasis is now being given to biological technologies for enhancing and sustaining farm systems productivity

6 2 2 OBJECTIVES

Ekona TLU works to improve food crop production of small holders in South West and Littoral provinces through diagnosis of agricultural constraints and opportunities, testing of improved varieties and agronomic cultural practices, and informational liaison between the extension services and IRA Research in 1991-1993 focussed on

1 Diagnosis of farmers circumstances and practices
2 Identification of biological technologies for improving soil fertility and for weed control
3 Identification of appropriate crop protection practices
4 Identification of improved and well adapted crop varieties and
5 Dissemination and monitoring of technologies

6 2 3 CONSTRAINTS

Project activities were seriously affected by the "Ghost Town" and an extended strike by IRA staff which started on October 6, 1992 and is still on Other difficulties include (1) bad roads (2) lack of sufficient maize seeds for farmers especially with the absence of a dryer in the seed room - even the little maize harvested from on-station trials for seeds was difficult to handle because of the lack of a dryer and (3) lack of an agricultural economist support research staff

6 2 4 ACCOMPLISHMENTS

1991

6 2 4 1 Focus Village Meetings

In 1991 TLU staff led in discussions by highlighting to farmers, available improved technologies The advances e g maize of different colors or furadan or better spacing for maize intercropped with cassava, are high-lighted Farmers views were sought and their other pressing problems discussed This approach tended to limit discussion to those topics identified by farmers

6 2 4 2 Price Data

Price monitoring at six markets located in strategic sites in Southwest province for cassava, maize, plantain, cocoyams and processed cassava (gari) showed a declining trend of commodity prices (Table 1) This issue often raised during focus village meetings concerns farmers since they assert that they receive less and less while the prices of all other commodities increase The price information also helps in analysis of the mixed crop systems common in the humid coastal area of West and Central Africa

Table 1 Mean prices of various crops from 3 markets in Fako Division, Cameroon 1988-1991

Commodity	1988/89	1989/90	1990/91
1 Maize green cob	108 (100)	105 (97)	107 (99)
2 Maize dry grain	90 (100)	72 (80)	68 (76)
3 Cassava root	49 (100)	39 (80)	29 (59)
4 Cocoyam Xanthosoma	119 (100)	114 (96)	100 (84)
5 Taro Colocasia	57 (100)	55 (96)	42 (74)
6 Plantain	86 (100)	77 (90)	52 (60)
7 Yam D rotundata	148 (100)	141 (95)	104 (70)
8 Sweet Potato	79 (100)	75 (95)	49 (62)
9 Groundnut unshelled	206 (100)	154 (75)	104 (50)
10 Egusi unshelled	423 (100)	428 (101)	348 (82)
Average	135 5 (100)	126 0(92 3)	100 3(73 5)

Relative prices (%) with 1988/89 as base are in brackets ()

Source TLU, Ekona

6 2 4 3 Productivity of multiple cropping systems

Low individual crop yield characterizes the multiple cropping system practiced in the Coastal Humid zone of Cameroon However, total productivity per area is generally higher in mixed than in sole crop systems Factors responsible for reduced individual crop yield included competition for nutrients and light and lower individual crop population in mixtures than in sole Observed mixed crop yields in farmers complex mixture fields in SWP average 918 kg for maize, 7486 kg for cassava, 3719 for cocoyam and 842 kg for groundnut These are much lower than yields obtained in monocrop systems and in two crop mixtures

6 2 4 4 Adoption, retention and diffusion of IRA maize

A maize adoption, retention and diffusion study of minikit (trial-in-a-bag) users between 1987-1991 was conducted in the four key zones of the South West Province in 1991 One hundred and ninety seven (197) users spread in 63 villages of the province were earmarked for the study Examples of some of the villages were Mukundange, Bafia, Matoh, Mbakwa Supe, Batoke, Ewelle, Mbongo Balundu, Kendem, Dikome Balue and Bissingi One hundred and forty two (142) participants were finally interviewed IRA maize irrespective of the variety (CMS 8501 or CMS 8704) produced more than farmers local variety Farmers preferred fresh CMS 8704 (yellow) roasted and flinty white CMS 8501, for fufu (maize flour) Adoption, retention and diffusion rates were 85%, 63% and 44%, respectively (Table 2) Farmers personal characteristics like sex, education and family size and variety characteristics such as colour, texture, yield and maturity time were significantly associated with adoption, retention and diffusion Farmer to farmer diffusion was quite common Some constraints to retention were animal damage (birds, rodents, etc), maize storage (weevils), consumption of harvest because of better taste, some users not willing to release the technology to others and others still planting locals

Table 2 Maize retention and diffusion rates among minikit participants per variety and factors

Research Domain	Retention Rates (%)			Diffusion Rates (%)		
	Saved for seed	Planted first season 1991	Saved & Planted 1st season 1991	Sold/ given as seed	Sold as dry or fresh grain	Sold/given as seed + sold as dry or fresh grain
LV	95	51	73	60	70	65
KC	86	52	69	52	41	47
S	81	29	55	29	26	28
M	79	26	53	47	26	37
SWP	85	40	63	47	41	44

