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

National Cereals Research and Extension Project (NCRE)

Phase II
Project 631-0052
Contract 631-0052-C-00-1011-00

Five Year Terminal Report 1986-1990

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

Acknowledgement

The success of the National Cereals Research and Extension (NCRE) Project can be attributed to the contributions of many persons and groups

The IITA/NCRE technical assistance team is very grateful to the Government of the Republic of Cameroon for its total support of the project activities through its Ministry of Higher Education, Computer Services and Scientific Research (MESIRES) and the Institute of Agricultural Research (IRA)

The team is particularly indebted to the Director of IRA, Dr Jacob Ayuk-Takem, for his valuable professional guidance able leadership, constant understanding, patience and intellectual stimulation His counsel and suggestions have been invaluable

Equally important has been the support received from all IRA Chiefs of Centers, Stations and Substations and from the scientific administrative and support staff In particular we would like to acknowledge the important contribution of the national counterparts and technicians who have provided invaluable advice to the technical assistants Some of the national counterparts and technicians have already taken over the role of the technical assistants We expect that all of them will carry on the work started by this project Without their cooperation and receptiveness this project could not have been a success

The collaborative effort of ICRISAT with regard to the project's sorghum unit is greatly appreciated The assistance we received from CIMMYT and IRRI is also greatly appreciated We would also like to acknowledge SAFGRAD MIDEVIV, MIDENO, SODECOTON WADA SODERIM UNVDA SEMRY, Projet Semencier and the staff at the Karewa Experimental Farm

We are thankful to IITA for its administrative and technical support and for its encouragement

Perhaps the greatest contributions to the success of the NCRE Project have come from the food crop farmers of Cameroon Without their cooperation and receptiveness, this project could not have been successful To them we say thank you

We would also like to express our deepest gratitude to the Government of the United States of America through its Agency for International Development (USAID) whose financial assistance has made this project possible

We cannot talk about the NCRE Project and USAID-Cameroon without mentioning the dedication and support of Mission Director Mr Jay Johnson and his close collaborators To these people and to the entire USAID-Cameroon Mission we are deeply indebted

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EXECUTIVE SUMMARY

The second phase of the National Cereals Research and Extension (NCRE) Project finished its' fifth and last year on December 31st, 1990 The main project goal continued to be that of increasing agricultural production in the Republic of Cameroon This goal is being achieved through development of the Cameroonian institutional capacity for high quality research on Maize, Rice, Sorghum and Millet During this phase the project its TLUs also continued to work on development of the necessary linkages between farmer and researcher to facilitate transmission of useful research results

During this phase a total of twelve international staff were recruited and 14 outside consultants were contracted to provide assistance to IRA staff Other consultants were provided without cost by IITA and ICRISAT Over 600 visitors from national and international agricultural research organizations learned about NCRE and USAID activities Project activities were reviewed by both USAID evaluators and IITA evaluation teams

A total of 21 IRA National Counterparts were approved for degree training during this period Over 25 IRA staff received short-term training at IITA under NCRE financing Even more were trained under direct IITA financing

The Highland Maize Breeding program has developed into an extensive germplasm development program serving West and Central Africa Two varieties originating in Zaire, Kasai and Shaba, were put through extensive testing and eventually distributed for use in the mid-altitude zone of Cameroon Source populations have been developed to permit development of varieties with local germplasm

Highland Maize Agronomy worked on soil fertility maintenance and the use of maize in the existing cropping system Tests of residue management and fertilizer applications indicated that fertilizer should be used in place of burning residue underground Planting Maize with cover crops prevented decline of maize yields

Lowland Maize Breeding built on previous years work and initiated programs on striga and drought tolerance Existing gene pools were maintained and improved with addition of external germplasm Acid tolerant varieties were tested and incorporated in the overall breeding program New varieties were formed and released for distribution to farmers and research programs in neighboring countries

The Lowland Maize Agronomy unit was reinforced with the arrival of an IITA staff in 1989 During this time the unit concentrated on fallow management systems, green manure production and more productive crop associations Due to the short time involved few conclusive results were obtained This work will be continued in the next phase

The Rice Breeding program continued its' emphasis on high yielding varieties with tolerance or resistance to environmental and biological stress During the 1985-90 period over 192 varieties were selected for study and variety trials and five varieties were released for farmer use in specific rice growing regions of the country Several advanced lines show resistance to important diseases

The Rice Agronomy program operated in close collaboration with the breeding program to test and develop practices for the new varieties In addition extensive data sets were collected to characterize recommendation domains Specific research themes concerned fertilizer application, green manuring, dates of planting, machine transplanting, weed control, milling tests, cropping patterns and cultural practices for associated crops.

The Cereals Agronomy unit at Garoua concentrated on practical conservation farming technologies for sustained cropping systems This indicated that a minimum tillage system could be productive when proper weed control and fertilization is applied Micronutrient deficiencies were also documented and solutions recommended Seed treatment was found to be a critical factor for both maize and sorghum A Striga control program was also initiated

Sorghum and Millet breeding continued to develop varieties for farmer use Genotypes were identified with resistance to grain mold, grain smut, foliage diseases, stem borer and Striga Promising varieties were selected for both rainy season and dry season (Muskwari) sorghum planting Improved pearl millet varieties were also selected

A full time Sorghum/Millet Agronomist was appointed by NCRE in 1986 During the 1986-90 period research concentrated on soil cultivation methods, fertilization, crop associations and Striga control in rainy season sorghum Muskwari sorghum research was concerned with soil management, planting dates, irrigation and double cropping Research on Millet was primarily concerned with dates of planting

The Bambui TLU identified several new maize and rice varieties for recommendation to farmers In addition to diagnostic and descriptive surveys, on-farm trials were done to define fertilizer response variety response and cropping patterns to be recommended for maize and rice

The Ekona TLU was established in 1986 During the 1986-90 period it concentrated on baseline surveys, variety testing, fertilizer application, soil management and maize storage in Cassava and Maize based cropping systems

The Maroua TLU was also established in 1986 It has concentrated on Sorghum, Peanut, Cowpea, Millet and Maize Extensive on-farm variety tests were conducted for all crops in addition to fertilization and soil management trials. Both diagnostic and multiple visit surveys were done in several zones.

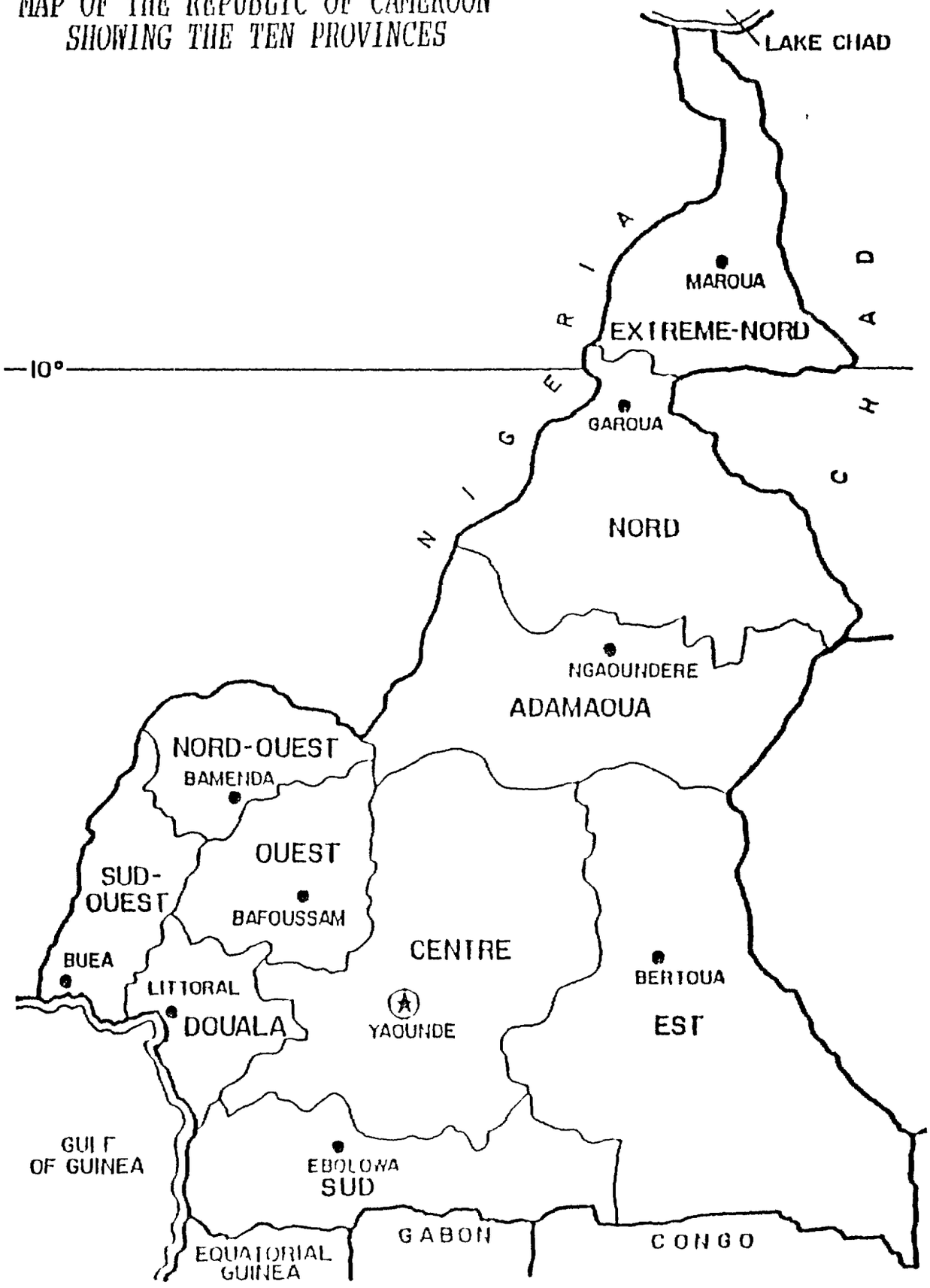
Since its' establishment in 1986 the Nkolbisson TLU has concentrated on a few representative villages It has done rapid appraisal surveys, field monitoring, farmer assessment surveys and market price monitoring On-farm testing has tested varieties, planting practices, fertilization and weed control as well as cropping and agro-forestry systems

Cereals Pathology within NCRE was handled entirely by IRA researchers with back stopping in IITA Maize pathology research concentrated on collaboration with breeding programs to develop resistant or tolerant varieties The major diseases concerned were Maize Streak, blights (Turcicum and Maydis), rusts (Sorgi and Polysora) and Rhizoctonia stalk rot Rice pathology research worked on surveys of rices diseases, their control and the influence of cultural practices on disease incidence

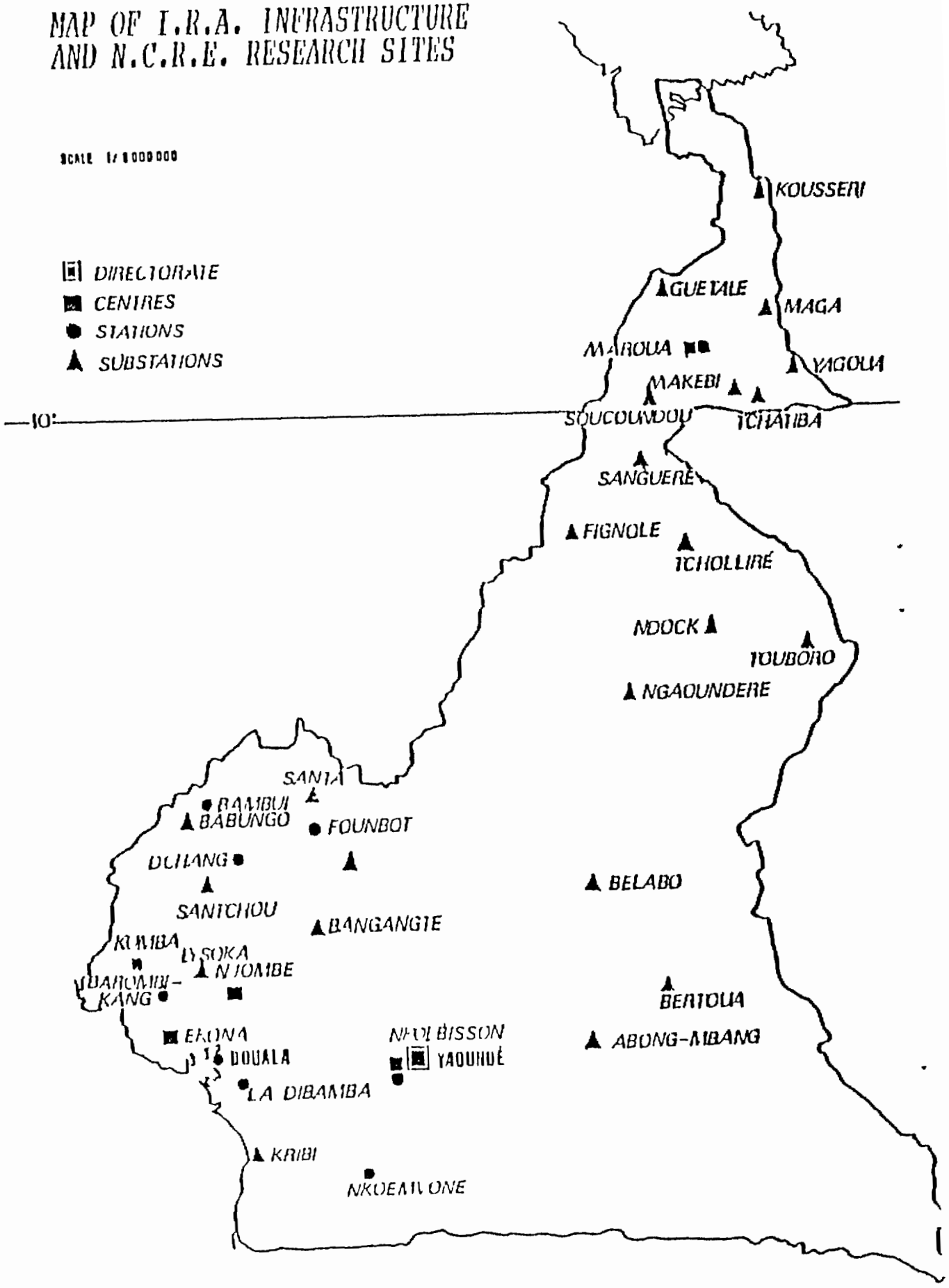
Cereals Entomology was also handled by IRA National Counterparts The highland entomology unit did extensive work on farmer storage methods for maize using local materials Surveys of insect populations were done for Rice, Sorghum and Millet Lowland entomology research concentrated on surveys of maize borer populations and their effects on different varieties Studies have been initiated on the use of Carbofuran for borer control

Because this report cannot contain details of all the research work done over five years a list of detailed papers and presentations is included This listing includes 90 Conference Papers and Presentations, 57 Reports, 23 Refereed Publications, and 5 Dissertations

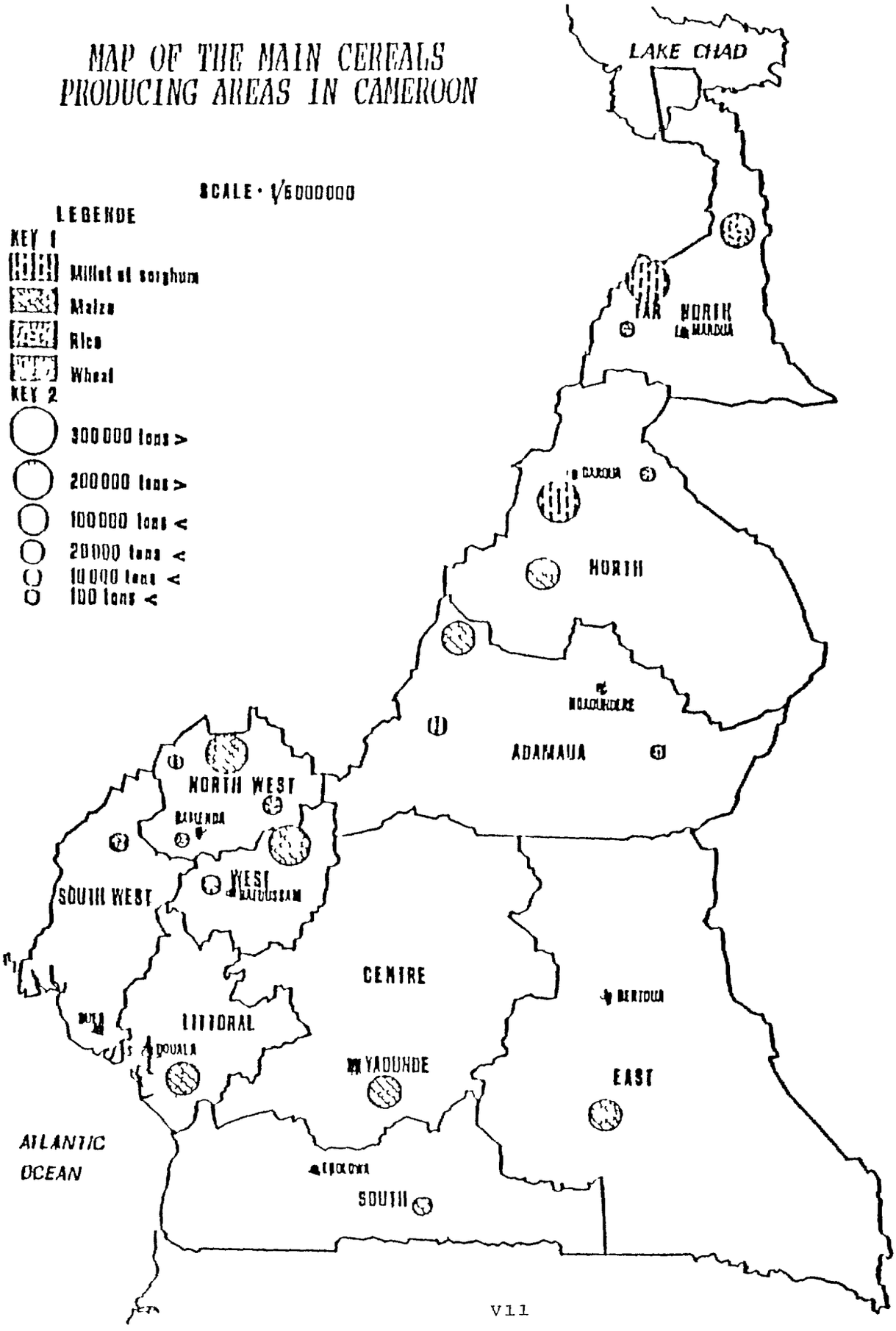
MAP OF THE REPUBLIC OF CAMEROON
SHOWING THE TEN PROVINCES



MAP OF I.R.A. INFRASTRUCTURE AND N.C.R.E. RESEARCH SITES



MAP OF THE MAIN CEREALS PRODUCING AREAS IN CAMEROON



1 ADMINISTRATION

1.1 INTRODUCTION

The administrative unit of NCRE has been composed of a core staff including the Chief of Party, Administrator, Administrative Assistant plus office staff during the entire 5 year span of this report period In mid-1989 a Deputy Chief of Party was added Three individuals have occupied the post of Administrator during this five year period The administrative unit is concerned with both scientist support and project planning/coordination Since these functions are handled by different persons they are dealt with separately in this section

1.2 OBJECTIVES

The Chief of Party has the objectives of:

1 Providing overall planning and supervision of technical performance of the technical assistance team
2 Facilitate liaison between USAID, IITA, IRA and other organizations cooperating with the project
3 Providing leadership to the technical assistance team in applying research to local problems
4 Assist IITA in recruiting candidates for technical assistance positions
5 Assist IRA to develop overall plans in linking research to extension services and farmers
6 Plan and coordinate long and short-term training of national counterparts

The Deputy Chief of Party has the objectives of

1 Assisting the Chief of Party and act in his absence
2 Computerize the project inventory system
3 Computerize the project accounting system
4 Train project staff to use existing and new software

The Administrative Officer has the following objectives:

1 Facilitate liaison between researchers and IITA and USAID
2 Provide administrative support to researchers
3 Provide research and office materials and vehicles to researchers

1 3 CONSTRAINTS

A major constraint to all project activities has been communication between staff locations The IRA radio network was established and expanded with NCRE support It is now the principal means of communication between all IRA/NCRE researchers A continuing constraint is the poor communication between Cameroon and IITA headquarters in Nigeria

A second major constraint was the economic crisis affecting all parts of the Government of Cameroon This resulted in drastic cuts in the operational budget of IRA Supplementary funding by USAID helped to ease the effect on cereal programs but all other programs were adversely affected

1 4 ACCOMPLISHMENTS

Chief of Party

1 Providing overall planning and supervision of technical performance of the technical assistance team.

At the start of NCRE Contract II a comprehensive 5 year workplan was formulated for all technical and administrative units. Interim supervision has been accomplished by regular visits to each location, annual meetings, field tours and invitation of outside researchers for technical backstopping During 1989 the project received a review team to evaluate the progress of the project with respect to further USAID funding A USAID-Washington team visited the project in 1989 to evaluate project impact on farmers Two IITA teams visited project locations in 1990 as part of the IITA external review of management and technical programs

2. Facilitate liaison between USAID, IITA, IRA and other organizations cooperating with the project

A total of 14 outside consultants have been contracted by NCRE to assist researchers with specific problems A larger number visited project staff under outside support Normally IITA research programs provided guidance through staff visits but these were not charged to NCRE budgets ICRISAT also provided several visits in support of the Sorghum Program in Maroua and Garoua. Over 600 visitors were received at the Nkolbisson offices during this five year period Most were representatives of national and international agricultural research organizations A significant number were from neighboring countries in central Africa

3. Providing leadership to the technical assistance team in applying research to local problems

NCRE staff participated in the Biennial Conference on Food Production Research held in Yaoundé in 1987 and 1989 The project also assisted IRA with the presentation of cereals research findings during the Agricultural Expositions held in Maroua in 1987

4. Assist IITA in recruiting candidates for technical assistance positions.

The Chief of Party also assisted IITA Administration to recruit candidates for technical and administrative positions A total of twelve international staff were recruited during the 1986-1990 period

5 Preparation of NCRE Contract III Proposal

A major activity of the Chief of Party and his collaborators towards the end of this phase of the project has been the preparation of the NCRE Contract III proposal, budget and bids for sub-contractors A technical proposal was formulated and submitted to USAID Several budget scenarios were prepared to plan for different possible levels of funding during the 1991-94 period

6. Assist IRA to develop overall plans in linking research to extension services and farmers

Yearly IRA coordination meetings are now conducted in all regions where NCRE has staff These meetings involve all regional agricultural research and extension services. Their objectives are to avoid duplication of effort, disseminate research findings and recommend practices for farmer adoption. Normally these meetings include crops other than cereals

7 Plan and coordinate long and short-term training of national counterparts.

A total of 21 counterparts were approved for degree training during this period Eight have completed their degree programs at the time of this report Another seven are scheduled to complete their degree programs by the end of 1990 Three are continuing their programs past 1990 while another three await university placement All those who have completed their degrees under NCRE have returned to work in the IRA Cereals Program as planned Over 25 IRA counterparts received short-term training at IITA under NCRE financing A larger number participated in training and conferences under direct IITA financing

Deputy Chief of Party

1 Assisting the Chief of Party and act in his absence.

During all absences of the Chief of Party the Deputy has been present to assure continuity of program and work in progress Acting with the Chief of Party, the Deputy has also taken primary responsibility of some activities to distribute the workload and assure timely execution of activities

2 Computerize the project inventory system

The project inventory has been computerized A detailed project inventory now exists which relates each item of equipment purchased with its final use by a staff member A complementary system of purchase order files, equipment card files and equipment assignment files is maintained

3 Computerize the project accounting system

A complete accounting system has been installed. The system is in use by the central Nkolbisson office and under test by selected researchers It will be distributed to all research locations by 1991 The system permits rapid preparation of all monthly reports required by IITA It is also possible to closely follow individual research program expenditures

4. Train project staff to use existing and new software.

Over 85 IRA and NCRE staff have received formal training in the use of word processing and statistical analysis software Other individuals have received informal on-the-job training for use of specific software such as graphics preparation and computer system utilities The training has been conducted both at Nkolbisson, Ekona, Maroua, Garoua, Bambui and Dschang

Administrative Officer

1. Facilitate liaison between researchers and IITA and USAID

Yearly reports, yearly work plans and semi-annual progress reports have been prepared in accordance with USAID requirements Links have been made with CGNET, a computer communications network to enable low-cost rapid contact with other international centers and universities

2. Provide administrative support to researchers

All international travel by IITA and IRA staff has been assisted by provision of travel documents and air tickets Regular monthly financial reports have been prepared for IITA concerning disbursement of project funds In addition NCRE administration has processed reports of a special USAID grant to IRA for operating costs since 1987 These funds are parallel to but independent of normal NCRE grant funds IITA also made yearly audits of project accounts and procedures to ensure compliance with contract requirements

3. Provide research and office materials and vehicles to researchers

During the 1986-1990 period a total of 99 purchase orders were processed through the Nkolbisson office All ordered equipment has been purchased with only a small amount in transit at the time of this writing All equipment were distributed upon receipt to the concerned research programs In addition to the purchases made through IITA, there were major purchases of furniture and vehicles through USAID All project vehicles were replaced during the 1986-1990 period These were distributed as received During 1987 and 1989 the project received computers to facilitate data analysis and reporting At the time of this report there are a total of 19 computers in use by project staff and counterparts

1.5 PRIORITIES FOR THE FUTURE

1. Assign Administrative Clerks to each location to permit decentralized accounting and inventory records

2. Phase all technical programs into full IRA supported programs

3. Active monitoring and supervision of in-service degree programs

4. Active monitoring and supervision of project purchasing.

2 MAIZE RESEARCH UNIT

2.1 HIGHLAND MAIZE BREEDING

2.1.1 INTRODUCTION

Highland maize breeding targets the altitudes 1000 to 2000m The physiological effect of temperature on plant growth as well as the prevalence of pathogen species with lower temperature optima preclude direct use of lowland varieties in the highlands A further subdivision is made between the midaltitudes (1000-1600m) and the high altitudes (1600-2000m), due to the genotype by temperature interaction observed across these two zones In Cameroon, the high altitude zone is limited principally to the eastern ridge of the Northwest Province, an area of intense maize cultivation The midaltitude zone is concentrated in three provinces the West, the Northwest, and the Adamaoua, and is responsible for over half the maize production in the country

Maize breeding in the Cameroon Highlands began in the 1960's in Dschang with a French researcher, Mr Prachan, who developed an open pollinated variety "Polyhybrid 290", based on East African hybrids and varieties This late maturing, white denty grained variety is still prevalent in the Western Province In the 1970's and early 1980's, Dr J Ayuk-Takem developed several varieties while he was Chief of Station, Bambui The two varieties from this era still being produced are COCA, a late maturing white grained variety also based on East Africa materials, and BACOA, an earlier maturing yellow grained variety based partially on U S inbred lines

The international research centers (IITA and CIMMYT) have concentrated their maize breeding efforts on the lowlands a large range of excellent varieties has been available for immediate adoption in the Cameroon lowlands and these have also been used as parents of new varieties which can quickly come on-stream International variety development for the mid-high altitudes of Africa is recent and very limited IITA released the population MSR in 1983 for the first cycle of international progeny testing, and CIMMYT had made available an East Africa population, Pool9a, adapted at 1600-2000m It was not until 1986 that the first international center substation for midaltitude maize breeding was opened, initially with one breeder, in East Africa Most varietal development for the African highlands had occurred in national programs, and was concentrated in hybrid development, where the parental lines are not released to other countries

Given the importance of mid-high altitude maize in Cameroon, and the very limited international breeding available to support it, the NCRE-IRA Highland Maize Breeding unit was initiated in 1984 with the transfer of L Everett from IITA-Ibadan to IRA Bambui Station, Bamenda He was joined by the Cameroon counterparts J Eta-ndu (late 1984), M Ndioro (late 1986), and I Tabi (early 1989)

In 1982-83, J Chung, NCRE maize breeder based at Nkolbisson Station, Yaounde, had tested the IITA MSR population, CIMMYT subtropical populations, and two varieties developed in a CIMMYT-USAID bilateral project in Zaire, at several locations in the Cameroon midaltitude zone Expanding on this experience, the new unit evaluated multilocational introduction screening trials in the 1984A (rainy) season varieties, hybrids, and populations from Kenya Zimbabwe, Zaire Guatemala Costa Rica, Brazil, Thailand, CIMMYT, IITA, the U S , and other sources were tested from 1000 to 2000m altitude on a wide range of soils Based on these results, a comprehensive breeding program including both open pollinated and hybrid variety development was instituted. Close collaborative work with the Bambui plant pathologists (C. Nankam and Z Ngoko) and the TLU was begun

Varietal constraints identified through the TLU and other sources indicated a need for the following open pollinated varietal types 1 late maturing, white and yellow flinty grain with high yield and improved storability 2 early maturing, white and yellow flinty grain for an early season food source and for sale on higher priced early markets 3 a range of plant types to optimize light penetration for intercropping, or resist difficult (acid) soil conditions The increasing commercial (large and small farm) sector needed the uniformity and high yield that only hybrids can provide There was no hybrid seed company in the country, so these farms were importing hybrid seed, principally from East Africa

2 1.2 OBJECTIVES

The objectives of the Highland Maize Breeding Unit are

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 systems of germplasm development which will cyclically improve the varietal and line sources while producing a continuous stream of new varieties
3 Train counterpart scientists through an integrated program of on the job experience alternated with U S graduate degree studies and international center short courses
4 Train technicians through on the job experience
5 Determine specifications for appropriate equipment to facilitate operations in maize breeding and plant pathology.
6 Determine design requirements for construction of efficient work facilities

2 1.3 CONSTRAINTS

The constraints encountered may be classified as follows:

Site management Some of the test sites are on heterogeneous, acid, and Phosphorus fixing soils Characterization and management studies by a soil scientist would have led to improved trial uniformity faster than the interactive approach we had to u e

Target environment sampling Not all of the major mid and high altitude maize growing areas are well represented by available IRA test sites It was necessary to place trials at non IRA locations· principally the University Farm at Bansoa to represent the Bafoussam Plateau, the MIDENO TDC at Ndu-Mbiyeh for the high altitude zone, and initially, SODEBLE-Wassande to represent the Adamaoua Plateau The Adamaoua is especially difficult in that there is no on farm testing unit for extensive variety testing and only one IRA site in the Province

Training The most important objective of the project is to train Cameroon scientists capable of taking over the leadership of the various units An indispensable element of this is timely graduate training This was not forthcoming following seven years of this unit's operations, no counterparts, either in breeding or pathology, are in Ph D training

Equipment Procurement delays led to less efficient field, seed processing, and data processing operations Extensive use of a personally owned computer and Land Rover was necessary to continue operations until suitable equipment arrived Most equipment requested was ultimately delivered, however, and the dry season irrigation system greatly improved operations

Facilities Work facilities (seed drier, seed processing, and seed storage), projected for construction since 1982, are still awaited, and designs have not been coordinated with this unit Temporary, less efficient substitutes have been employed throughout the life of this unit Maize streak virus screening facilities, requested since 1984, are not yet installed

Operating funds A crisis in operating funds occurred in late 1986 when IRA became unable to contribute its portion USAID eventually took over complete funding of operations Recent difficulties in timely reimbursement of expenses continue.

2.1 4 ACCOMPLISHMENTS

The Highland Maize Breeding Unit has developed into perhaps the most extensive national maize germplasm improvement program in West and Central Africa comparable or more extensive programs can be found only in a few countries of East and Southern Africa Seven years is a short period in plant breeding (the Zimbabwe program dates to the 1940's), however accomplishments can be cited

First, a comprehensive system of germplasm improvement, variety formation, and variety testing, has been established, a major feature of which includes multilocational evaluation, both during germplasm improvement and final variety testing All three highland provinces are included in this testing, sampling major soil and altitude zones Rapid selection progress has been possible by using two seasons per year (main rainy season plus an irrigated dry season nursery) totaling 13 seasons since 1984.

A list of test and nursery sites used in 1989 follows as illustration

HIGHLAND MAIZE TRIAL AND NURSERY SITES

Site	Province	Altitude	Soil P M	Area Pl.
Foumbot*	West	1000m	Recent Volcanic Ash	5.0 Ha
Babungo	N West	1100	Alluvial/Colluvial	3.5
Tibati/Meng	Adamaoua	1000	Alluvial	0 1
Mbang Mbirni	Adamaoua	1200	Volcanic Plain?	2 0
Nfonta*	N West	1200	Volcanic Plain? (acid, P fixing)	3 0
Bansoa	West	1400	Basalt	2 0
Santa	N West	1700	Volcanic crater (acid, P fixing)	2 0
Upper Farm	N West	2000	Volcanic (acid, P fixing)	0.7
Mbiyeh	N West	2000	Basalt?	0.7
Xeng	N.West	2000	?(acid, P fixing)	0 1
				19 0

* Includes rainy season nursery (additional 2 0 Ha irrigated nursery at Foumbot in dry season)

The second accomplishment was to carry the two Zaire introductions which performed well in the midaltitude zone (Kasai and Shaba) on through extensive testing and into seed production and distribution Kasai, with a short plant type, performs especially well in the range of 800 to 1400 meters altitude on fertile soils and is being distributed in the West and Northwest Provinces by UCCAO and MIDENO Its release was strongly pursued by the TLU as a result of on farm trials Shaba was the first improved variety ever released and distributed on the Adamaoua Plateau, which is similar in climate and soils to the Shaba Province of Zaire where the variety was developed Following farmer demand for seed, Projet Semencier has been increasing production and distribution A strong demand for maize by the mill at MAISCAM, Ngaoundere, is ensuring a rapid increase in area planted by farmers and thus for seed of Shaba

Third, varietal source populations have been developed, cyclically improved, and are currently in advanced variety trials The High Altitude Population (HAP) was formed in response to on farm trials which indicated that the midaltitude variety which was being extended in the high altitude zone was not performing better than the local farmer variety an improved variety targeted to the high altitude area was necessary. The Acid Tolerant Population (ATP) was formed principally to introduce acid tolerant germplasm from other countries, but is also filling the need for a late maturing, flinty yellow grain variety. The Early White population (EW) responds to the need for an early maturing white flinty grain variety Population descriptions and status of improvement follow:

1. High Altitude Population.

Objective: Provide varieties for high altitudes (1600-2000m)

Composition	Material	Source
	Highland Hybrids	Kenya
	Pool9a	CIMMYT
	V301,V304	Guatemala
	MSR	IITA
	Dekalb 690	Dekalb
	SR52, ZS206	Zimbabwe
	Ndu Local	Cameroon

Status Three cycles recombination followed by two cycles half-sib family selection (3 locations, 2 reps, approx 350 families) completed Population has been tested as a variety since 1989

2. MSR (IITA Midaltitude Streak Resistant population)

Objective Provide white grained, late maturing, streak resistant varieties for the midaltitudes (1000-1600m)

Composition:	Material	Source
	ZCA, ECEM-573, SR52	Zambia
	48 S1's	Zimbabwe
	Katumani, H614, 7801	Kenya
	7880, 7621, 7696	Tanzania
	BACOA, BACOB	Cameroon
	Tlat 7844	CIMMYT
	U S Cornbelt x Midalt	U S./IITA

Status: Four cycles of international full sib family selection have been completed Varieties from the population have been in testing since 1985, but none yet recommended A new variety is in formation for 1991 testing

3 Acid Tolerant Population

Objective Provide yellow flint grained varieties tolerant to acid soils of midaltitude zone

Composition	Material	Source

ESAL QYF3, Q5VF1	Brazil
CMS 36 SAFRI	CIMMYT/Brazil
HE1066, 1049	Limagrain
Suwan 1	Thailand
Across 7728	CIMMYT
COCA	Cameroon
Shaba	Zaire
MSR	IITA

Status Three recombinations followed by three cycles of half sib family selection completed and a fourth in progress Two locations with two reps/location of approximately 300 families are tested Needs more disease resistance, as parents are primarily lowland materials

4 **Early White Population.**

Objective Provide early maturing, white grained varieties for the midaltitudes

Composition CIMMYT subtropical population 34
Early maturing MSR lines from IRA/NCRE program
IITA-EMSR lines (being introgressed)

Status Three cycles of family (full and half sib) testing were completed in pop 34 itself, followed by testcrossing early inbreds onto 34 and subsequent evaluation Selected testcrosses were recombined to form the population, which is being tested as a variety Disease resistance ear tip cover, earliness, and flinty grain are principal selection criteria

In addition, three germplasm donor populations are receiving more limited improvement attention IITA-EMSR, CIMMYT-43SR (Tuxpeno), and CIMMYT-32 (Eto) All three are being cycled through inbreeding and per se line testing with subsequent reconstitution of the population from S2 or S3 lines

Currently released varieties are maintained in ear to row isolations for selection and seed increase each year Three of them are undergoing backcross introduction of streak resistance, with screening at IITA Foundation seed is distributed to seed producers each year

Varieties COCA, late, white, Cameroon variety, N.W Prov
BACOA, an early, yellow, Cameroon var , N W Prov
Shaba, late, white Zaire introd , Adamaoua Prov
Kasai, short, white Zaire introd , N W & W Prov

Specialty maize varieties are also under very limited improvement two midaltitude sweetcorn varieties have been developed (MSR-sh and MSR-su), and inbred parents of U.S public popcorn lines are under backcross adaptation for midaltitude use, though progress is very slow

Finally, the most striking accomplishment in the breeding program has been the development of inbred lines for use in both

hybrids and synthetics (a form of open pollinated variety formed from advanced inbred lines), in a variant of Eberhardt's "comprehensive breeding program" An initial group of 714 segregating lines was brought from IITA in 1984, from which a few lines were advanced and evaluated in testcrosses and hybrids. Sixteen lines were recycled through reciprocal synthetics and crossed onto East Africa hybrids and varieties for extraction of new inbreds These, along with lines selfed directly from MSR and MSR crossed onto introductions, provided the inbred parents which are in hybrids and testcrosses currently being evaluated In 1990, approximately 360 testcrosses and 230 hybrids were tested at four locations, including 15 selections from 1989 in advanced hybrid trials. The inbred development system currently has sufficient segregating lines in progress to provide the maximum testable number of new hybrids through 1993.

Source germplasm for crossing with our streak resistant lines and synthetics for inbred extraction are listed below

Parental Sources	Material	Source
	MSR	IITA
	Hybrids	Zimbabwe, Kenya
	Varieties	Tanzania, Kenya, U S , CIMMYT

Seed of advanced and segregating lines has been requested by breeders in Zambia, CIMMYT-Harare, and Pioneer Overseas-Harare, who have visited this program As an earlier shipment to CIMMYT-Harare included lines which occupied the top positions their 300 entry testcross trial, it is likely that some of those and more recent lines will be rapidly advanced into hybrid seed production, both in East Africa and, through Pioneer, in Cameroon.

Varietal synthetics have been formed from four sequential groups of inbreds Three have been entered in the national variety trial-midaltitude by 1990 In 1989, the Synthetic 2 ranked first in yield and was superior in most agronomic traits to the open pollinated varieties developed in traditional population improvement programs It would appear that hybrid and open pollinated variety development, at least for the late maturing, white grained type dominant in the inbred program, can be accomplished with the same lines, effecting a savings in resources parallel programs of population improvement and inbred line development would not be necessary

Results from the 1989 National Variety Trial-Midaltitude and High Altitude are included as Tables 1 and 2 to illustrate the current status of advanced varieties The agronomic quality of the midaltitude synthetics is reflected in the low scores (1 is best) for traits such as lodging, husk cover, ear rots, etc. as well as the high yield ranking The synthetics also rank among the flintiest of the advanced varieties, a desirable trait for grain storage The first cycle of the High Altitude Population proved superior to other available varieties in the high altitude trial Tables 3 and 4 present results from Hybrid Sets 1 and 4 from 1989 Entries can be observed which are competitive in

yield and agronomic characteristics with the best known East Africa hybrid, ZS206, included as a check In addition, NCRE hybrids have flintier grain type and less ear rot, desirable features in the Cameroon Highlands, which receive much more precipitation than Zimbabwe

2 1.5 IN-SERVICE TRAINING

On the job training is a continuous process for counterpart scientists and technicians In the first years of the unit, this required close supervision of all operations by the IITA scientist When a nucleus of experienced staff had been developed, they were able to help train new staff which were added to the unit since 1984 In the last two years, population improvement work has been managed by IRA scientists in consultation with the IITA scientist The more complicated hybrid program has been supervised directly by the IITA breeder with assistance from IRA staff the first IRA counterpart returned with an M S only this year Overall unit supervision requires Ph.D training

In Phase II, short courses at IITA were attended by two breeder counterparts M Ndioro attended one course each in germplasm conservation and plant pathology techniques, and I. Tabi attended one course on maize streak virus screening techniques J Eta-ndu, while on training in the U S , attended the annual meetings of the American Society of Agronomy and the American Seed Trade Association

Technician and scientist trainees from the various technical schools and the Dschang University Centre, averaging approximately two per year, worked with the unit for training periods of one to three months

2 1.6 PRIORITIES FOR FUTURE RESEARCH

Future progress in the program will be directly proportional to available operating funds and to the quality of unit management Timing of fund availability is critical, as operations must be carried out on time or dropped for the year Subprogram priorities are listed below by order of retention from minimal to optimal funding levels

Variety maintenance Those varieties being produced and distributed to farmers must be maintained and foundation seed delivered to the seed producers each year Ear to row selection/seed increase is preferred when isolations are possible Selection pressure must be maintained to avoid 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 adaptation to acid or fertile conditions, etc) can be maintained as resources permit, recognizing that the number of isolations possible at IRA sites under current management practices is very limited and requires the hiring of field guards at some locations

Population improvement Open pollinated populations, such as ATP and EW, which serve as varieties or sources of varieties, can be improved at a faster rate than that obtained in ear to row maintenance/selection by employing more intense selection methods, such as half sib family or inbred (S1-S2) recurrent selection across locations with recombination of selections from remnant seed in the dry season Inbreeding is especially effective in improving disease resistance and should be employed for one or two cycles in ATP, HAP, and other populations in selection for resistance to leaf blights (**E. turcicum** and **B. maydis**), rusts (**P sorghi** and **P polysora**), **Phaeosphaeria** leaf spot (now observed in the high altitude zone), **Diplodia macrospora** leaf stripe, and streak virus. Inherent in the cyclical development of new varieties is the requirement for multilocational variety testing to determine varietal recommendations.
3. Inbred development A self sustaining (private sector) seed industry capable of producing and distributing high quality seed will have hybrid maize as its foundation Development of this industry is dependant on availability of good inbred parental lines, developed in the public sector or by their own breeders Availability of adapted public inbreds cuts initial investment costs, making the investment more attractive Collaborative trials with Pioneer-Harare have been run for two years and lines are being provided to their breeder CIMMYT-Harare and the IITA Jos program will be able provide valuable source germplasm Systematic inbred development should continue, producing parents of hybrids and varietal synthetics It is recommended that these varietal synthetics eventually replace the populations currently in the late maturing, white grain category