6 2 4 5 Maize minikits

Across all varieties and zones, the IRA maize outyielded the local by about 53% (P< 01, N=113, t-test) About half the farmers complained that it dried more slowly than their local

The perceived yield advantage was 73% CMS 8501 (P< 01, t-test, 17 cases), 53% for CMS 8704 (P< 01, t-test, 9 cases), 73% for CMS 8503 (P< 01, t-test, 13 cases), 17% for CMS 8806 (P< 05, t-test, 19 cases) The high-land varieties all had higher perceived yields all with P< 01

Relatively low ratings for roasting were given for the highland varieties and CMS 8501 and 8503, while 8704 and 8806 were preferred Generally, ratings were same for boiling, and CMS 8501 was rated very highly in this case For fufu, CMS 8501 received higher ratings than all the others Pap, Koki and cornchaff were also prepared by some people, and the IRA varieties were considered good in these forms Weevils were to be less in IRA varieties though responses were few About 50% said they will pay more for IRA maize in the market The return rate this season was very low, however, CMS 8501 continues to have higher perceived yields across all zones It should continue in minikits to ascertain quality characteristics but because of high rating of CMS 8704 and its desirability for green maize, it should continue as minikits

1992

6 2 4 6 Potential to adopt Agroforestry Technology

Generally, farmers in Southwest and Littoral provinces retain only few trees in their food crop farms Trees observed were very sparse and included only economic species such as bush mango (*Irvingia gabonensis*), native pear (*Decryodis edulis*) and bitter cola (*Cola aguminata*) Other trees protected were Iroko, mahogany and buma for structural purposes Land tenure system by inheritance compared with purchase is high (87%), therefore adoption of agroforestry systems may be easy under these conditions

6 2 4 7 Cocoyam Production in Fako, SWP.

Labor is the most limiting factor in crop production in S W P A specific survey to ascertain labor use in cocoyam production showed that most of the producers were women (79%) Major production constraints are labor, agricultural credits, root rot disease, marketing and transportation Family labor accounts for 92% of total labor Cocoyam production is a profitable venture with a net gain of 112,000 FCFA/ha Cocoyam output is influenced by land, planting materials and household labor (Table 3)

Table 3 Average cost of input factors per ha+ of cocoyam

Input factor	Cost FCFA	Percent
Land	20 142 86	4 01
Labor	460 037 94	91 65
Farm Tools	1 725 56	0 34
Planting Material	20 041 32	4 00

+ TLU, Ekona Annual Report, 1992

6 2 4 8 N-Economy for improving soil fertility

A trial was established in 1989 to determine maize performance at 3 N levels and in hedgerows of two legume species The soil is a sandy sedimentary clay loam (Paleudult) with pH of 5 3 The plot was first established in 1989 and it has been since then re-established in the original randomization The test crop was originally maize to which cassava had been added since 1992

The four year performance of the treatments is presented in Table 4 High maize yields were obtained with increasing N during the first year Thereafter, yields declined rapidly and were similar to those with the hedgerow during the 2nd year By the third and 4th years, the yields of the N treated plots, particularly at 40 kg N, were lower than those from the hedgerows Note stability of grain yields from the hedgerows with Leucaena where it yielded higher than with Gliricidia At zero N, maize yield declined linearly with time

Table 4 Four year maize yield (1989-1992) at Yoke site as affected by Nitrogen and hedgerows

Treatment	First season yields, Kg/ha				Mean
	1989	1990	1991	1992	
0-N	2272	1923	1592	1271	1765
40 N kg/ha	4230	2613	2138	1663	2661
80 N kg/ha	5197	3299	2963	2628	3522
Gliricidia	3644	3422	3470	3518	3514
Leucaena	3276	2962	3026	3089	3088
LSD 0 05	973 8	539 7	677 1	463 1	654 8
Mean	3724	2844	2638	2434	
Grand mean	2910				

6 2 4 9 Cover Crops Studies

A screening exercise involving perennial covercrops, annual covercrops and complex crop mixtures for their effectiveness as ground covers to (a) control weeds (b) check erosion and (c) leave a reserve of nutrients for subsequent crops was established Preliminary results show that (i) *Mucuna*, cowpea and melon associated systems provided rapid ground cover of 50 to 60% of the field surface at 36 days after planting *Mimosa and Pueraria* covered only 10-15% of the surface while *Crotolaria* covered 40% Thus *Mucuna*, egusi melon and cowpea are good shades for weeds at early stages of plant growth (Table 5) This advantage of early shading continues till about 76 days or more *Mucuna* and other covercrops established sole (without cassava and maize) covered the ground at the same rate as cassava + maize and could shade weeds only at early stages of growth (See Table 5, and B and D)