The streak screening facility, currently on order by IITA, should be installed at the dry season nursery site (Foumbot) and the junior breeder should receive degree training in Entomology to manage the facility He would screen materials for both the low and high altitude programs, and would manage the large nursery and trial area at Foumbot, which currently requires extensive commuting from Bambui

Collaboration with the pathologists should emphasize development of inoculation techniques for the two newly identified diseases prevalent at some locations in the Northwest Province. **Diplodia macrospora** in the mid altitude and **Phaeosphaeria** in the high altitude zones

TABLE 1 1989 NATIONAL VARIETY TRIAL, MIDALTITUDE TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT CM	EAR HEIGHT CM	ROOT LODGE 1-5	STALK LODGE 1-5	PLANT ASPECT 1-5
COCA	77	270	141	2 8	2 5	3 3
BACOA	76	258	138	2 8	2 3	3 4
KASAI	76	238	121	1 6	1 5	1 7
SHABA	78	256	140	1 9	1 7	2 0
SYNTHETIC 1	79	264	139	1 6	1 7	1 8
SYNTHETIC 2	79	262	142	1 6	1 9	2 4
FBT 3 MSR 85	77	262	139	1 8	2 2	2 6
FBT 3 MSR 87	78	261	138	1 8	2 0	2 3
FBT 4 MSR 87	78	265	146	2 1	2 3	2 6
FBT 5 MSR 87	80	264	137	1 9	1 6	2 4
Number of Locations	6	6	6	7	7	6
*LSD 05	1	10	8	0 4	0 4	0 5
S E	0 33	3 57	2 93	0 09	0 09	0 11
C V %	2	7	10	24	24	22

CONTINUED

VARIETY	BLIGHT (E T) 1-5	RUST (P S) 1-5	HUSK COVER 1-5	EAR ASPECT 1-5	EAR ROT 1-5	YIELD T/HA
COCA	1 8	1 9	2 3	2 7	2 6	8 3
BACOA	2 5	2 9	2 8	2 8	2 7	7 1
KASAI	1 2	3 1	2 0	2 6	2 5	8 0
SHABA	1 5	3 4	2 1	2 4	2 5	8 1
SYNTHETIC 1	1 9	1 9	2 4	2 3	2 4	8 2
SYNTHETIC 2	2 0	1 9	2 5	2 1	2 4	8 5
FBT 3 MSR 85	1 8	2 6	2 3	2 3	2 6	7 9
FBT 3 MSR 87	2 2	2 5	2 4	2 1	2 7	8 2
FBT 4 MSR 87	1 8	2 0	2 5	2 3	2 7	8 4
FBT 5 MSR 87	2 2	2 4	2 5	2 1	3 0	8 1
Number of Locations	3	2	6	7	7	7
*LSD 05	0 6	0 5	0 4	0 3	0 3	0 7
S E	0 15	0 19	0 10	0 09	0 09	0 12
C V %	28	22	20	19	19	8

* Note V X L interaction used as error on all traits except plant height, ear height and rust

TABLE 2 1989 NATIONAL VARIETY TRIAL, HIGH ALTITUDE
TRAITS ACROSS TWO LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT CM	EAR HEIGHT CM	EAR ROT 1-5	YIELD T/HA
HAP-C1	113	251	146	2 1	6 0
POOL 9a SYN	115	234	129	2 0	4 7
POOL 9a	121	243	140	2 0	4 7
NDU LOCAL	115	274	164	2 3	5 2
COCA	110	238	126	2 6	5 3
LSD 05	5	27	23	0 4	0 8
S E	1 7	9 4	8 0	0 13	0 27
C V %	4	10	15	16	14

TABLE 3 1989 HYBRID SET 1 TOP YIELDING ENTRIES
TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT CM	EAR HEIGHT CM	STALK LODGE 1-5	PLANT ASPECT 1-5
88069 X 88099	77	278	157	1 7	2 3
88069 X M131	80	297	153	1 8	1 8
ZS 206	76	288	145	1 8	2 1
88094 X M131	78	292	156	1 5	2 3
88069 X 88044	77	272	146	1 5	2 0
88069 X 88030	78	293	151	1 5	2 1
88069 X 88104	77	276	143	1 3	2 3
88069 X 88033	77	278	131	1 2	1 8
88069 X 88038	77	290	148	1 3	2 0
88069 X C70	78	288	141	1 5	1 5
KU1414 X 87069	78	264	136	1 2	1 5
88036 X M131	80	281	147	2 0	2 2
SHABA	78	273	143	1 3	2 6
Number of locations	4	3	3	2	4
LSD 05	2*	13	12	0 8*	0 5
S E	0 52	4 8	4 4	0 23	0 18
C V %	2	5	9	36	28

CONTINUED

VARIETY	HUSK COVER 1-5	EAR APECT 1-5	EAR ROT 1-5	YIELD T/HA
88069 X 88099	3 3	3 1	3 0	12 3

88069 X M131	2 5	2 0	2 7	12 2
ZS 206	2 8	1 3	2 8	11 7
88094 X M131	2 3	1 5	2 8	11 3
88069 X 88044	3 0	2 9	3 5	11 3
88069 X 88030	2 5	2 4	2 7	11 0
88069 X 88104	3 2	2 0	3 5	11 0
88069 X 88033	2 8	2 3	2 9	10 8
88069 X 88038	3 0	3 0	3 2	10 7
88069 X C70	2 5	2 1	2 7	10 6
KU1414 X 87069	2 4	2 7	3 1	10 6
88036 X M131	1 8	1 8	2 5	10 6
SHABA	2 2	2 9	3 3	10 1
Number of Locations	4	4	4	4
LSD 05	0 4*	0 5*	0 6*	1 0*
S E	0 13	0 13	0 14	0 25
C V %	19	20	18	9

* Location x Variety used as error

TABLE 4 1989 HYBRID SET 4 TOP YIELDING ENTRIES TRAITS ACROSS LOCATIONS

VARIETY	DAYS TO SILK	PLANT HEIGHT CM	EAR HEIGHT CM	ROOT LODGE 1-5	STALK LODGE 1-5
88067 X 87036	76	288	144	1 2	1 2
88067 X 88060	76	285	144	2 0	2 2
88067 X 88103	78	295	166	1 3	1 3
ZS 206	75	283	144	2 5	1 5
88060 X 88103	78	293	169	2 0	2 8
87366 X M131	77	267	151	1 7	1 5
88067 X M87	76	276	158	1 5	1 0
88018 X C70	76	296	157	2 0	1 0
87366 X 88030	77	272	152	2 2	1 7
SHABA	77	265	137	1 8	1 7
Number of Locations	3	3	3	2	2
LSD 05	2*	15	15	1 0*	1 1*
S E	0 5	5 5	5 2	0 27	0 22
C V %	2	6	11	40	31

CONTINUED

VARIETY	PLANT ASPECT 1-5	HUSK COVER 1-5	EAR ASPECT 1-5	EAR ROT 1-5	YIELD T/HA
88067 X 87036	1 3	2 2	1 8	2 5	11 0
88067 X 88060	2 6	3 1	2 0	2 9	10 8
88067 X 88103	2 3	3 1	2 2	3 5	10 4
ZS 206	2 2	2 8	1 6	2 9	10 4
88060 X 88103	2 8	2 0	1 4	2 6	10 4
87366 X M131	1 7	3 3	1 9	3 2	10 3
88067 X M87	2 0	2 3	2 3	3 0	10 1
88018 X C70	2 1	1 6	2 3	2 8	10 1
87366 X 88030	2 0	1 9	2 0	2 1	8 9
SHABA	2 4	2 1	2 8	3 3	7 8
Number of Locations	4	4	4	4	4
LSD 05	0 8*	0 5*	0 5*	0 5*	1 0*
S E	0 17	0 14	0 13	0 15	0 28
C V %	26	20	20	18	10

* Location x Variety used as error

2 2 HIGHLAND MAIZE AGRONOMY

2.2 1 INTRODUCTION

The goal of the highland maize agronomy is to develop agronomic practices that will result in sustainable, highly productive maize based cropping systems in the Western Highlands

This is set against the background that maize is a staple food of most people in the area, it is intercropped with other crops such as beans, potatoes, colocasia, groundnuts and coffee Formerly a purely food crop, it is becoming a cash crop especially with the fall in price of cash-earning commodities like coffee Due to the high population in the area, there is great pressure on land to the extent that it is cropped continuously Yields have consequently dropped to very low levels in the highly populated areas

The area is mountainous with high rainfall (often more than 2000 mm per annum) This has resulted in a severe danger of soil erosion Most soils are highly acidic resulting in a possibility of aluminum toxicity and a deficiency of minerals such as calcium and magnesium Due to the high altitude, the soils are rich in organic matter To avoid these soil fertility related problems some farmers in the area burn plant residue underground a practice known as "Ankari" which is believed to have negative effects on subsequent fertility

The rain falls between March and October/November with a peak in August and September The available maize varieties have to be planted at the onset of the rains if good yields are to be obtained Late planting results in high disease pressure and insufficient mineral uptake associated with the low radiation and cool and wet conditions in the middle of the season This results in harvesting during the peak of the rains (August/September) which may result in ear rot and poor grain quality

Prior to 1985 there was little agronomic work done in the area apart from some soils work done at Dschang and some agronomic studies carried out Bambui with the adaptive agronomy section of the Testing and Liaison

2.2 2 OBJECTIVES

Highland Maize Agronomy is a stations' agronomy component of the project Although some work has been done at Public farms such as Trial and Demonstration Centers, Seed Farms and University Farm most of the work is done at IRA station, sub-stations and trial farms Its role could be seen as bridging the gap between pure research and the on-farm research It has the following as its main broad objectives

1) To develop agronomic practices that would sustain the productivity of a maize based cropping system In this respect it has carried out studies in residue management, improved fallow and agroforestry, liming, long term fertilizer studies and on methods of land preparation
2) To fit maize into the existing cropping system In this regard, it has carried out studies in maize varietal adaptability to soil fertility, plant population ,and date of planting Work has also been done on the suitability of maize varieties for intercropping and response of such a system to chemical weed control

2.2.3 CONSTRAINTS

There have been two major constraints, lack of support staff and limited working facilities The number of counterparts has been very limited and there has been no overlap between joining and leaving for further training There have been only two counterparts during the period 1986-1990 The unit has also lacked technicians and capable recorders This has resulted in hiring of temporary recorders who are not sufficient as far as continuity is concerned The Technical Assistant has had to spend more than 60 % of the time supervising field work.

There has been lack of some vital research facilities such as ovens and working space This has resulted in insufficient handling of samples Also important instruments for the collection of climatic data have been inadequate
Soil testing services have also been unreliable and inadequate.

The lack of suitable grain legumes has hampered progress on the assessment of their compatibility with maize In some cases maize varieties have also been insufficient This is mainly so at the high altitudes

The economic crisis within IRA has also affected the quality of the workers hired and thus increased the amount of time required for supervision

2 2.4 ACCOMPLISHMENTS

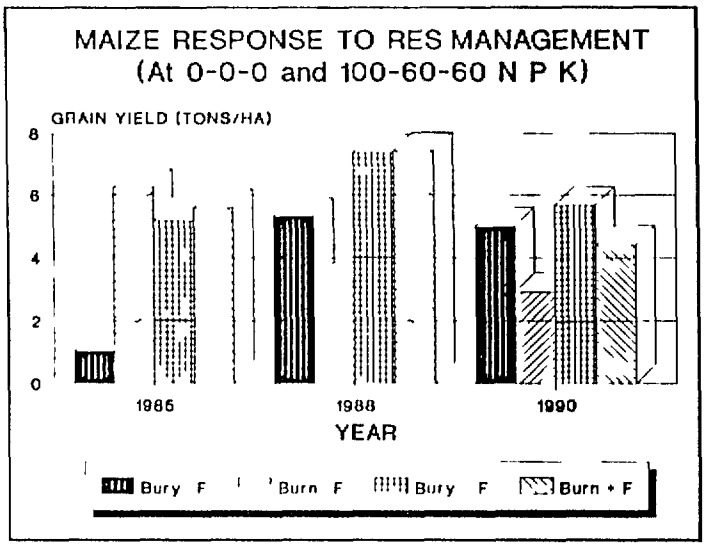
A total of ten studies have been undertaken during the period Most of those which were started at or before the beginning of the Phase have been completed and the long term trials will be continued in the next Phase They have been mainly in the areas of soil fertility maintenance and fitting the maize crop into the existing cropping system

A) SOIL FERTILITY IMPROVEMENT

Under soil fertility maintenance studies have been carried out on ,residue management, liming,improved fallow and long-term fertility studies

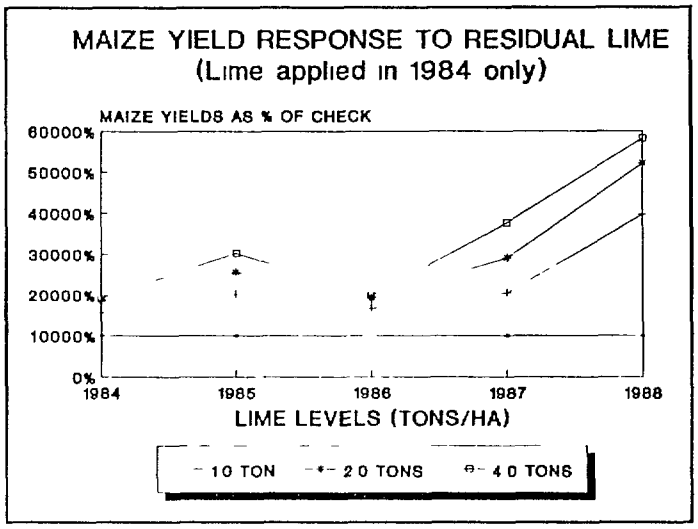
Residue Management

Many farmers in the area bury plant residue and burn it.This way they claim that they obtain good yields of the major crops namely maize, colocasia and vegetables The authorities are however, against the practice that it destroys the subsequent fertility To characterize the effect of the practice of burning plant residue underground a study was conducted from 1985 through 1988 and then in 1990 The performance of maize over the full period was determined under three residue management systems with different levels of fertilizer The management systems were burying residue, burning it at the soil surface and burning it underground The fertilizer levels were 0-0-0,100-60-60, and 200-120-120 kg N P K/ha The burning was carried out in the first two years of study and discontinued afterwards until 1990 when it was repeated The results obtained showed no difference in crop response to burning residue at the soil surface and burying it Also, although there was a difference in the magnitude crop response to the highest fertilizer level was similar to that of the medium level The study showed that burning plant residue underground resulted in very high initial yields but then declined with continuous cropping (Figure 1)) In the first year of cropping, yield obtained from plots where residue was burned underground but no fertilizer applied were slightly higher than those obtained from plots where residue was buried and fertilizer applied They were over 500% of those obtained when residue was buried and no fertilizer applied The situation was reversed in subsequent years to the extent that in 1988 and 1990 the plots where residue was buried were 40% higher than those obtained in plots where residue was previously burned underground In all cases fertilizer application reduced the effect of impact of the residue management The results indicate yield responses to no fertilizer applied and when a medium level has been applied



The results indicated that burning plant residue underground results in very high yields which decline thereafter to those inferior to the ones obtained when residue is buried. There are no clear differences in yield when fertilizer was applied which implies that burning should be discouraged while at the same time promoting the use of moderate levels of fertilizer. The fertilizer formulation should have a high level of calcium and be able to promote the raising of soil pH both of which were found to be high when residue was burned underground This is in favor of lime application

To determine the effect of increased calcium and increase in soil pH, **crop responses to lime** have been studied in a trial that was initiated in 1984 and maintained until 1988. Response to lime applied in 1984 was followed through 1988 with maize in the main season followed by beans or cowpeas. Lime was applied at the rates of 1 0,2 0, and 4 0 Tons/ha. This was in combination with phosphorus at the rates of 50,100, and 150 kg P_2O_5/ha Both lime and phosphorus were applied only in 1984 and the residual effect followed afterwards Only the effect of liming is discussed **Figure 2** shows crop response to a single liming application in 1984 The response is mainly due to a reduced yield With continuous cropping, yields of the check were decreasing, the yields being 2 18, 1 48, 2 18, 1 05 and 0.39 Tons/ha for 1984, 1985, 1986, 1987 and 1988, respectively Soil pH went down from 4 7 to 4 0 when beans could not grow at all and only a few stands of maize could survive This (pH 4 0) was too low for the beans to grow (they died two weeks after germination) and maize yield was as low as 85 kg/ha in some of the plots In the case where lime was applied at the rate of 4 0 Tons/ha the soil pH went up to 5 1 at the in the year of application and was lowered to 4 7 by the end of the study



The sustenance of reasonable yields by moderate applications of lime over years suggests that it could be economical to apply lime even at the present high price If it could be the only means to lead to any yields at all (the case of beans) then it might be absolutely necessary to lime As a follow up a study was started in 1989 to screen different sources of lime so as to determine the most efficient The study compares Agri 56, a waste product of the local cement company, CEMENCAM against commercial lime products It is comparable to commercial sources as far as the supply of calcium and magnesium are concerned and superior to agricultural limes as regards its effect on raising the soil pH If proved superior, it could be recommended for use in the Northern part of the Central Ridge since transportation would make it practicable for the Western Highland for the time being.

Another trial was started in 1989 to compare yield responses of maize and late season beans to compost and a moderate level of dolomitic lime (5 0 Tons/ha) The preliminary results indicate that the two amendment practices give similar maize yields but lime gave higher bean yields

Phosphorus studies A similar long term study has been conducted using different **Sources and rates of phosphorus** started as part of collaborative effort with the International Fertilizer Development Center, IFDC-Africa The response of maize followed by late season beans to rates and sources of phosphorus was determined over a 4-year period The novel sources Rock Phosphate (PR) and a 50% partially acidulated rock phosphate (PAPR) were compared at rates ranging between 0 and 300 kg P_2O_5 Also applied were DAP, TSP and Bicalcium phosphate at the rate of 150 kg P_2O_5/Ha Phosphorus was applied in 1987 and the residual effect of this application were determined in subsequent years until 1990

Results obtained showed that SSP was superior to the novel sources This superiority in the first year was continued over the years as per grain yield per kg of P_2O_5 **(Table 1)**

Table 1· Maize yield response to applied phosphorus from different sources

YEAR	YIELD OF CHECK (TONS/HA)	Maize Yield Kg/kg of P_2O_5 50% PAPR	SSP	ROCK-P
1987	2 69	17	34	11*
1988	3 51	10	28	4
1989	3 77	9	19	4
1990	1 20	6	10	4

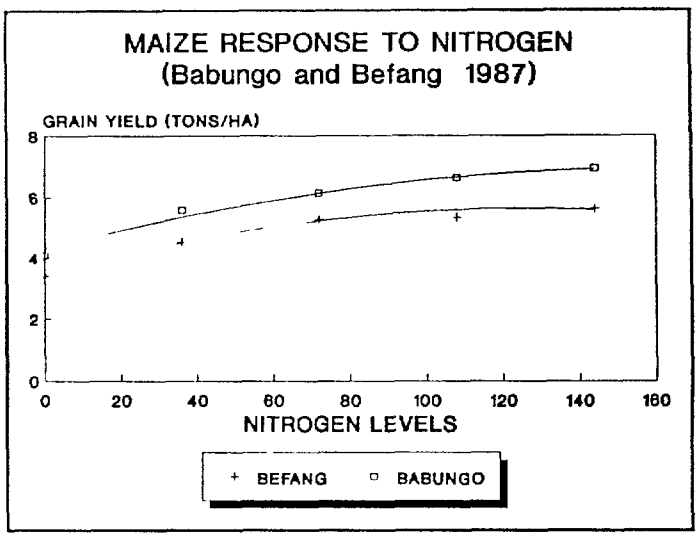
* Obtained from regression coefficient

The results also show that there was still a reasonable response for years after application especially in the case of single super phosphate (10 kg of grain per kg of phosphate applied) There was no significant difference in yield between the check where only N and K were applied and the absolute check

The yield of beans also followed a trend similar to that of maize although yields were much lower due to lack of adapted varieties and the poor reliability of the season Single Super phosphate showed the best yield which showed a curvilinear response that suggested a biological optimum at the rate of 137 k of P_2O_5 to obtain 85% of the biological optimal (6 15 tons per hectare) The affordability of such rates is enhanced by the fact that each application leaves some phosphorus in the soil thus leading to build-up

When all the sources were compared at 150 kg P_2O_5/ha Bicalcium phosphate and SSP gave the highest yields of both maize and beans most of the time
The results from the lime study and phosphorus studies emphasize the importance of calcium deficiency since the sources that gave good results are the ones with high calcium content This suggests that lime could be applied in quantities that supply it

Nitrogen responses have also been studied at two locations. The results obtained (**Figure 3**) show curves fitted from means of four nitrogen sources (Urea, Calcium Ammonium Nitrate, Sulphate of Ammonia and Urea Supergranules) four applications. The rates ranged from 0 to 144 kg N/ha Sole maize was the test crop.