Table 5 Effects of cropping systems and time on percent ground cover

	DAYS AFTER PLANTING (PERCENT GROUND COVER) 18	36	54	76	300	Weed % at 300
A Three crop mixtures Bar Ca+Mz						
Ca+Mz+Egusi	25	50	80	100	77	7
Ca+Mz+Cocoyam	13	35	65	80	61	13
Ca+Mz+Sweet potato	3	25	50	75	65	15
Ca+Mz+Cowpea	30	65	85	90	42	63
B Cover Crops I Season fb Cassava+Mz-II						
Mucuna S1(fbCa+MzSII)	25	60	85	100	11	67
Mimosa S1(fbCa+MzSII)	5	30	45	60	9	46
Crotolaria S1(fbCa+MzSII)	10	30	75	97	33	22
Pueraria S1(fbCa+MzSII)	40	20	30	40	40	22
C Cover Crops Y1 fb Ca+Mz Yr2)						
Mucuna Y1(fbCa+MzYr2)	15	50	80	95	66	45
Mimosa Y1(fbCa+MzYr2)	5	10	15	25	95	22
Crotolaria Y1(fbCa+MzYr2)	10	40	55	75	100	24
Pueraria Y1(fbCa+MzYr2)	1	15	35	45	100	2
D Ca+Mz(fb Ca+Mz)I	10	30	55	75	42	53

A comparison of the effect of one year fallow management (system D) on maize grain yields with that from the continuous cropping (system D) suggested that fallow management system with *mimosa* for nutrient improvement gave the highest residual effect on maize yields of 3 22 t/ha followed by *crotolaria* and *pueraria* while *mucuna* gave the lowest yield among the legumes Besides giving lowest residual yield, *mucuna* is apparently not a good fallow legume because of its volunterism and it's tendency to twine and wrap preceeding maize plants thereby strangulating them However, since this is from only one years data, it is necessary to reduce the number of treatments to include only the three promising legumes to further investigate the usefulness of these cover crops in cassava + maize systems

Based on timing of ground cover, an observation suggested to ensure both rapid and continuous ground cover is to identify and grow in mixture, rapid growing and late spreading cover crops eg *Mucuna* and *Mimosa* if they are complimentary

6 2 4 10 Control of imperata cylindrica

Shading is one means of controlling spear grass, *Imperata cylindrica* which is one of the most noxious weeds Appropriate shade varies with location and practices Consistent reduction of spear grass incidence has been observed in alley hedgerow plots unpruned for a year (Table 6) Similar relative reductions of spear grass incidence were observed in plots which were established after one year of perennial cover crops such as *Mimosa, Crotolaria* *and Puerarıa* The spear grass could be eradıcated ıf shadıng ıs extended to 2-3 years and thıs may be possıble wıth hedge row specıes and by adoptıng the method ıllustrated wıth compatıble cover crop mıxıng

Table 6 Effect of fertılızer and hedgerow on spear grass *Imperata cylındrıca* ıncıdence

Treatment	Imperata Score (1-4)	% Incıdence
0-N	4 0	100
20-N	4 0	100
80-N	3 5	88
Glırıcıdıa	3 0	75
Leucaena	2 0	50
LSD 0 05	1 48	-
CV(%)	13 8	-

6 2 4 11 Cocoyam Root rot reductıon by shadıng

Cocoyam grown ın alleys partıcularly the fast growıng specıes whıch rapıdly produce shade reduce the Pythıum rot severıty symptoms and led to hıgher corm yıeld, about 48% (Table 7) Healthy cocoyams under shade are commonly observed ın farmers cocoa or ıntercrop fields hence thıs observatıon ıs practıcal A hıghly posıtıve correlatıon was also observed between cocoyam cormel and corm yıelds (Y= -00 137 + 2 53X where X ıs corm yıeld) Thıs equatıon may be ımportant ın on-farm research where the cormel may be mılked by farmers or stolen prıor to data collectıon Wıth the corms ıntact, the expected cormel yıeld can be obtaıned (Table 7)

Table 7 Cocoyam root rot dısease and yıeld ın an alley system

	Dısease severıty score 1-5 scale	Actual cormel Yıeld t/ha	Predıcted cormel Yld t/ha	Yıeld corms t/ha	Actual total yıeld t/ha	Expected total yıeld t/ha	% stolen from plot
Control 0 fert	3 34	1 07	2 133	2 59	3 66	4 71	43 00
Control fert	2 85	1 42	2 830	3 46	4 88	6 29	36 71
Accasıa	3 30	1 35	2 691	3 28	4 63	5 97	36 76
Calıandra	3 10	1 44	2 870	3 50	4 90	6 37	36 75
Leucaena	3 00	1 78	3 548	4 22	6 00	7 77	37 16
Glırıcıdıa	2 74	1 88	3 747	4 58	6 46	8 33	36 72
Cassıa	2 25	1 90	3 787	4 83	6 73	8 62	36 01
±SE	2 94	1 64	3 087	3 78	5 41	6 87	37 59