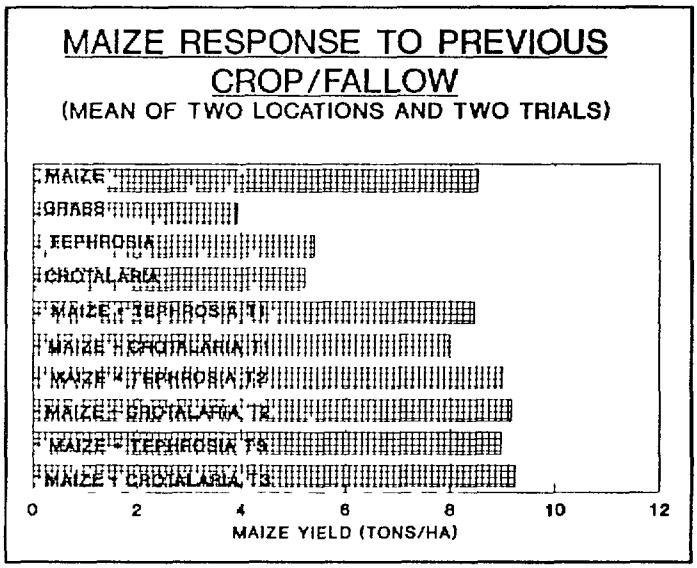


The results show that at Befang the optimal yield of 5.63 Tons/Ha was reached at 120 kg N/ha but to obtain 85% of this optimal rate it would require only 47 kg/Ha Application of 1 kg N resulted in a yield increase of 37 kg

Responses at Babungo were similar although the optimal yield was higher

In another study , the response of maize and beans to combinations of nitrogen and phosphorus is being determined at several locations The results obtained show that there is very little interaction between the two elements This lends more credence to the results obtained with the individual nutrients above

Improved Fallow Studies. In order to reduce the decline in yield with continuous cropping a study was initiated to determine the effect of cover crop species as simultaneous fallow or whether it was better to plant the species in one year and crop in another The trial was started in 1986 when the legumes were planted at Befang (600 m), Babungo (1176 m) and Bambui Plain (1330 m) The species initially tested were, Crotalaria, Tephrosia, Mucuna and Sesbania These were later reduced to Crotalaria and Tephrosia which were planted either as sole species or planted with maize at various stages The stages used were, at the same time with maize (T_1) at Maize knee-high stage (T_2) or at two weeks after silking (T_3). The later trials were planted only at Babungo and Bambui Plain. The



legumes were established in the first year and sole maize was planted in the following year Yields from the two years of cropping were compared **Figure 4** shows the yields obtained from two trials at two locations (Bambui Plain) The results indicate that at the present state, maize has to be planted in both years since sole maize outyielded the sole legumes in the first year. The results also indicate that planting legumes gives higher yields than leaving the land under natural fallow giving at least 1 ton of maize yield increase

Planting the legumes at the same time with maize resulted in yields similar to planting than later but the quality of the crop was poor due to high humidity within the canopy. Also late planting of the legumes resulted in their poor growth establishment and growth The search for legumes that could establish slowly during the first cropping season and flourish after harvesting the crop should be intensified The incorporation of legumes has the advantages of, increasing organic matter, ground cover and thus controlling erosion reduction of weed infestation in addition to nitrogen production and nutrient recycling Some of the woody ones such as Tephrosia are also used locally as fuel-wood From the results obtained it is recommended to plant Tephrosia at the time of moulding (T_2) since this allows good growth of both maize and the species The search for more efficient legumes should consider the ease of establishment and multi-purpose legumes

This work could be done in close collaboration with institute of animal research to identify those that would be efficient as forage for the animals

Agroforestry· A limited amount of work has been done in the area of agroforestry This has been in the collection of species that have been proved to be good for alley cropping and the general area of agroforestry We have not been successful in that the species that we obtained were not adapted for the cool climate with highly acidic soils Of the 32 species planted only **Calliandra calothyrsus**, **Leucaena leucocephala** and to a certain extent, **Cassia spectabilis**, seem to show promise as far as growth is concerned In an establishment trial where the growth when fertilized is compared to no fertilizer applied, these species seem to respond to moderate levels of fertility
The growth of Calliandra seems to be impressive although its flowers tend to be heavily attacked by thrips to the extent that it is difficult to get seed Otherwise, it could be recommended to the farmers on a trial basis

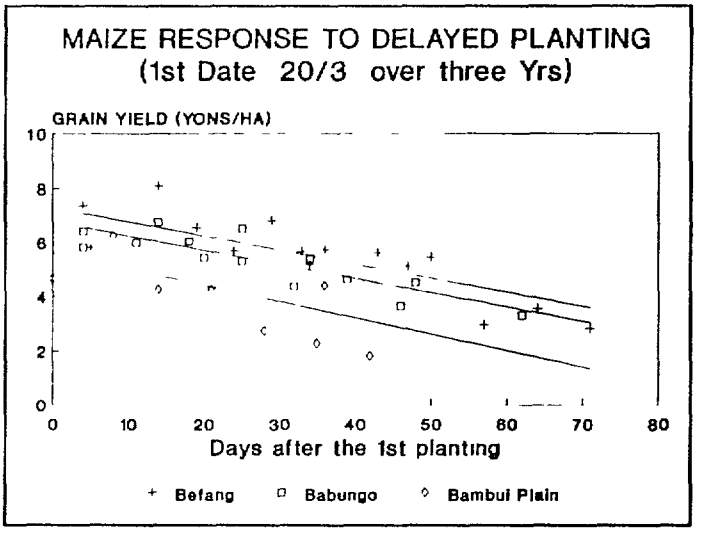
Management studies with leucaena established at Babungo in 1987 were started in 1990 It is still too early to determine its efficiency

FITTING MAIZE INTO THE CROPPING SYSTEM

In order to determine whether new varieties of maize fits into the farming system, work has been done to determine maize varietal response to fertilizers and to planting date.

Planting Date· Presently farmers have to plant immediately at the onset of the rains as recommended by the extension service. The recommendations were based on the response of the old varieties With more varieties being developed ,it was felt necessary to determine whether there were some that were less responsive to date of planting and thus allowing for more flexibility to the farmers at the peak periods of planting , weeding, and drying A trial was therefore carried out for 3 years at three sites, Befang (600 m., Babungo (1176 m) and Bambui Plain (1330 m) representing major agroecological zones with suitable varieties Planting was carried out at weekly intervals spreading over 42 days in 1986, 10-day interval over 30 days in 1987, and at a 14-day interval for 42 days in 1989 All planting started between March 20 and March 28 except at Befang in 1986 when planting started April 10 and Babungo in 1989 when the first planting was done on April 5 At Befang Ekona, White and Kasai 1 were planted in all the three years of study, CMS 8501 and CMS 8507 in two years and Ndock 8701 in only one year At Bambui Plain, COCA and BACOA were planted in all the there years, Foumbot- 3- MSR in two of the years and Kasai 1 in only one year In the case of Babungo, COCA and Kasai 1 were planted each year, BACOA and Foumbot-3-MSR were planted in two of the years while Synthetic-AB was planted only one year The choice of varieties depended on the comparison to be made , availability of seed and the adaptability of the variety

There were no major differences in varietal response although the relatively never varieties namely Foumbot-3-MSR and Synthetic-AB were relatively less responsive than the older varieties COCA and BACOA at the Mid-altitude locations. While Kasai 1 showed less yield reduction than COCA with delayed planting at Babungo, its yield was reduced more than that of Ekona White at Befang especially in the year when planting was generally delayed



In all cases there was a significant linear relationship for most varieties at all locations thus indicating that even the shortest delay caused some reduction The reduction, however was greatest when planting was done beyond April 15 (Data not shown) The response was similar at Befang and Babungo where the reduction in yield was 52 3 and 52 8 kg reduction per hectare , respectively for each day delayed after the onset of the rains (**Figure 5**) The reduction was slightly greater (59 9 kg Ha^{-1} day^{-1}) higher altitude of Bambui Plain The yield potential was also lowest at Bambui Plain and highest for Befang

The results confirm the fact that delayed planting results in reduction in yield They also show the magnitude of yield reduction which was previously unknown.

There were also some indications of varietal differences although they were not consistent Disease pressure, mainly blight was only severe when planting was carried out in May. That reduction was greatest at Bambui Plain which has more over cast skies in the middle of the season suggests that the cause of the reduction in yield was mainly physiological Grain yield was found to be highly correlated with the number of ears per hectare which suggests the effect of the climate on growth and development during the reproductive phase

Preliminary results show that farmers can plant in the middle of the dry season without suffering any loss in plant establishment and yield reduction It is therefore recommended that farmers could plant at or before the onset of rains. In the present study, a slight delay in planting resulted in a slight increase in yield in the years when there was an early drought. This was only minor

With the varieties tested, farmers will have to plant at the beginning of the rains if they are to get high yields This forces them to harvest at the peak of the rains More research is necessary that leads to varieties that could be planted later and give good yields

It is recommended that breeding programs develop varieties that could either be planted late or could make full use of the rainy season if good quality maize is to be obtained. This is especially so if yields are to be increased beyond what the farmer can dry using present methods

Land Preparation Over 85% of the farmers in the area prepare land by creating ridges This was perceived as time consuming with no additional benefits A study was therefore started in 1988 to compare yields and labor requirements of maize intercropped with a legume under different land preparation methods Ridging was compared with planting on the flat with land hoeing and where no hoeing was done This was carried out for two years at two years at two locations The results obtained are summarized in Table 2

Table 2. Effect of Land Preparation on Maize Yields

Land Preparation Method	BAMBUI PLAIN Yield Tons/Ha	BAMBUI PLAIN Labor Manhour/Ha	BABUNGO Yield Tons/Ha	BABUNGO Labor Manhour/Ha	MEAN Yield Tons/Ha	MEAN Labor Manhour/Ha
Ridge	4 15	1007 4	4 45	893 4	4 30	950.5
Flat	3 12	1116 8	3 67	926 3	3 44	1021.6
No till	2 91	862 3	3 50	854 9	3 21	858 6
MEAN	3 42	995 3	3 87	891 5	3.65	943 7

The trial was conducted on the same plot for 2 years At Bambui Plain the yield of flat planting was 77% of that obtained from ridge planting Similarly at Babungo the yields obtained were only 82% of those obtained The yield of beans at Bambui Plain and those of soybeans at Babungo followed similar trends to those of maize In all cases, no till had the lowest yield

In both cases planting on the flat has higher labor requirement than planting on the ridges This was due to the fact that although land preparation took similar amount of time, planting and weeding crop planted on the flat look more time than that planted on ridges

It is therefore advantageous to plant on the ridges since the greatest labor demand was for land preparation which is done in the slack period and resulted in higher yields It also has a positive long-term effect in that it is easy to bury plant residue, brings leached minerals to the surface and when properly done across the slope, will reduce erosion No till might be relevant for plantation crops but had lower yields that decreased with continuous cropping

It is therefore confirmed that land preparation using ridges results in high yield without costing more labor compared to planting on the flat Considering other possible benefits, it should be promoted over other methods

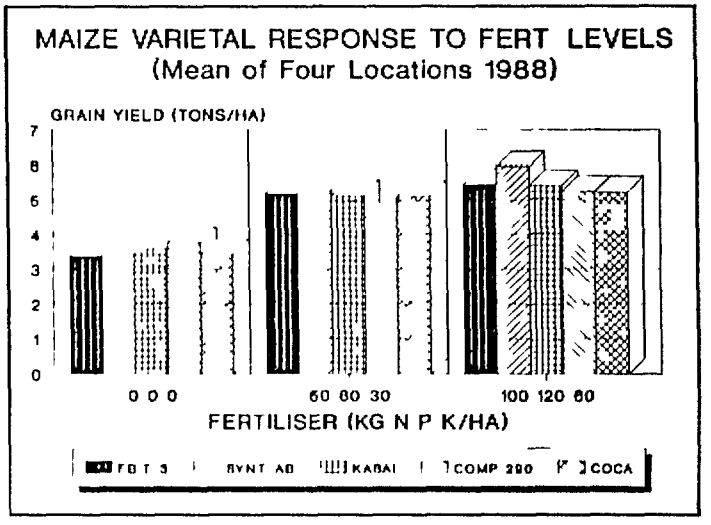
Chemical Weed Control A study to determine maize, beans and groundnut response to herbicides was carried out in 1987 and 1988 at Bambui Plain, Babungo and Befang The objective was to determine whether it was possible to use herbicides on intercrops This would be useful for both researchers and farmers. The herbicides involved in the study were combinations of Lasso, Linuron, Amiben, Dual and Basagran which were compared with the unweeded and weed free checks The herbicides were applied according to the label recommendations

The results obtained showed that lasso was a good herbicide as far as weed control was concerned, had no phytotoxicity on maize and very little phytotoxicity on beans Ronstar had a very high phytotoxic on legumes and considerable toxicity on maize although maize recovered to give good yields Basagrah could control the broad leaf weed and sedges, had no phytotoxicity on crops but could not control the grass weeds and did not harm the crops

The results suggest that a combination of 2 5 kg Lasso and 2 0 kg Linuron would control most of the grass and broadleaf weeds in maize, beans and groundnut crops without damaging the crops

Varietal response to Fertilizer levels and Plant population. Studies have also been conducted to determine varietal response to fertilizer levels and plant population Breeders select varieties under ideal conditions of optimal fertility and plant population Soil fertility is usually low at farmers' fields and

the populations used are lower than those used by the breeders to allow favorable conditions for intercropping The objective of the study was to determine whether there were differences in newly developed varieties in response to conditions as found on farmers fields namely, low fertility and reduced plant population Response of Foumbot-3-MSR,Foumbot-4-MSR, Kasai 1, and Composite 290 to 0-0-0,60-40 and 120-80-60 kg N P K /ha was determined at two locations in 1987 A similar trial was planted in 1988 with Foumbot-3-MSR, Synthetic-AB, Kasai 1, Composite 290, COCA AND BACOA as the test varieties These were planted at four mid-altitude locations in the Western and North-West provinces. The newer varieties outyielded Composite 290 in 1987 between 800 kg and 1200 kg/ha There was, however no significant difference among the newer varieties Fertilizer application increased yield between the low and medium but further increase had no significant effect All varieties responded similarly to fertilizer application A similar response was obtained in the trial conducted in 1988 When combined over four locations and fertilizer levels, Synthetic-AB outyielded all the other varieties except Kasai 1 There were no other significant difference among varieties All varieties showed similar response to fertilizer (Figure 6) They all responded well to the medium fertilizer level but the yield increased only slightly when this level was doubled The yield increase with added fertilizer was associated with the number of ears per plant



Partial stability analysis over the four locations indicated very little difference among varieties Kasai 1 was most environmentally stable while Synthetic-AB was the most unstable Kasai 1 is a shorter variety compared to the others and has shown greater stability against lodging when planted on ridges as farmers do It has also been well received in the areas where it has been introduced The selection of any of the varieties should depend on factors other than their response to fertility

The study was continued in 1989 when the response of varieties to two fertilizer was determined at two populations The varieties used were, Foumbot3-3MSR, Synthetic 1 and 2,Kasai 1, and COCA, fertilizer levels were, no fertilizer and 50-60-30 kg N P K/ha, and The plant populations used were 53,333 and 26,666 plants/ha corresponding to the standard used by breeders and that used by farmers , respectively The trial was planted at Babungo, Bansoa and Wum Maize was intecropped with soybeans There were no varietal differences in response to plant population and fertilizer levels The higher plant population resulted in a significant increase in yield of maize only at

Babungo but decreased the yield of soybean significantly. Kasai 1 was the second highest yielder after Synthetic-2 (difference of only 160 kg/ha) and the yield of the soybeans planted in the Kasai plots was second to that planted in the COCA plots
The results obtained to date indicate that there are very minor differences in response to cultural practices among the presently available open-pollinated varieties although Kasai 1 seems to stand out This implies that the choice among them will depend on other attributes such as storability, and general farmer preferences Similar studies need to be carried out as frequently as new varieties become available. The studies should also be extended to include hybrids as soon as they become available. They should also involve more intercropping as soon as well adapted varieties of legumes and other crops normally intercropped with maize become available

2 2.5 IN-SERVICE TRAINING

A total of 21 students from the University Center, college of Agriculture and School of Agriculture have been trained in the unit on projects as partial fulfillment of their degree diplomas and certificates These have been distributed as follows:

Category	Number trained Year					
	1986	1987	1988	1989	1990	Total
1) University Ingenieur Agronome		2				2
2) University Ingénieur de Travaux	1	1	1	2	1	6
3) Senior Technician	1		2	1	1	5
4) Junior technician	3		2	2	1	8
	5	3	5	5	3	21

There has also been the continuous on job training of technicians and workers in the unit Presentations have also been given to technicians in the field about " management of research plots"

One counterpart is Mr Nguiguim who is receiving Masters training at North Carolina State University Another one, Ngong has received a short-term training at IITA on Maize Technology Transfer.

2.2.6 PRIORITIES FOR FUTURE RESEARCH

A lot of information has been generated regarding maize responses to various cultural practices The following areas should receive high priority

1) Soil improvement through improved fallow This should involve a comparison of soil improvement using fast growing legume and non legume species The evaluation of the species should take into consideration their value in erosion control, soil organic matter evolution (in the low organic matter areas) and their value as forages
2) Evaluation of the combination of fertilizer and organic farming in sustainability This should involve determination of crop combination performances when mineral nutrients are combined with organic farming
3) Strengthening intercropping studies at Station level This should take into consideration the present poor performance of legumes when intercropped with maize Work should also be done in the area of double cropping The late seeded crop would utilize the moisture that usually supports weeds.
4) Agroforestry should also be intensified The approach should be to identify species that would be able to grow fast enough for the recycling of nutrients The production of organic matter might not be so important in the highlands apart from areas where it has been removed by erosion

2 3 LOWLAND MAIZE BREEDING

2.3.1 INTRODUCTION

Prior to 1986, the lowland breeding devoted his effort in identifying adapted introduced maize varieties which had good yield potentials and/or good agronomic characteristics. These maize varieties were either released with or without minor change or used as parents in the breeding program By the end of 1986, the following accomplishment were made

* heterotic patterns of adapted introduced lowland maize were studied
* A gene pool for long-term variety improvement were made
* Line development for use in a hybrid/synthetic varieties was in progress
* Use of "Floury" endosperm gene from the local accessions in an effort to produce acceptable soft endosperm maize was in progress
* Acid tolerant varieties were tested in acid soil and the selected varieties were being incorporated in the breeding program
* Specialized maize such as sweet corn, pop corn and quality protein material (QPM) were being introduced

From 1986 to 1990, the lowland maize breeding improved on all past achievement In addition, research program designed to solve new constraints such as striga, drought tolerance were initiated

Finally, the program developed, tested and released new varieties Breeder seeds of these varieties are maintained and part of them are distributed to the seed company and NARS from neighboring country

2 3.2 OBJECTIVES

The main objective of the lowland maize improvement unit is to develop stable, high yielding varieties with good agronomic characteristics acceptable to the diverse farmers requirements, for each of the lowland agroecological zones.

Important selection criteria include the following:
* High grain yield potential
* Days to maturity
* Grain color and texture
* Resistance to disease and pest (streak, borer, termite, striga)

* Tolerance to soil fertility problem (acid soil, zinc and magnesium)
* Drought tolerance in savanna zones
* Grain quality (QPM, soft endosperm, sweetness)

2 3.3 CONSTRAINTS

The main constraints to production encountered are

- Soil fertility (zinc and magnesium deficiency in savanna, acid soil in forest)

- Fertilizer not readily available

- Inadequate rainfall distribution in savanna

- Disease and pest damages (streak virus, termite, blight, striga, borer, grain storage-insect), additional constraints include

- lack of adequately trained staff and support staff

- poor or no storage and drying facilities

- limited vehicle

- untimely availability of funds and research equipment.

2 3.4 ACCOMPLISHMENTS

I GERMPLASM INTRODUCTIONS

New germplasm were collected by the unit and tested as E V.T (experimented variety trial) Similarly, cooperative trials with IITA, SAFGRAD, CIMMYT, CIRAD, Pionneer and Dekalb are also included in this group, but the trials are planted separately to allow the above institutions to have a combine analysis over all their testing sites

From 1986 to 1990, the lowland maize breeding unit tested about 9364 new genotypes Trials names of those germplasm, their origin and the number of entries tested each year are shown in table 1 This table showed that 87% of the new germplasm were developed by the unit itself, 11% were from IITA, 15% from SAFGRAD and only 0 5% from other sources such as CIMMYT, Pionneer, CIRAD and Dekalb

The objectives of germplasm introduction is to identify adapted materials that could be released or used as parent stock in the breeding program

From 1986 to 1990, 37 selected open pollinated materials tested as E V T were advanced to national variety trials (N V T) About 200 inbred lines tested were found to be a

good combiners in three ways and/or single crosses hybrids About 50 lines have showed some potential as drought tolerant lines and about 10 lines are showing some tolerance to striga

II NATIONAL VARIETIES TRIALS (N V.T)

EARLY TO INTERMEDIATE SET

About 15 varieties issued from E V T were tested as national variety trial (N V T) a total of 38 environments The varieties names, their means across the two zones and across the two growing seasons for each testing year are presented in table 2 Data obtained in 19 environments during 1990 are not yet available.

The best intermediate white variety tested in over 38 environments was CMS 8503 (4 8t/ha) The best intermediate yellow variety available up to date is E V 8435SR with 4 6t/ha across 30 environments

The best early yellow variety tested in 23 environment is CMS 8806 (4 7t/ha) Pool 16 SR (4 1t/ha) was identify as the best early white when tested over 23 environments Its counter-part Pool 16 DR (5 0t/ha) (drought resistant) version is being recommended, eventhough it has been tested only in 6 environments Preliminary results obtained in 1990 over 19 environments seemed to confirm this choice

B LATE SET

About 22 late varieties selected from the E V T were evaluated as national variety (N V T) in 38 environments Data from 19 additional 1990 N V T trial are not yet available The variety name, their means across the two zones and over the two growing seasons in forest are presented in table 3

From 1982 to 1986, Goes TZB (6 2t/ha) was identify to be the most stable and high yielding variety It was not released because it was susceptible to maize streak virus It was therefore converted to be streak resistant in 1985 and named CMS 8507 In addition, it was extensively used as parent in population development and improvement

Table 1 also showed that up to 1986 testing, most varieties were introduced from other program Starting in 1987, more than 50% of the N V T entries were varieties developed by the program

The best late white varieties tested in over 30 environments are CMS 8710 (5 2t/ha), Ndock 8701 (5 1t/ha) and CMS 8501 (5 1t/ha)

In 1989, the Ndock 8701 and CMS 8710 entered the SAFGRAD Regional testing. Their ranking were 2nd and 3rd respectively with 5 5t/ha tested in 6 different African countries. These two entries were the best in Guinea and Niger and their seeds were requested by those countries for further testing

CMS 8501 was released in savanna zone and is being grown by 70% of the farmer of this zone

The best late yellow varieties tested in 23 environments is CMS 8704 (5 3t/ha) This variety was released in 1989 in both the forest and savanna zone and is to be used as green maize

HYBRID

Line development started in 1984 The first three-way hybrid were tested in 1987 A total of 585 white and 314 yellow have been tested Three-way hybrids were tested between 1987 and 1990 Testing condition were the same as with open pollinated varieties Varieties selected were generally at least 15% superior to the best open pollinated The best hybrid showed more than 30% yield increase over the best open pollinated (Table 4)

Starting in 1987, new lines from the NCRE populations were grouped into three heterotic groups In 1989, single crosses were produced and tested using the tester of each group as one of the parent In addition single crosses were produced between line of different heterotic group (tester single crosses) Result presented in table 5 showed that higher yielding single crosses were being identified In addition, crosses between lines from different heterotic group yielded higher single crosses suggesting good initial work for their classification

POPULATION IMPROVEMENT

Population improvement involved varieties selected from the N V T The unit developed from the original gene pool at least 15 new open pollinated CMS 8501 has been released in the savanna where seed are being multiplied and given to farmers In addition, two other open pollinated Ndock 8701 and CMS 8701 did well in international testing and may be released soon.

The program also improved in some introduced open pollinated such as CMS 8704 (Suwan ISR) and CMS 8806 (DMR ESR-Y) The first variety is in the process of being released both in savanna and forest areas as green maize The second one is undergoing extensive on farm trial in forest and is being used as "mais de case" in the soudan savanna zone

LINES DEVELOPMENT

Up to date, the program is extracting lines from 17 populations Those lines are classified into 3 heterotic groups after testcrosses in S_3 Those lines also are being evaluated under heavy striga infestation in an attempt to identify lines that are tolerant to this disease In addition, all those lines are being evaluated for tolerance to drought and acid soil.

BREEDER AND FOUNDATION SEED

Seeds of ten major varieties are being maintained on a yearly basis due to poor storage conditions In 1989, the foundation seed requests were estimated at four tons The program made special effort to produce at least six tons of seed of various varieties in 1990 In general, from 1986 to 1989, the unit produced and distributed more than ten tons of seeds

2 3.5 IN-SERVICE TRAINING

Mr. Zonkeng Celicard was sent to U S A for a M Sc in plant breeding in 1988 Mr Anatole Howna a technician based at Ntui was sent to E N S A for an Ingenieur de Travaux degree training in 1988 Mr Fakreo Jean, a technician based in Sanguere was sent to OUAGADOUGOU for six months training course in June 1990 Mr Nkoa Mevoli Roger, an Ingénieur Agronome based in Yaounde, was sent to IITA for a three months training course in maize breeding in September 1990

On the job training continued for the two technicians, Njume Micheal and Ndjobo Jean Paul One casual labor (ASHU Tambe) has been trained to a technician level and is capable of conducting all operations needed in the breeding program

Finally Mr Zangue Cheuka Jean Bosco returned from the U S A in 1988 after obtaining his M sc degree in plant breeding at Cornell University

2.3 7 PRIORITIES FOR FUTURE RESEARCH

- Breeding for tolerance to striga, drought, stem borers and acid soil conditions

- Breeding for quality maize (soft endosperm, quality protein material, sweet maize)

- Breeding for low input technology

- A comprehensive breeding program based on heterotic pattern

- Breeding for improved agronomic characteristic of released varieties such as husk cover, stray green, plant height and lodging resistance

Table 1 Trial names and origin of introduced varieties from 1986 to 1990

Trial Names	Origin	Entries				
		1986	1987	1988	1989	1990
E V T	NCRE	12	15	10	24	-
E V T ESR-W	IITA	14	-	-	8	14
E V T LSR-W	"	12	-	-	14	14
E V T LSR-Y	"	11	-	-	-	-
E V T MSR	"	-	-	-	12	-
PTT	"	-	300			400
INT white hybrid	"	10	10	10	10	10
INT yellow hybrid	"	10	10	10	10	10
E V T 15A	CIMMYT	22	-	-	-	-
R U V T - 1	SAFGRAD	12	-	13	14	13
R U V T - 2	"	11	12	12	13	-
R U V T - 3	"	12	-	12	13	13
Acid tolerant	Various	-	-	21	-	-
Pionneer	U S A	-	7	-	-	17
Dekalb	"	-	-	15	-	-
CIRAD	France	-	-	-	17	20
Int Striga	IITA	-	-	15	11	8
Inbred lines	"	-	-	-	15	15
Inbred lines	NCRE	-	1500	2488	2000	1000
TOTAL		126	2079	2806	2145	2120

Table 2 Summary of N V T early conducted from 1986 to 1989

Varieties	Mean grain yield (t/ha)					Location
	1986	1987	1988	1989	Mean	
E V 8431 SR	4 7	3 4	3 8	3 8	3 3	38
E V 8449 SR (CMS 8503)	4 6	5 3	4 5	4 8	4 8	36
TZESR-W	4 4	3 9	4 9	3 5	4 1	38
E V 8435 SR	4 4	-	5 0	4 3	4 6	30
SAFITA - 2	4 2	-	-	-	-	7
BSR 81	4 7	4 6	3 6	4 0	4 1	38
TZUT	-	-	5 3	4 3	4 7	23
DMR ESR-Y (CMS 8806)	-	-	4 7	4 7	4 7	23
Pool 16 SR	-	-	4 4	3 8	4 1	23
E V 8430 SR	-	-	4 1	-	-	8
DMR ESR-W	-	-	4 1	4 5	4 3	23
BSR Syw I	-	-	-	4 0	4 0	15
BSR Syw II	-	-	-	3 7	3 7	15
TZ ESR - SE	-	-	-	2 5	2 5	3
Pool 16 DR	-	-	-	5 0	5 0	6

Table 3 Summary of M V T late conducted from 1986 to 1989

Varieties	Mean grain yield (t/ha)					Locations
	1986	1987	1988	1989	Mean	
Gusan TZB	6 2	-	-	-	6 2	7
E V 8443 SR	6 5	-	-	-	6 5	7
P R 7822 SR	6 5	-	5 1	5 4	5 6	37
CMS 8507	6 6	4 2	4 8	5 4	5 6	37
CMS 8503	6 2	3 7	4 9	4 6	5 2	37
Suakoko TZPM	6 3	4 3	4 7	5 3	5 4	37
E V 8328	6 0	-	5 0	3 9	5 0	22
CMS 8505	5 5	3 6	5 4	7 2	5 4	37
CMS 8509	5 8	4 1	-	-	4 9	14
Ekona white	5 9	-	-	-	5 9	7
CMS 8704	-	-	5 3	5 4	5 4	23
Ndock 8701	-	4 4	4 9	5 4	5 1	30
CMS 8710	-	4 3	5 8	5 2	5 2	30
Yaounde 8701	-	4 2	4 3	5 0	4 7	25
Across 8701	-	4 2	4 9	5 1	4 9	30
Bertoua 8710	-	4 2	5 4	5 1	4 9	25
Sawan x gene pool	-	4 2	5 2	5 3	5 1	37
Kasai x gene pool	-	3 6	5 0	-	4 5	15
CMS 8501	-	3 9	5 1	5 4	5 1	37
8321 - 18	-	-	5 8	5 6	5 7	23

Table 4 Summary of three-way hybrids from 1987 to 1990

Year	Set	Number tested	Number selected	Mean yield (t/ha)	Mean of best hybrid	% of best hybrid check	% of best open poll-inated
1987	White	225	22	6 9	9 2	113	136
	Yellow	46	6	5 1	8 6	107	116
1988	White	175	42	6 7	10 4	118	139
	Yellow	105	24	4 7	9 1	112	143
1989	White	140	18	6 5	9 2	-	114
	Yellow	133	13	7 0	8 3	-	112
1990	White	45	-	-	-	-	-
	Yellow	30	-	-	-	-	-

Table 5 Summary of single crosses performances in 1989

Year	Sets	Number tested	Number selected	Mean yield	Best hybrid	% best open pollinated
1989	NCRE group$_1$	35	11	6 9 15 8	9 2	115
	NCRE group$_2$	90	10	7 8 6 0	8 4	116
	NCRE group$_3$	133	15	7 1	9 1	129
	Tester single crosses	90	23	7 4	9 3	124

2 4 LOWLAND MAIZE AGRONOMY

2.4.1 INTRODUCTION

The lowland maize agronomist position was vacant until 1989 when the present incumbent joined the NCRE Project Therefore, this report summarizes the work done during the three seasons of 1989-1990

The maize agronomy program collaborates with the maize breeder and the Testing and Liaison Units (TLU) of Nkolbisson and Ekona in developing appropriate agronomic packages for improved maize production in the target area Development of agroforestry systems for maize production is carried out in collaboration with the IRA/ICRAF agroforestry team based at Nkolbisson

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

In broad terms, the following are the important constraints to intensification of food production systems involving maize

1. Declining soil fertility and soil erosion,
2. Weeds infestation,
3. Erratic rainfall distribution,
4. Scarcity of inputs including labor high cost and undependable supply, and
5. Poor rural infrastructure and marketing

2.4.2 OBJECTIVES

The main objective of the program is to increase and sustain the productivity of cropping systems involving maize Improvement and maintenance of soil fertility as well as control of weeds, insect pests and diseases, and soil erosion are essential to achieve the above goal Owing to the limited availability of cash and labor in rural farms, greater attention was given to the development of efficient low cost technologies including agroforestry systems, that can be sustained with within-farm resources

Specific objectives were to

- Develop improved fallow management systems,
- Design in-situ green manure production techniques with legume trees,
- Test new crop associations and rotations with maize,
- Develop efficient and balanced use of supplementary fertilizers in the above systems, and
- Train counterpart scientists and technicians in maize systems research and soil fertility management

2 4.3 CONSTRAINTS

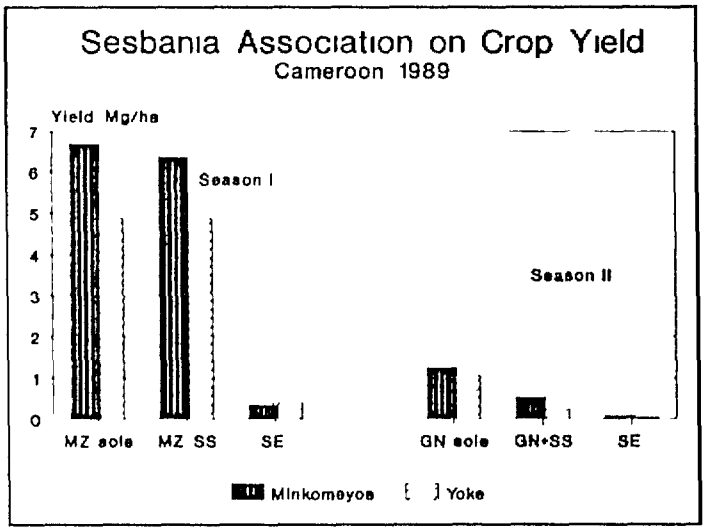
Problems encountered during 1989 and 1990 were (a) poorly developed research sites with no fencing and poor access road, (b) absence of a well-trained farm manager to maintain the research farm, (c) lack of sample drying and processing facilities, and inadequate research equipments, (d) insufficient technical support staff, and (e) non-availability of improved varieties for certain crops such as groundnut, soybean, cocoyam, etc

2 4 4 ACCOMPLISHMENTS

2 4 4 1 Improved Fallow Management for Soil Fertility Maintenance and Weed Control

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

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



The top growth of fallow vegetation provided 22 to 67 kg/ha of N, 4 0 to 7 9 of P, 22 to 46 of K, 23 to 41 of Ca, and 12 to 22 of Mg to the soil-plant system Chromolaena odorata

although poorer in leaf N than Sesbania contributed almost similar quantities of N in top growth due to the large amount of foliage dry matter produced by the former at Minkomeyos This gave similar grain yield response of maize in the following season (Table 1) Thus, Chromolaena improved soil fertility and crop yields similar to fallow legumes Imperata cylindrica, a dominant fallow vegetation at Yoke, was poor in N contribution compared to Sesbania and this was reflected in the response of the succeeding maize crop (Table 1) Addition of N fertilizer significantly increased the maize yield further.

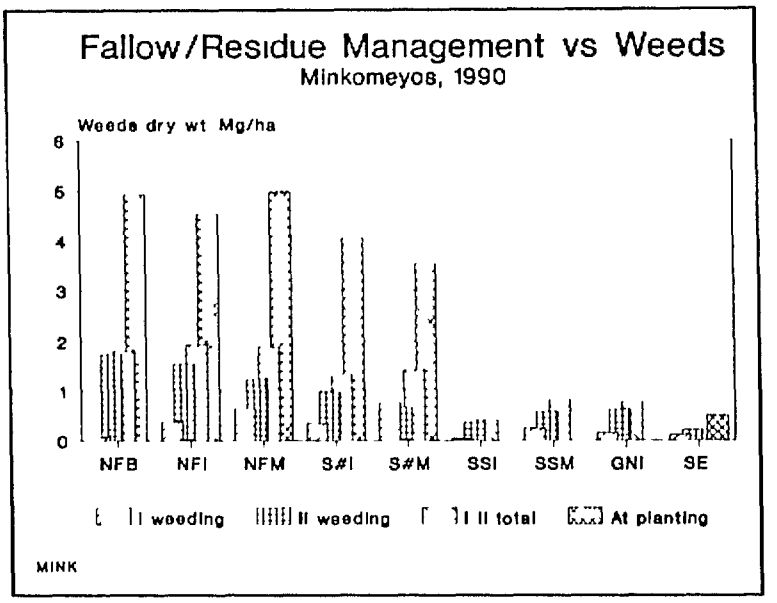
Table 1 Effect of type of fallow and residue management on grain yield of subsequent maize crop at three sites in southern Cameroon, 1989-1990

1989 Fallow treatments		1990 March	1990 March season					
March	September	Residue management	Minkomeyos		Yoke		Ntui	
			Biomass N added	Maize yield	Biomass N added	Maize yield	Biomass N added	Maize yield
			kg/ha					
MZ	NF	B	57+	5508	39+	3107	32+	2762
MZ	NF	I	60	5248	32	2441	20	2395
MZ	NF	M	65	4878	41	1924	21	2812
MZ	SS#	I	43	4556	22	3148	18	2644
MZ	SS#	M	41	4406	28	3069	11	2418
MZ + SS	GN	I	57	5107	54	5484	63	4251
MZ + SS	GN + SS	M	68	4337	62	4325	53	2651
MZ	GN	I	4	4366	30	3811	8	1876
SE			11	460	6	336	5	289
p <			0 01	NS	0 01	0 000	0 000	0 000
CV, %			43	18	34	21	36	11
N - 0 kg/ha			-	4169	-	2791	-	2459
N - 60 kg/ha			-	5432	-	4036	-	2993
SE			-	154	-	129	-	50
p <			-	0 000	-	0 000	-	0 000

Fallow x N rate interaction for maize grain yield NS

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

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

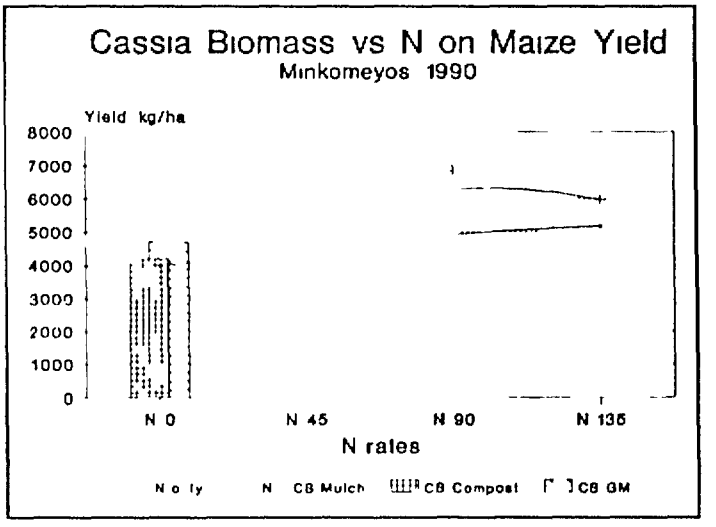


2 4 4.2 In-situ Mulch/Green Manure Production Through Cassia

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

2 4 4 3 Response of Maize and Soybean to Cassia Biomass and N Fertilizer

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



2 4.4.4. Fertilizer Response of Improved Maize Varieties

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

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

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

Fertilizer rates, kg/ha	MINKOMEYOS Maize grain yield, kg/ha (15% moisture)			TUI Maize grain yield, kg/ha (15% moisture)		
	1989		1990	1989		1990
	I season	II season	I season	I season	II season	I season
N levels, kg/ha						
0	5410	2436	4227	3493	937	3007
40	5755	3221	4643	3987	1748	4934
80	5842	3054	4546	4564	2062	5627
120	6654	3216	4826	3336	1547	4790
160	6512	3069	5351	3514	2055	5467
SE	481	185	321	314	255	365
p <	NS	0 05	0 05	NS	0 05	0 000
CV, %	23	18	19	20	37	19
P levels, kg/ha						
0	5885	2872	4591	3058	1554	4353
40	6184	3121	4847	4499	1785	5157
SE	305	117	203	199	161	231
p <	NS	NS	NS	0 05	NS	0 05
N x P interaction NS				N x P interaction NS		

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

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

Fertilizer rates, kg/ha	Maize grain yield, kg/ha (15% moisture) 1989 I season	1989 II season	1990 I season
N levels, kg/ha			
0	2654	1421	2703
40	4751	2096	4123
80	5677	2533	4754
120	6015	2715	4707
160	5549	3273	4660
SE	443	156	212
p <	0 05	0 05	0.000
CV, %	25	18	14
K levels, kg/ha			
0	4781	2376	3744
50	5078	2440	4635
SE	280	99	134
p <	NS	NS	0 000
N x K interaction NS			

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

2 4 4 5 Maize/Groundnut/Soybean Association and Rotation

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

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

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

Unlike groundnut, soybean yields well in both the first and second seasons (fig. 4) Thus, soybean can be a good alternative grain legume to groundnut in the forest zone and attempts should be made to popularize this crop among farmers More work is needed to incorporate soybean in local dishes and food preparations

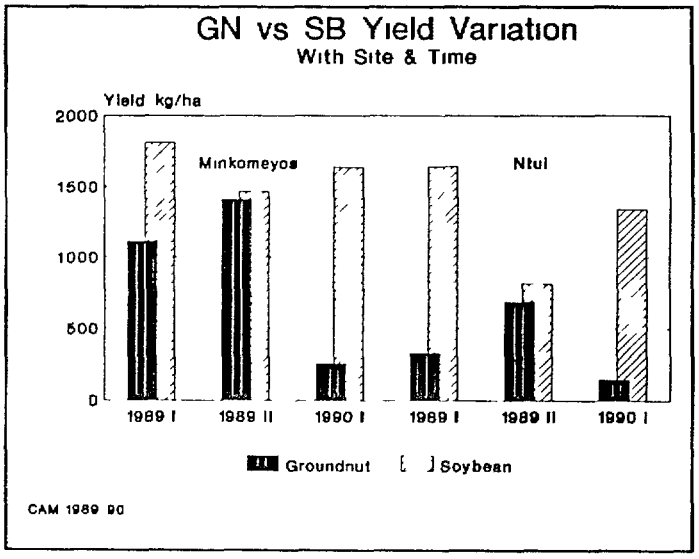


Table 4 Crop yields and land-use efficiency of maize + groundnut or soybean associations and rotation at two sites in the forest zone of Cameroon, 1989 & 1990

CROPPING SYSTEMS		MINKOMEYOS				NTUI			
Season I	Season II	Maize, kg/ha	G'nut, kg/ha	Soybean, kg/ha	LER	Maize kg/ha	G'nut, kg/ha	Soybean, kg/ha	LER
1989 First Season									
MZ + GN	SB	3994	813	-	1 45	2626	133	-	1 30
MZ + SB	GN	3247	-	534	0 88	2444	-	977	1 43
MZ	GN	6030*	-	-	1 00	3033*	-	-	1 00
MZ	SB	5067*	-	-	1 00	2839*	-	-	1 00
GN	MZ + SB	-	1223*	-	1 00	-	324*	-	1 00
SB	MZ + GN	-	-	1502*	1 00	-	-	1673*	1 00
GN	MZ	-	1003*	-	1 00	-	330*	-	1 00
SB	MZ	-	-	2120*	1 00	-	-	1618*	1 00
SE									
p <									
1989 Second Season									
MZ + GN	SB	-	-	1343*	1 00	-	-	813*	1 00
MZ + SB	GN	-	1129*	-	1 00	-	601*	-	1 00
MZ	GN	-	1684*	-	1 00	-	781*	-	1 00
MZ	SB	-	-	1586*	1 00	-	-	819*	1 00
GN	MZ + SB	1171	-	1181	1 27	876	-	595	1 10
SB	MZ + GN	1237	627	-	0 93	1013	455	-	1 09
GN	MZ	2662*	-	-	1 00	2427*	-	-	1 00
SB	MZ	2394*	-	-	1 00	2317*	-	-	1 00
SE		129	63	111	-	164	58	144	-
p <		0 000	0 000	NS	-	0 000	0 000	NS	-
1990 First Season									
MZ + GN	SB	3350	182	-	1 23	2202	89	-	1 20
MZ + SB	GN	3125	-	956	1 06	2121	-	746	1 12
MZ	GN	6815*	-	-	1 00	3885*	-	-	1 00
MZ	SB	6299*	-	-	1 00	3715*	-	-	1 00
GN	MZ + SB	-	277*	-	1 00	-	164*	-	1 00
SB	MZ + GN	-	-	1565*	1 00	-	-	1347*	1 00
GN	MZ	-	227*	-	1 00	-	122*	-	1 00
SB	MZ	-	-	1710*	1 00	-	-	1328*	1 00
SE		237	28	76	-	164	13	57	-
p <		0 000	NS	0 000	-	0 000	0 05	0 000	-

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

2 4.4 6. Cassava Based Cropping Systems

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

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

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

Production efficiency of association as defined by Area Harvests Equivalency Ratio (AHER) was greater than 1 00 for paired-row association of cassava with maize-groundnut (AHER = 1 08) or groundnut-maize (AHER = 1 04) sequence at Ntui Other systems showed advantages (AHER = 1 12-1 14) only with groundnut-maize sequence at Ntui (Table 5) At Yoke, only paired-row system of cassava with groundnut-maize sequence was advantageous by 14% compared to monocrops Farmers' mixed cassava systems gave 2 to 15% higher productivity than total monocrops

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

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

Season I	Season II	Season I		Season II			AHER*
		Maize kg/ha	G'nut kg/ha	Maize, kg/ha	G'nut, kg/ha	Cassava, t/ha	
Ntui 1989							
1 CS pure	CS	-	-	-	-	26 6	1 00
2 MZ pure	GN pure	3990	-	-	815	-	1 00
3 GN pure	MZ pure	-	502	1771	-	-	1 00
4 CS1+MZ	CS1	3195	-	-	-	14 8	0 96
5 CS2+MZ	CS2+GN	3227	-	-	339	12 4	1 08
6 CS3+MZ	CS3+GN	2737	-	-	715	4 7	0 96
7 CS1+GN	CS1	-	525	-	-	15 9	1 12
8 CS2+GN	CS2+MZ	-	377	374	-	14 9	1 04
9 CS3+GN	CS3+MZ	-	539	1212	-	6 9	1 14
10 CS4+MZ+GN*	CS4	1372	210	-	-	17 1	1 02
SE		247	39	269	87	1 9	-
p <		0 000	0 000	0 05	0 05	0 000	-
CV, %		17	18	48	28	27	-
Yoke 1989							
1 CS pure	CS	-	-	-	-	14 6	1 00
2 MZ pure	GN pure	5316	-	-	852	-	1 00
3 GN pure	MZ pure	-	471	1441	-	-	1 00
4 CS1+MZ	CS1	3697	-	-	-	5 9	0 75
5 CS2+MZ	CS2+GN	3475	-	-	502	5 1	0 97
6 CS3+MZ	CS3+GN	3633	-	-	707	3 2	0 98
7 CS1+GN	CS1	-	426	-	-	7 0	0 93
8 CS2+GN	CS2+MZ	-	305	430	-	9 7	1 14
9 CS3+GN	CS3+MZ	-	283	1248	-	2 6	0 91
10 CS4+MZ+GN*	CS4	1092	332	-	-	10 1	1 15
SE		228	18	198	60	1 4	-
p <		0 000	0 000	0 05	0 05	0 000	-
CV, %		12	9	33	15	33	-
No of harvests in one year		2	2	2	2	1	-

CS1 = Cassava CS 1 5m CS CS2 = Cassava CS-CS 3m CS-CS CS3 = Cassava on border of plot,
CS4 = Cassava at random as in farmers' practice
*AHER = Area Harvests Equivalency Ratio

2 4.4 7 Maize Date of Planting vs Improved Varieties

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

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

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

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

2.4 5 IN-SERVICE TRAINING

On-the-job training of the counterpart staff Mr K A B Nguimgo and technicians in maize agronomy and soil fertility management research continued as part of the program Mr Nguimgo went to IITA to participate in the group training course on Sustainable Food Production Systems from June 18 to July 6, 1990.

2.4.7 PRIORITIES FOR FUTURE RESEARCH

Since the maize agronomist position will be abolished during 1991-1994, the TLU agronomist should continue the (a) Improved fallow management, (b) Mulch/green manure production by Cassia, (c) Maize + groundnut/soybean association, and (d) N x P and N x K trails to obtain conclusive results and to support the on-farm research in the forest zone

Efficient methods of incorporating planted fallow technology into existing farmers' mixed cropping systems should be explored The most difficult part is to establish fallow legumes with minimum labor and inputs cost to farmers

Soil erosion control studies and agroforestry experiments should be intensified in the Western highlands of Cameroon, where the need for such studies is the highest and most urgent.

In collaboration with the soil chemist of the IITA substation at Mbalmayo, basic research on the problems of P-fixation soil acidity and very low rates of organic matter decomposition in highland soils should be undertaken.

3 RICE RESEARCH UNIT

Rice, a relatively new crop in Cameroon, is currently grown on about 16,000 hectares of irrigated and upland fields and is fast gaining popularity as a major food in both urban and rural areas. Over 50,000 farm families cultivate rice in a broad range of climatic conditions from a dry tropical climate with less than 900 mm of rain in the Northern Provinces to a humid tropical climate with over 2,000 mm of rain in the Western Highlands.

Irrigated rice is the most widely practiced production system, accounting for over 90 percent of the land area under rice and contributing about 94 percent of total annual production There are four main irrigated rice production zones situated in different parts of the country as indicated in Table 1. Upland rice is grown by peasant farmers in isolated areas around the country and accounts for about five percent of total national rice production

The major constraints to increased domestic rice production include socio-economic factors, such as deficiencies in pricing and marketing policies and unavailability of appropriate technology Domestic rice has been uncompetitive due to the high value of the cfa, which effectively subsidizes imported rice, and to high production costs due to less than optimal production packages, as well as high over head for parastatal production and processing practices

The principal aim of the IRA\NCRE Rice Research Program is to increase rice production in Cameroon through research on irrigated and upland ecologies Research focus between 1985-1990 is on the development of superior adapted varieties with resistance to major stresses and on development of appropriate cultural practices to enhance the performance of the varieties.

3 1 RICE BREEDING

3.1.1 INTRODUCTION

Since 1981, the rice breeding program emphasizes the development of high yield potential varieties with tolerance or resistance to major environmental and biological stresses such as low temperature, blast, sheath rot and glume discoloration These stresses limit yields and cause instability in performance of improved varieties in Cameroon

For the irrigated lowlands the rice breeding thrust in addition to yield potential and good grain quality, is on earliness, resistance/tolerance to leaf blast, neck blast, sheath rot, glume discoloration and low temperature More emphasis has been placed on irrigated rice research but work have also been carried

out on rainfed upland rice where the thrust is to select for earliness, drought tolerance and for resistance to diseases such as leaf blast, neck blast, leaf scald and brown spot

Two main approaches were adopted to varietal improvement, namely identification of superior types from among introduced varieties and selection of improved lines from crossing work that began much later in 1988

The screening of introduced varieties began in 1981 and by 1986 several promising varieties had been identified and recommended for general cultivation by farmers These varieties are, however, lacking in some important characteristics By end of 1988, several parental material with the desired traits had been identified and crossing and selection began A series of promising lines have been selected from several crosses

It is against this background of successful varietal improvement that we approach the end of the second phase of the NCRE program One of the main aims of the crossing program is to achieve further gains in production through the development and identification of well adapted varieties that can lower the per unit cost of production Availability of such varieties can serve as a stimulus to increased national rice production

3 1.2 OBJECTIVES

The major objective of the rice breeding program 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 objective, 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 are fraught with 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, North West and West Provinces unfolded the following

3.1.3.1 Biological Factors

Lack of suitable varieties with
High and stable yield potential
Resistance to local diseases
Leaf and neck blast
Sheath rot
Leaf scald
. Brown spot
. Bacterial leaf blight

. Short/medium duration
Resistance to lodging
. High milling recovery
Tolerance to low temperature, hot, dry and dust laden wind.
Adaptation to low sunshine hours
Tolerance to imbalance soils
Good grain properties

3 1.3.2 Natural Factors

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

3.1.3.3 Infrastructure Factors

Inadequate infrastructural development for rice research and production
. Poor storage, processing and marketing
. Inadequate irrigation, soil and water conservation system

3 1.3.4 Technological Factors.

Inadequate input supply (e g fertilizer, pesticide etc.) to increase production

3.1.3.5 Management and Labor Factors

. Inadequate trained manpower for research, extension and production
Non-availability of adequate labor especially at peak farming operations at some sites

The above outline reviews a series of production constrains in the rice sector It suggests, among other factors, that biological and climatic conditions have respectively caused significant reduction in rice yields and affected grain quality over the years Table 2 indicates the physical and biological constraints to increased rice production in Cameroon at various zones of cultivation It is clear from the results that constraints in the Northern Provinces are less than those in the North West and West Provinces

3.1 4 ACCOMPLISHMENTS

3.1 4.1 SUMMARY OF RESEARCH RESULTS

3 1 4.1 1 Varietal Introduction

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 introduced 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/fertilizer responsiveness, tolerance to low temperature, resistance to major diseases, suitable plant stature and good grain type have been identified and are being exploited in the breeding program. During the past five years a number of promising lines have been identified for irrigated (Table 3) and upland (Table 4) conditions Recommended varieties for the major production zones are as follows

3 1 4 1.1 1 Irrigated Rice

3 1 4 1 1 1 1 **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 grain shatter or break during milling

Only one variety, IR46 which is moderately resistant to the constraints mentioned above is currently recommended for cultivation in 11,000 hectares in the Extreme North Province IR 46 matures in 129 days It is of medium stature, about 110 cm high but has weak culm and therefore, lodges at optimum fertilizer application It yields about 5 tons per hectare under farmers' conditions It is moderately resistant to bacterial leaf blight, the most common disease in the Extreme North Its grains are medium and slender but are chalky therefore, percentage breakage on milling is fairly high

3 1.4 1 1 1 2 **North - lagdo dam 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 7033-3-3-2-2-3 was released in 1986 and is moderately resistant to these diseases It matures in 125-130 days and is of medium stature (115 cm) The culm is slightly weak and therefore lodges at optimum fertilizer application Another variety grown by some farmers in the lagdo area is ITA 222 which is showing increasing susceptibility to leaf and neck blast

3 1.4 1 1 1 3 **North West - Ndop Plain** At 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 cold tolerant variety

previously grown by farmers was Tainan V, but its poor grain quality, (bold, short, chalky grain and poor keeping quality) did not allow it to compete with imported rice in the open market IR7167-33-2-3 was therefore, released for general cultivation in 1987 The medium length, bold shape, and moderate chalky grain of IR 7167-33-2-3 were modest improvement over Tainan V

3.1.4.1.1 1.4 West - Mbo Plain The major constraints at this plain is the disease, leaf and neck blast Interestingly, most of the lines rated as resistant or moderately resistant to blast in other parts of the world were 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 is now widely cultivated by farmers at Mbo Plain CICA 8 has long and slender grain type Threshability is good and milled rice is white and translucent This makes it competitive with imported rice in urban open market It is moderately resistant to leaf blast, neck blast and glume discoloration

3.1.4 1.1.2 Upland 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. Effort have been made in the past four years to identify, high yielding, disease tolerant varieties with good grain quality, adapted to the upland (Table 4) Among the lines that have been found to perform well in upland conditions across locations are IRAT 10, ITA 120, ITA 208, IRAT 112 and M55 At Mbo Plain two popular varieties that have been well received by farmers are ITA 120 and IRAT 10 and at Ndop Plain are IRAT 112 and IRAT 109.

3.1.4.1.2 Germplasm Characterization And Conservation

Germplasm characterization was initiated in 1988 to identify materials with suitable traits for use in the breeding program By end of 1989, 94 accessions have been characterized for 48 morphological, physiological and agronomic characteristics. Preliminary analysis of the data has shown the overwhelming majority of varieties to be medium statured and of medium duration (Table 5) Panicles are generally large, resistant to shattering and show high spikelet fertility Considerable variability has been recorded for grain size, shape and to a less extent grain color Only few varieties were rated as resistant or moderately resistant to both leaf and neck blast. Most varieties rated as resistant to leaf blast subsequently suffered some damage to neck blast A catalogue of rice germplasm is being produced

Samples (1 kg) of the 94 purified and characterized accessions and a further 1,500 varieties/lines that have been tested and have shown some adaptation to rice growing conditions in Cameroon are conserved as a working collection in a newly constructed air conditioned cold room that became operational at Santchou, Mbo Plain in January, 1989

3 1.4 1.3 Breeding Program

A breeding program specifically addressed to the problems related to rice varietal requirements in the irrigated conditions was initiated in 1988 Varieties currently grown by farmers are lacking in some specific characteristics such as suitable agro-morphological traits, good grain properties, and resistance/tolerance to low temperature and blast The breeding program was, therefore, initiated to incorporate these characteristics into already identified improved varieties Among the agro-morphological traits, we are selecting for intermediate stature, stiff culm to resist lodging, moderate to high tillering ability, good seedling and vegetative vigor, and early maturing varieties for the second crop

By mid 1990, 92 successful crosses have been made and over 2,000 promising F_2 - F_5 segregating populations have been selected at Mbo Plain, Ndop Plain, Dschang, Lagdo and Maga We followed the pedigree method in handling and making selections in most of our segregating populations The pedigree method allows simultaneous evaluation of pedigree lines for agronomic traits and resistance to different stresses as the generation advances towards homozygosity

A number of multiple crosses were made to enlarge the genetic variability in the breeding populations Back crosses were also made to improve on certain characteristics such as blast resistance and good grain quality properties of some recommended varieties and promising lines

3 1 4.1 3 1 Agronomic Characteristics

The currently recommended varieties are generally medium statured with weak culm and lodge easily especially under conditions of high fertility Loss of grain due to lodging in recommended varieties like, IR 46, BKN 7033-3-3-2-2-3, and IR 7167-33-2-3 varies from 12 to 60 percent depending upon the time at which the crop lodges

Among the upcoming lines derived from crosses targeted for the irrigated ecology are several promising lines that combine yield potential, intermediate stature, lodging resistance and good grain properties Some of these lines are Tox 3344-Toc-3-4, Toc 3145-Toc-34-2-3, Toc 8-40-2-1, Toc 12-13-3-2 and Toc 19-29-4-1 Lines like Tox 3344-Toc-3-4 and Tox 3145-Toc-34-2-3, have dark green and erect leaves which utilizes solar energy efficiently

3.1 4 1.3 2 Varietal Resistance To Diseases

In Cameroon plants grown under natural field conditions are subject to attack by numberous diseases The most common diseases are blast, sheath rot, glume discoloration, brown spot and leaf scald and specific to Extreme North is bacterial leaf blight Since 1985 efforts are being made to screen existing germplasm and to develop improved varieties with better resis-

tance to diseases. Varietal resistance is essential for yield stability. Donors with resistance to blast, sheath rot and glume discoloration are IRAT 13, Lac 23, Moroberekan, Rok 16, CISADANE, IR7167-33-2-4 IR7167-33-2-3, IR 11248-3-3-3 and IR 8608-125-3-3 Two donors with resistance to bacterial leaf blight are IR46 and BKNLR 7500 Among the advanced lines that have shown promise in reaction to fungal diseases are Tox 3344-Toc-3-4, Tox 3145-Toc-34-2-3, Toc 8-42-2-3, Toc 8-10-5-2, Toc 16-4-2-2.

3.1.4.1.3.3 Varietal Resistance To Insect Pests

Several species of insect pests have been collected from rice fields in Cameroon However, only a few are considered to be pest of economic importance such as the stalk-eyed borer and the rice bug We therefore, have screened for resistance against stalk-eyed fly and the most promising entries, are Tainan V, ITA 222, CISADANE and several advanced lines including Tox3344-Toc-3-4 and Tox 3145-Toc-34-2-3 (Table 6)

3 1.4.1.3.4 Varietal Tolerance To Low Temperature

Between 1985 and 1989, a total of 1,366 introduced varieties and over 2,000 segregating populations have been screened for low temperature tolerance at the Bamunka experimental site in Ndop Plain and at Dschang The number of varieties introduced in the various years, their origin and number selected for further studies are shown in Table 7 Through this exercise several parental materials like Tainan V, IR 7167-33-2-3, IR 64, IR 2853-10-3-1, IR 3167-33-2-4, ITA 212, ITA 222 and B 2161C-MR-57-1-3-1 were identified and are being exploited in the breeding program The variety, IR 7167-33-2-3, was released for general cultivation at Ndop Plain in 1987 Two advanced lines, Tox 3344-Toc-3-4 and Tox 3145-Toc-34-2-3 have been identified for possible release for cultivation in Ndop Plain in 1991 because of their superior grain type, (long, slender and translucent) better yield performance and tolerance to low temperature, sheath rot and glume discoloration.

The screening exercise revealed considerable variation of the introductions and segregating populations Only a few of the introductions (about two percent) were rated as tolerant to low temperature. A number of varieties recommended currently or in the past for cultivation were included for comparison purposes and were rated as moderately tolerant or susceptible to low temperature at seedling and/or flowering stage of the plant cycle Pedigree lines with tolerance at both seedling and flowering stages of plant growth have been identified and included several selections from crosses such as Toc 3 (IR 35366-90-3-2-1/IR 2853-10-3-1) Toc 7 (IR 64/IR45051-73-1-3) TOX 4281-Toc 33 (IR22105-7-5-2/IR7167-33-2-3) Tox 4213-Tox 35 (IR7167-33-2-3/ITA 212) and Tox 4294-Toc 36 (IR7167-33-2-3/ITA222) These selections are showing considerable improvement in agro-morphological traits and all have long, slender grain type

3.1.4.1 4 Seed Multiplication, Purification And Distribution

Seed purification and multiplication have been carried out each year since 1988 to obtain breeders' seed of recommended and promising elite lines and, therefore, fill seed requests from IRA Scientists and parastatals In 1988, a special seed purification exercise was initiated for IR46 which was highly mixed and pure quality seed was handed over to the seed multiplication unit of the SEMRY in 1989 Breeders' seed have also been produced from eight other varieties, CICA 8, Tainan V, IR7167-33-2-3, BKN 7033-3-3-2-2-3, ITA 222, ITA 212, CISADANE, IR7167-33-2-4 and two advanced lines Tox 3344-Toc-3-4 and Tox 3145-Toc-34-2-3 Small quantity of seeds of one or more of the varieties was distributed to farmers and seed multiplication agencies on request. In 1990, UNVDA received 30 kg each of Tox 3344-Toc-3-4 and Tox 3145-Toc-34-2-3 These varieties are being further multiplied for distri bution to farmers in 1991

3 1.4 2 Transfer Of Technology To Farmers

The primary goal of the NCRE's agricultural research is to enhance adoption of suitable technology With this in view, the rice team, since 1985, have been engaged in on-farm testing of promising varieties with active participation of the parastatals, TLU's and farmers

Due to the collaboration that exists between the rice research team and the rice development projects, the new varieties are developed and tested on farmers' fields together Once a variety is accepted by the rice development project, it is extended to the project farmers through the extension service of the project Hence, there is no difficulty in achieving the transfer of technology to the farmers associated with the rice development projects Table 8 indicates the varieties released for general cultivation after on-farm testing It also gives estimate of the areas under cultivation and number of farmers currently growing the varieties

Between 1985 and 1990, the rice team has also co-operated with the TLUs and farmers that cultivate rice in the traditional manner (i e farmers with no connection with the rice development projects) in testing a number of promising varieties on farmers' fields

The rice team has also collaborated with village extension projects and farmers to test and extend the improved varieties.

3.1 4.3 Co-operation With International And National Institutions

Since its inception in 1981, the rice team have worked in close partnership with some international agricultural centers and developed strong linkages and cooperation with national agencies and organizations responsible for research, training and technology transfer in Cameroon Since 1985, this collaboration have been strengthened

3.1.4.3 1 International Institutions.

The rice team regularly cooperate with international institutions such as IRRI (Philippines) IITA (Nigeria), CIAT (Columbia), WARDA (Cote d'Ivoire) and IRAT (France) in the development and testing of suitable varieties and in exchange of germplasm and literature An example of such collaborative work is the crossing at IITA of parents originally selected in Cameroon. The field selection of segregating populations of these crosses was done at Ndop Plain between 1985 and 1989. Such collaboration successfully led to the development and identification of several improved varieties tolerant to low temperature such as Tox 3344-Toc-3-4 and Tox 3145-Toc-34-2-3.

3.1.4.3.2 National Institution

The collaboration with national rice development projects such as SEMRY (Extreme North), Agri Lagdo (North), UNVDA (North West) and SODERIM (West) involved joint planning and conducting of varietal trials, supply of pure seeds of recommended varieties and exchange of literature

A major advantage of collaborating with these rice development projects is the on-site testing program initiated in 1988 to evaluate the performance of promising varieties and breeding lines One of the objectives is to identify the appropriate rice varieties for cultivation based on performance, farmers' need, and farmers' agronomic conditions In addition, on-site testing of varieties will lead to better understanding of the constraints limiting varietal performance at each location

3.1.5 IN-SERVICE TRAINING

Strengthening of national research capability is an important aspect of the NCRE rice research program This is accomplished through various activities including training of young scientists and technicians

The team has been involved in on-the-job training of young scientists, technicians and extension workers since 1982 Apart from training in various rice research methodologies, the young scientists and technicians were also exposed to the use of new equipment supplied by the NCRE project For each of the past three years, students from the University Centre of Dschang have worked at Dschang or Mbo Plain for their final degree dissertation under the supervision of the breeders Selected topics are related to the projects program of activities and serve to train the students in rice research methodology. Since the scheme started five students have been trained

Between 1985 and 1988, two researcher have been trained at U S. Universities to M Sc in plant breeding One researcher is currently undergoing training in a U S University in courses leading to M Sc in Plant Breeding/Extension Seventeen technicians and young scientists received short term training for six

weeks to three months in rice production, fertilizer management and genetic evaluations and utilization from international centers such as IITA and IRRI

Apart from our regular contacts with farmers through farmers' field visits and on-farm activities, we have organized two farmers field days, one each in 1988 at Ndop Plain and 1989 at Mbo Plain All farmers field days were attended by farmers, extension workers, scientists, technicians and lecturers This served as a very important forum for the exchange of ideas and participants were exposed to the current phase of our rice development program

3.1 6 PRIORITIES FOR FUTURE RESEARCH

The research approach should continue to be multidisciplinary with greater emphasis placed on on-farm activities Therefore, collaborative work with parastatals, TLUs and farmers, training of young scientists/technicians in research methodologies and involvement in extension should be stressed to seed up the transfer of improved varieties to farmers

The main theme of the rice breeding program should remain unchanged with introduction, of varieties, collection and evaluation of local germplasm and crossing between the two continuing to play major roles

Efforts should be made to develop new rice varieties with high and stable yield potential while retaining those traits responsible for their adaptation to various rice growing conditions and acceptance to local consumers in Cameroon Therefore

- High and stable yield potential and good grain properties should continue to receive major attention

  Select for greater lodging resistance, nitrogen responsiveness, intermediate stature, sturdy culm, high tillering and dark green leaves

  Select lines with good grain properties (long, slender and translucent) and medium threshability to reduce shattering losses

  Continue to identify genes for resistance to each of the major diseases especially blast, sheath rot and glume discoloration

  Continue to identify new materials for tolerance to the major environmental stresses such as hot, dry dust laden wind and low temperature

  Present effort to develop materials with early (90-110 days) and medium (120-140 days) growth duration varieties should continue Early duration varieties are urgently required for the second season crop

Table 1 Rice production areas in Cameroon

Province	Zone	Location	Altitude (m)	Area* ('00 ha)	Area* (%)
IRRIGATED					
Extreme North	Northern Provinces	Yagoua	300	50*	35
		Maga	300	40*	28
		Kousseri	300	20*	14
North		Lagdo	300	0 6*	
North West	Western Highlands	Ndop Plain	1,200	20	14
		Menchum Valley	750	3	2
West		Mbo Plain	700	2*	2
UPLAND				6	5

* More than half the total area is double-cropped
Source Rice Breeding Unit, NCRE, Dschang, Cameroon

Table 2 Constraints to increased rice production at different locations

			Western Highlands			
	Extreme North	North	North West		West	
Constraints	(Irr)	(Irr)	(Irr)	(Upl)	(Irr)	(Upl)
High yield	-	-	X	X	X	X
Stable yield	-	X	X	X	X	X
Leaf blast	-	X	-	X	XX	XX
Neck blast	-	X	-	X	XX	XX
Brown spot	-	-	X	X	X	X
Leaf scald	-	X	-	X	X	X
Sheath rot	-	X	XX	XX	X	X
Glume discoloration	-	-	XX	XX	X	X
Bacterial leaf blight	X	-	-	-	-	-
Cold	X	X	XX	XX	X	X
Heat	XX	XX	-	-	-	-
Lodging	X	X	X	X	-	-
Height	-	X	X	X	-	X
Short duration	X	X	X	X	X	X
Medium duration	-	-	-	-	-	-
Grain quality	XX	XX	XX	XX	X	XX
Breakage of grains	XX	X	X	-	X	X
Soil problems	X	-	X	-	X	-
Water	-	-	-	-	X	-
Insect - borer	-	X	X	X	X	X
Birds	X	X	-	-	X	X

X = Moderate

XX = Major

Table 3 Characteristics of some recommended and potential varieties for irrigated conditions

Province/ Location	Variety	Average grain yield (kg/ha) on-station	Days To mature	Plant Height (cm)	DISEASE** Blast	Sheath rot	Grain disco	Grain type
West Mbo Plain	CICA 8*	5841	141	100	5	1	1	LS
	Tainan V	5189	125	109	3	1	1	SB
	ITA 222	6488	133	97	5	1	1	LS
	ITA 212	5819	137	98	5	1	1	LS
North West Ndop Plain	IR7167-33-2-3*	4703	146	101	3	1	3	MB
	Tainan V*	3913	157	95	1	1	3	SB
	B2161C-MR-57-1-3-1	5183	152	100	3	3	3	MB
	Tox 3344-Toc-3-4	5544	148	100	1	1	3	LS
	Tox 3145-Toc-34-2-3	5513	150	100	1	1	3	LS
Menchum Valley	ITA 222	7088	136	100	1	1	1	LS
	CICA 8	6547	145	101	1	1	1	LS
	CISADANE	6250	143	98	1	1	1	MB
North Lagdo	BKN7033-3-3-2-2-3*	7348	128	115	3	1	3	MB
	ITA 222	7106	128	97	5	1	3	LS
Extreme North Yagoua } Maga } Kousseri }	IR 46*	6150	126	108	1	1	1	MS
	BKNLR 7500	5342	115	110	1	1	1	LS

* Varieties officially released for cultivation

** Scoring for diseases according to the Standard Evaluation System For Rice, IRRI, (1988)

SB = Short bold

MS = Medium slender

MB = Medium bold

LS = Long slender

Source NCRE Annual Reports 1985-1989

Table 4 Characteristics of some recommended and potential varieties for upland conditions

Province/ Location	Variety	Average Grain Yield (kg/ha) on-station	Days To mature	Plant height (cm)	DISEASES** Leaf blast	Leaf scald	Brown spot	Grain type-
West								
Mbo Plain	IRAT 10*	2987	105	87	3	1	1	LS
	IRAT 79*	2170	125	118	3	5	1	MB
	ITA 120	3026	104	110	3	5	3	LS
	ROK 16	2800	128	142	3	5	3	MB
North West								
Babungo	IRAT 112	3977	135	72	1	3	1	LS
	IRAT 109	4177	137	68	1	3	1	LS
	ITA 208	3805	154	81	1	3	1	LS
	ROK 16	3342	157	111	3	3	1	MB
	M 55*	3941	126	96	1	1	1	MB
Befang	ITA 208	4282	124	87	1	1	1	MB
	IRAT 112	3601	108	82	3	3	1	LS
	ROK 16	3849	131	112	1	1	1	MB
	IRAT 109	4261	111	78	1	1	1	LS

* Varieties officially released for cultivation

** Scoring for diseases is based on the Standard Evaluation System For Rice, IRRI, (1988)

MB = Medium bold
LS = Long slender

Table 5 Classification of 94 varieties in terms of plant height and duration

Plant height (cm)	Duration (Days) Long (> 155)	Medium (130-155)	Short (< 130)	Total
Over 100	0	64	9	73
Under 100	0	16	5	21
Total	0	80	14	94

Table 6 Number of varieties/lines screened and number selected for resistance /tolerance to major environmental and biological stresses between 1985 and 1990

Accessions	Stresses: Low temperature	Blast: leaf blast	Blast: Neck blast	Sheath rot and glume disc	Bacterial leaf blight
Screened	3366	866	380	2994	134
Selected for tolerance/ resistance	434	15	10	24	3

* Selections also combine suitable agronomic triats and good grain properties

Table 7 Introduced varieties and segregating populations screened at Ndop Plain and/or Dschang for tolerance to low temperature between 1985 and 1990

Year	Number of Introductions	Number of Segregating populations*	Origin of Introductions	Number of introductions selected for further studies
1985	408	-	IRRI, IITA	34
1986	415	-	IRRI, IITA	28
1987	308	-	IRRI, IITA, elsewhere	12
1988	208	108	IRRI, IITA,	36
1989	108	1500	IRRI, IITA, WARDA	42
1990	127	2000	IRRI IITA, WARDA	56

* Selected from crosses made in Cameroon

Table 8 Varieties adopted after on-farm testing under irrigated conditions and estimated number of farmers cultivating the varieties

Province/ Impact zone	Variety Old	Variety New	Average yield (t/ha) on farmers' fields	Estimated number of farm families cultivating variety
West				
Mbo Plain	Tainan V			
		CICA 8*	4 0	1000
		ITA 222+	5 5	
			5 8	
North West				
Ndop Plain	Tainan V +	IR 7167-33-2-3*	3 0	6000
		Tox3344-Toc-3-4 +	3 5	
		Tox3145-Toc-34-2-3 +	4 2	
North				
Lagdo		BKN7033-3-3-2-2-3*	6 0	N A
Extreme North				
Yagoua	IR 46		5 0	}
Maga	IR 46		5 0	} Over 30,000
Kousseri	IR 46		5 0	}

* Current recommended varieties for cultivation
\+ Varieties in the pipeline for release
NA = Not available

3 2 RICE AGRONOMY

3.2.1 INTRODUCTION

The Rice Agronomy unit, began its field work in 1982 with the major goal of improving rice yield through better agronomic practices Our main research sites, are Mbo Plain (700 m) and Ndop Plain (1,150 m), the two major rice ecologies of the Western Cameroon This unit was not involved in research activities in Northern Cameroon as IRAT/CIRAD Scientists were taking care of the rice research and production problems in the North

The unit composition was one Technical Assistance Rice Agronomist, one Counterpart IRA Agronomist and a Technician The counterpart Agronomist was later replaced by a new recruit in 1986 when he left for higher studies in the USA.

Upland rice research was our priority for Mbo Plain in NCRE Phase I In 1986, the Rice Development Society at Mbo Plain (SODERIM) re-oriented its production goal from upland to irrigated rice At this point, irrigated rice research became our priority for Mbo Plain site Nevertheless, we carried on some work on rice-based cropping systems and component development for upland ecology of the plain Irrigated rice research has been our priority for Ndop Plain site from the very beginning

In developing our phase-II work plan, we tried to define our priorities for this phase to achieve project goals In the course of the execution of our research activities, however, we may not have accomplished all of our planned goals because of several elements beyond our control

3.2.2 OBJECTIVES

Our major goal being to improve rice yield through better agronomic practices, and identify suitable rice-based cropping patterns and component technology to improve total farm income we oriented our work plan with the following objectives:

3.2 2.2 Research

- Find optimum planting dates for improved rice cultivars to achieve stable and high rice yield
- Devise appropriate land preparation methods to maximize fertilizer efficiency, minimize weed management problems, and maximize rice yield
- Minimize cost of planting rice by the use of a simple and lowcost manually operated rice transplanter
- Determine optimum plant population density for high yields of improved rice cultivars under specific soil-climatic conditions
- Identify best fertilizer products and appropriate fertilizer management practices to optimize rice production.

- Determine optimum harvest time to improve quality of milled-rice
- Identify dominant weeds of lowland rice and devise effective weed management practices to improve rice yield
- Find appropriate management levels required to optimize lowland rice production
- Identify viable cropping patterns and develop appropriate component technology to fit into rice-based cropping systems of Western Cameroon

3 2.2 3 Institutional development

- Impart on-the-job training to national counterparts and technicians to equip them with rice research methodology
- Develop and upgrade research facilities to improve working conditions of national rice research team to help generate quality research data
- Publish research results in national and international journals and make presentations in professional meetings for dissemination of Cameroon rice research findings, and
- Establish linkages with national and international organizations

3.2.3 CONSTRAINTS

- IRA budgetary problem was the major constraint for work progress during the phase Although USAID special funding replaced IRA's share of operational finance, this in fact could not normalize the working atmosphere in the IRA system
- Departure of the only national counterpart Agronomist for higher studies in the USA in 1987 affected work progress Although he was replaced by a new recruit the situation did not improve much as the new recruit was transferred to another IRA location soon after
- Acute shortages of field support staff, particularly at the technician level, affected work progress to a great extent.
- The unit did not get even one laboratory technician for the agronomy laboratory at Dschang, although several requests were made for it As a result, little progress was made at the agronomy laboratory in respect of soil and plant analsis
- Many research equipments and supplies ordered for this unit did not arrive until late 1989-90, and as such the team could not utilize those equipments for research work.
- Vehicle breakdown and maintenance has been a problem till late 1987 when the old vehicles were replaced with TOYOTA Landcruisers which did well on the road to the end of phase-II

3 2.4 ACCOMPLISHMENTS

3 2.4.1 Site characterization: During the project period, we characterized the experimental sites in respect of soil, land use and climate Details were reported earlier in NCRE Annual reports Summary information are as follows

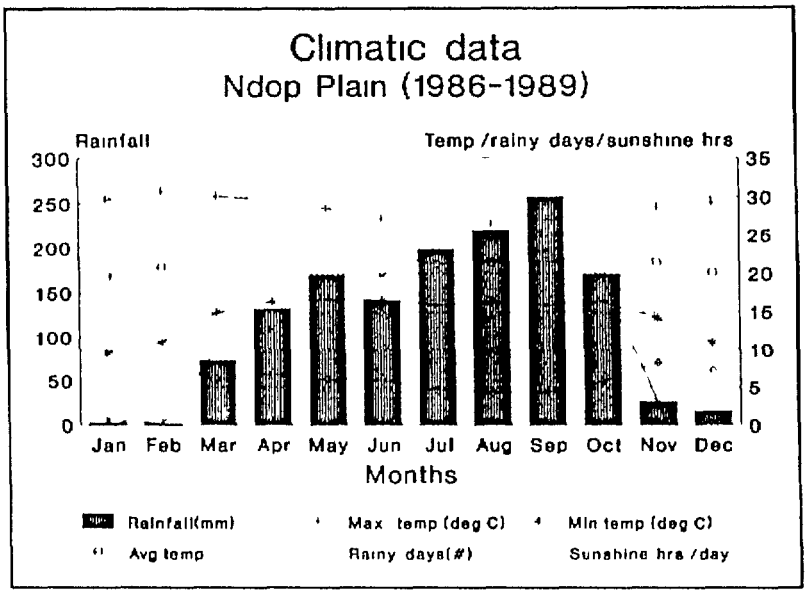
Soils:

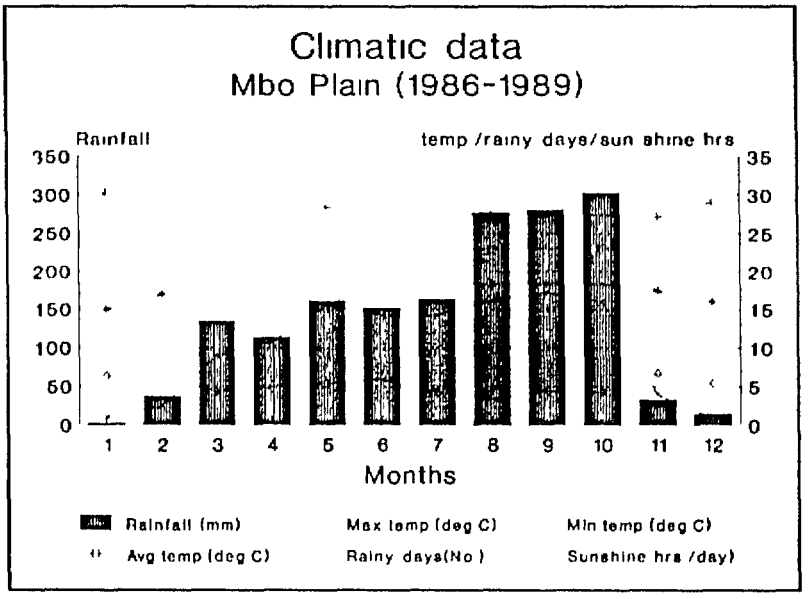
Location	Soil class	Land use
Mbo Plain		
Mbo-2	Aeric Paleaquult	Mainly upland rice, maize, beans and cassava
Mbomi-10	Aquic Paleudult	Mainly upland rice, maize, bean, cowpea and cassava.
Mbomi-2	Plinthic Paleaquult	Mainly irrigated rice
Nzock-5	Aquic Dystropept	Mainly irrigated rice
Ndop Plain		
Bamunka	Tropaquept	Mainly irrigated rice
Babungo	Typic Tropudult	Mainly maize, bean and cowpea

Climate

We collected climatic data on rainfall, temperature, relative humidity, sunshine hours, pan evaporation, soil temperature (and solar radiation values for Ndop Plain only) for each research site during 1986-90 Four-year means on rainfall, temperature and sunshine hours for Mbo and Ndop Plains are presented in figures 1 and 2 The summary information are as follows.

	Mbo Plain		Ndop Plain	
	4-year mean	range	4-year mean	range
Ann rainfall (mm)	1674	1406-1941	1410	1274-1497
No of rainy days	122	103-158	153	148-159
Max temp (°C)	28 5	25 8-30 0	28.5	27.6-29.0
Min temp (°C)	17 7	16 8-18 6	14 6	14 2-15.2
Avg temp (°C)	23 0	21 3-24 3	21 5	21 0-22.0
Sunshine hrs/day	5 1	3 6-6 2	6 2	5.7-6.4





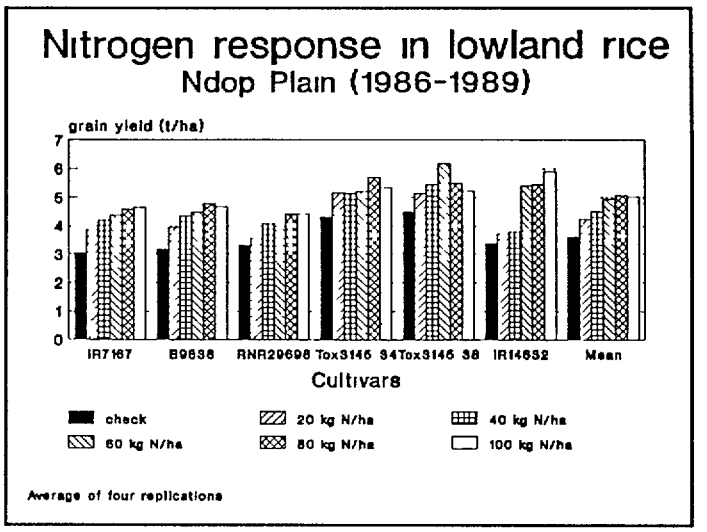
3 4.2 Summary of Research Results

3 4.2 1 Fertilizers and Fertilizer Management

3 4.2.1 1 Nitrogen response in rice

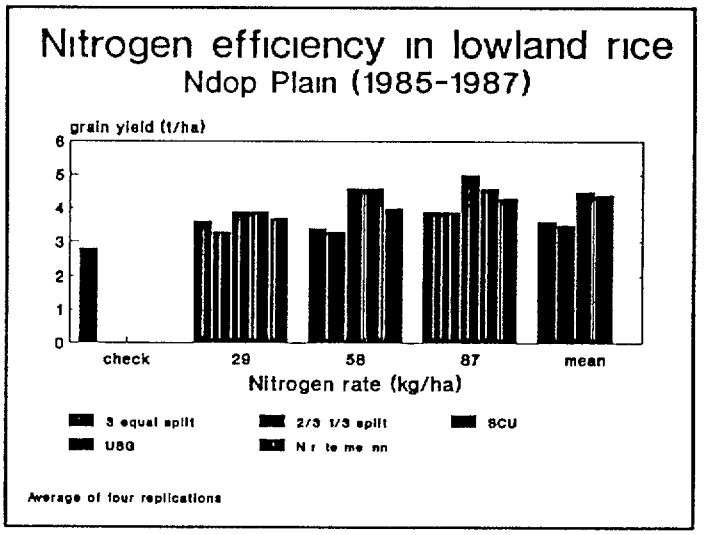
We conducted five field experiments each at Mbo and Ndop Plains during 1986-90 to evaluate N response in improved cultivars/selections Levels of applied N were 20, 40, 60, 80 and 100 kg/ha

At Ndop Plain, all test cultivars showed positive response to N application upto 80 kg N/ha Tox lines, were more efficient than other cultivars for N response They were also higher yielders at all levels of applied N (Fig 3) At Mbo Plain, check plot yields were over 6 t/ha, and additional N application did not increase rice yield markedly This trend was more or less similar in all test cultivars. Poor N response at Mbo Plain is believed to be associated with high native fertility level of the experimental soil



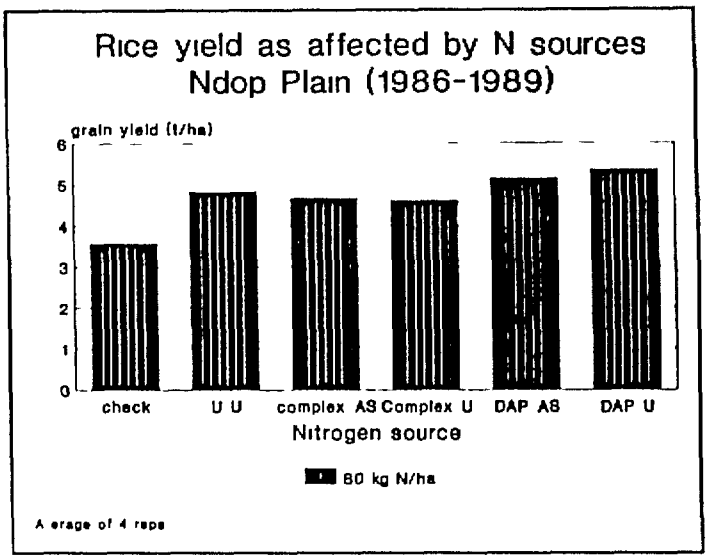
We compared Sulfur-coated urea (SCU) and urea supergranules (USG) with prilled urea (PU) as sources of N for low land rice at Ndop Plain during 1986 and 1987 The N sources were compared at 29, 58 and 87 kg N/ha levels PU was applied broadcast and incorporated at planting with or without standing water in plots followed by one or two top-dresses at tillering and/or panicle initiation stages USG was deep-placed in the saturated soil at 10-12 cm depth .

Rice yield increased with N application upto 87 kg N/ha SCU and USG were much superior to PU for rice yield at all levels of applied N Application of PU with or without standing water in different proportions did not affect rice yield (Fig 4)

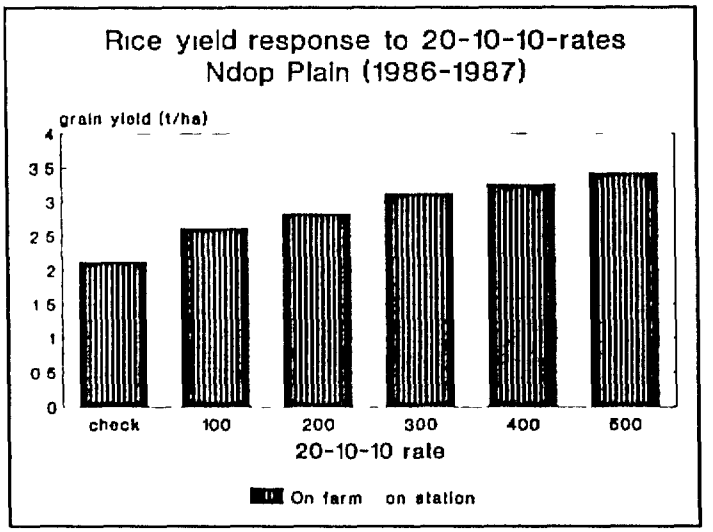


The 20-10-10 complex is known to be less efficient than single element fertilizers in lowland rice Because of easy-availability farmers use 20-10-10 as a rice fertilizer On the request of UNVDA, we compared 20-10-10, as a basal fertilizer for lowland rice, against urea + TSP and Diammonium phosphate (DAP) In a separate trial, we evaluated lowland rice response to 20-10-10 rates in one on-station and 12 on-farm research plots during 1986 and 1987

In the first trial, rice yield was improved from 3.6 to 5 3 t/ha by the application of 80 kg N/ha DAP or urea + TSP was superior to 20-10-10 as a basal fertilizer for rice yield There were visible N deficiency symptoms (pale green leaves) in 20-10-10 plots while the DAP and Urea + TSP plots were dark green Among the combination treatments tried DAP followed by urea top-dress appeared most impressive (Fig 5)



In the second trial, rice yield (mean over 13 locations) improved from 2 1 to 3 4 t/ha by increasing 20-10-10 rate from none to 500 kg/ha However, field observations at different locations and yield trends tend to indicate that 300-400 kg 20-10-10/ha would be the optimum rate for most locations (Fig 6)



3.4 2 1.2 Phosphate Response in Rice

We evaluated p response in lowland rice by comparing different P fertilizer products at varied levels of applications in long-term plots These studies were carried out at Mbo and Ndop Plains over a period of 3 to 7 years, from 1982 to 1989. A total of 13 trial seasons were involved in these studies

At Ndop Plain, we compared two phosphate rocks - Phosmak and Phosphate tricalcic with superphosphate, as P sources for lowland rice for 5 consecutive seasons Response to residual P was evaluated in the 6th and 7th crops At Mbo Plain, we conducted two trials In the first trial we compared single superphosphate (SSP), triple superphosphate (TSP), tricalcium phosphate (TCP), diammonium phosphate (DAP), and bicalcium phosphate (BCP), as P sources for lowland rice for three crop seasons In the second

trial, we evaluated rice response to frequency of P application at 40, 80 and 120 kg/ha of P_2O_5 applied to every crop, alternate crop or every third crop

At Ndop Plain, rice responded well to applied P. Grain yields (mean over 5 crop seasons) increased from 2 9 to 4.1 by an application of 60 kg P_2O_5/ha as TSP With respect to rice yield increase P sources were similar, except the lowest level of TSP (table 1) Rice response to applied P ranged from 7.3 to 31.6 kg grain/kg applied P_2O_5 Response to residual P ranged from 7 2 to 37.6 kg grain/kg residual P Phosphate rocks, in general, had better residual effect on rice yield than superphosphate.

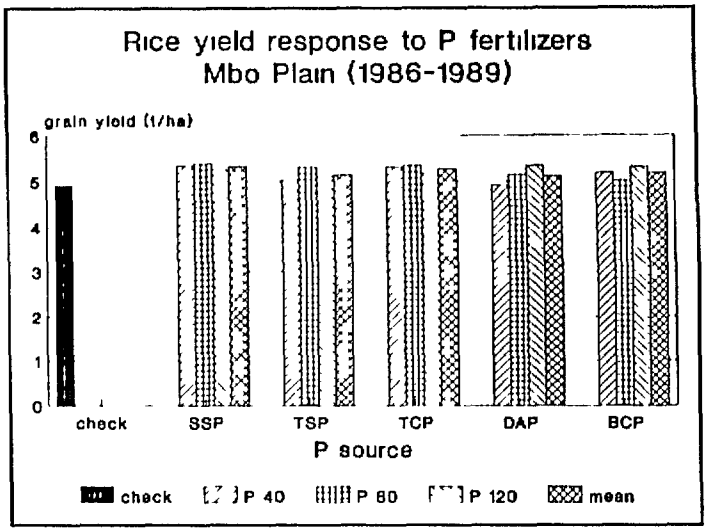
Table 1 Yield response to P sources in lowland rice Ndop Plain (1982-1988)

P source		P_2O_5 (kg/ha)	grain yield (kg/ha)[1] applied P (1982-86)	residual P (1987-88)	yield response to applied P (kg grain/kg P_2O_5)	yield response to residual P (kg grain/kg P_2O_5)
Check		0	2933	4026	-	-
Triple superphosphate		20	3187	4176	12 7	7 5
		40	3604	4316	16 7	7 2
		60*	4135	4681*	20 0	10 9
	mean		3642	4391	16 5	8 5
Phosmak		20	3569	4784	31 6	37 5
		40	3749	4847	20 4	20 5
		60	3728	4719	13 2	11 5
	mean		3628	4783	21 7	23 2
Phosphate tricalcic		40	3748	4918	13 6	22 3
		80	3520	4860	7 3	10 4
		120	3840	4937	7 5	7 6
	mean		3612	4905	9 5	13 4

[1] Average of four replications per year * Freshly applied P

At Mbo Plain, rice yield in the zero phosphate plot was quite high (about 4 9 t/ha), and we did neither detect marked phosphate response for any P fertilizer product, or for rate of applied P (Fig. 7). In the second trial, involving frequency of P application over 5 crop seasons, we similarly failed to detect any marked P response Check plot yield in this trial was 5.4 t/ha while the treated plot yields ranged from 5 3 to 5.7 t/ha We determined available P values for all treatments and they ranged between 3 7 and 8 4 (Olsen's) and from 2 6 to 4.6 (Bray

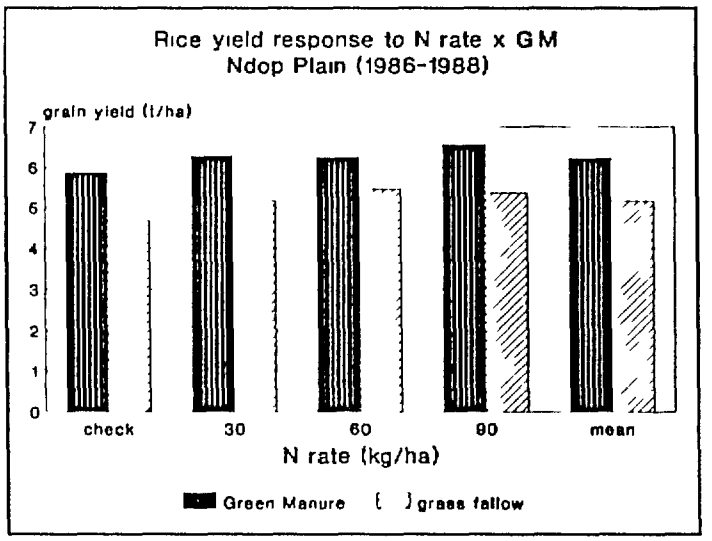
1), the lowest values were for the check plots Plant growth and development, including tiller and panicle production, were normal in all plots including the check There was no apparent nutrient deficiency or toxicity symptom in any plot These data probably suggest that either the native soil P was adequately available to rice for normal plant nutrition or poor response to applied P was associated with some hidden hunger which restricted further yield increase



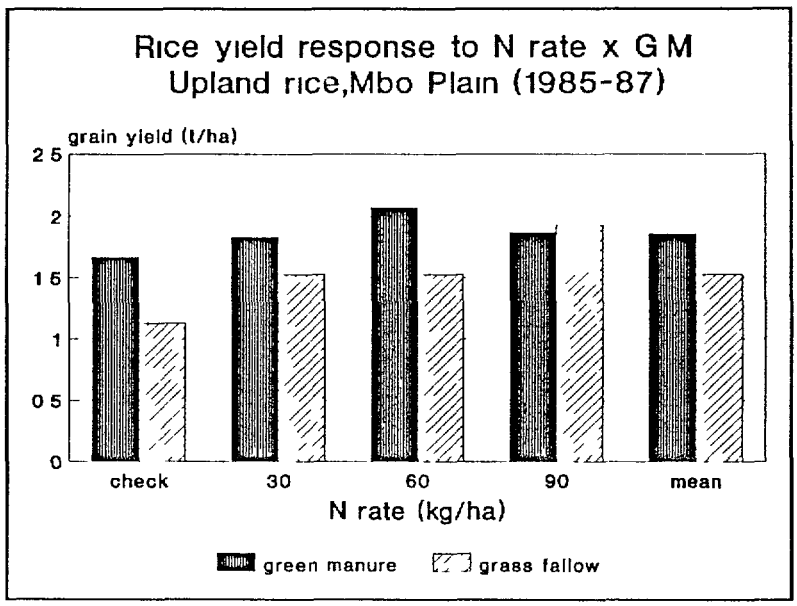
4 2.1.3 Green manuring in rice

Green manuring is a low input technology to improve rice yield and soil fertility We investigated rice response to Crotalaria green manure for three crop seasons during 1985 to 1988 The trial at Mbo Plain involved upland rice while that at Ndop Plain involved lowland rice Three levels of applied N were superimposed on green manure and grass fallow plots Crotalaria was grown in situ and incorporated into the soil two weeks before rice planting

At Ndop Plain, yield differences between green manure and grass fallow plots was over one ton per hectare even at 90 kg/ha applied N In general, green manuring with crotalaria had an yield advantage of about one t/ha of rice over grass fallow (Fig 8) At Mbo Plain, upland rice yield was low but there was a positive response to green manure and yield advantage for green manuring over grass fallow ranged from 300 to 500 kg rice/ha The highest yield response to green manuring was for the zero N plots (Fig 9).



These data confirm that Crotalaria green manuring is an economic way of soil fertility improvement and rice farmers of Western Cameroon can conveniently adopt this low input technology to improve their rice yield and economize N fertilizer use

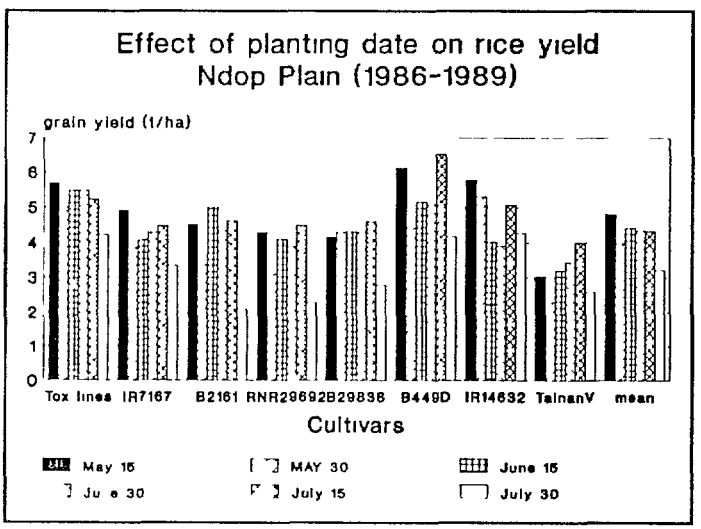


3 2.4 3 Cultural Management
3.2.3.3.1 Date of Planting

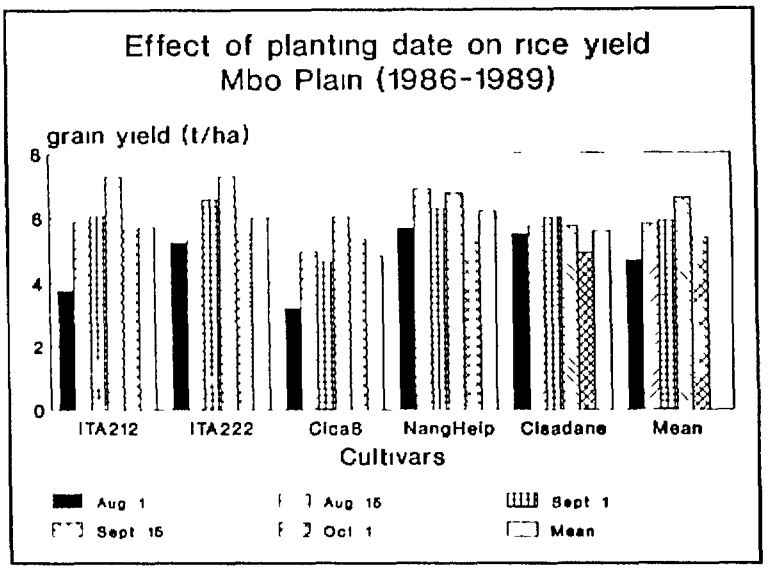
Most modern rice cultivars are sensitive to climatic changes and they react to date of planting We conducted date of planting trial with selected advanced lines/cultivars to find optimum planting dates to achieve high and stable yields of improved rice cultivars These trials were conducted at Mbo and Ndop Plains during 1986-1989 A total of eight trials at two locations were involved in this study

At Ndop Plain, we planted 8 cultivars/lines from May 15 to July 30 at an interval of two weeks Three of the 8 cultivars, however, were tested only in 1989 At Mbo Plain, we planted 5 cultivars/lines from August 1 to October 1 at an interval of 15 days These were tested for three crop seasons

At Ndop Plain, cultivars reacted differently to planting dates In general, grain yields were not much affected when the cultivars were planted between May 15 and July 15 July 30 planting resulted in drastic yield reduction due to high grain sterility in all cultivars (Fig 10) At Mbo Plain, August 15 to September 15 plantings were better for yields



The earlier planting was affected by leaf blast incidence while the later planting was affected by low night temperature which resulted in high grain sterility (Fig 11)



3 2 4.3.2 Plant Spacing

Optimum plant spacings are required to attain high yields of modern rice cultivars Varietal response to plant spacings vary with soil fertility levels During 1989, we evaluated plant spacing effect on rice yield at Mbo and Ndop Plains at two levels of applied fertilizers, 40-30-20 and 80-60-40 The plant spacings were 16, 28 and 40 hills/sq m There were three test cultivars at Ndop Plain and two cultivars at Mbo Plain

At Ndop Plain, cultivars differed in their responses to plant spacings At low fertility level, closer plant spacing was better for rice yield in two of the three cultivars At high fertility level, hardly there was any yield difference due to differences in plant spacing At Mbo Plain, higher plant density was better for yield at the lower fertility level while medium plant density was better for yield at the higher fertility level.

3.2 4 3 3 Effect of Management Level on Rice Yield

Modern rice cultivars are quite responsive to management levels Good management is essential for high performance of most cultivars but it is equally more expensive Poor management, in contrast, can result in very poor rice yield making rice production uneconomic We evaluated effect of management levels on rice yield by growing two rice cultivars at three management levels Details on management levels are given in table 2

Cica 8 responded better to management level than ITA 222 In Cica 8, yield difference between the highest and the lowest management level was about 1 7 t/ha In ITA 222 this difference was 600 kg/ha Medium management level (mainly level of land preparation) did not affect grain yield markedly over the minimum level of land preparation The effect of good land preparation with cage wheel tractor was distinctly superior to land preparation with hand hoe for rice yield

Table 2 Effect of management levels on the grain yields of two rice cultivars Mbo Plain (1989)*

Management level	management description	grain yield (kg/ha) Cica 8	ITA 222
M1	Good land preparation with a tractor 80-60-40 fertilizer well incorporated Weed-free at all time Insect control with Furadan Water control in plots (5-8 cm depth)	6391	5102
M2	Good land preparation with hand hoe 60-30-30 fertilizer well incorporated one hand weeding 40 DT** No insecticide application Uncontrolled water depth in plots	4944	4576
M3	Minimum land preparation with hand hoe 60-30-30 fertilizer after weeding One hand weeding 40 DT No insecticide application Uncontrolled water depth in plots	4707	4550

* grown in unreplicated large plots of 380 sq m per cultivar per management level with splittting of each mamangement level plot into two sub-plots of cultivars at random

3 2.4.3.4 Machine Vs. Manual Transplanting of Rice

Transplanting of rice is superior to direct seeding for good and uniform plant establishment of lowland rice but it is a quite labor intensive and back breaking operation In some Asian countries, particularly in Japan and China, rice transplanting is done by manually operated or powered rice transplanters We compared an IRRI devised manually operated Rice Transplanter with manual transplanting of lowland rice in large plots at Mbo and Ndop Plains during 1987 and 1988

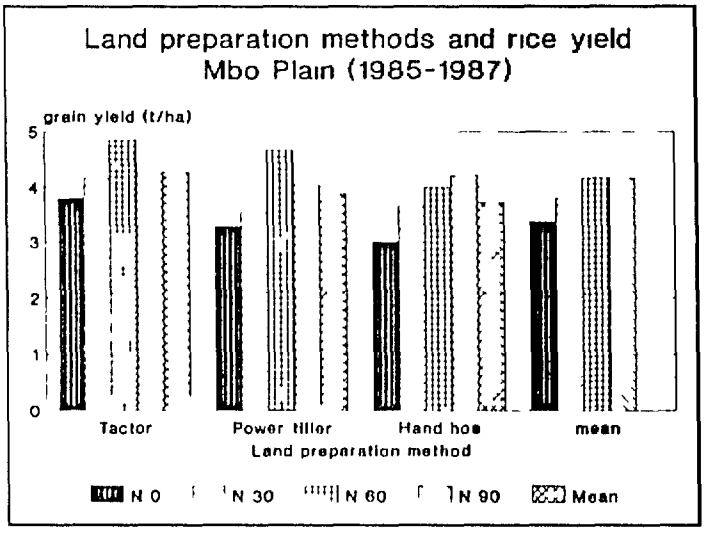
At Ndop Plain, machine transplanting was slightly better than manual transplanting for rice yield At Mbo Plain, the yield difference was less than at Ndop Plain Mean rice yields over two locations were almost similar for both methods of transplanting The labor requirement for transplanting, however, was reduced from 157 in manual transplanting to 57 in machine transplanting (table 3) These data indicate that semi-mechanization of rice transplanting by the use of a manually operated rice transplanter would be a good labor saving and practicable process in lowland rice culture

Table 3 Rice yield and transplanting time in lowland rice as affected by machine and manual transplanting Mbo and Ndop Plains (1986-87)*

Method of transplanting	grain yield (kg/ha) Ndop Plain	Mbo Plain	mean	transplanting time (man hr /ha) Ndop Plain	Mbo Plain	mean
Machine	4935	5938	5436	54	60	57
Manual	4335	6196	5265	150	165	157

* Average of two crop seasons per location, and meran over four cultivars at Mbo Plain

3 2 4 3 5 Land Preparation Method and Rice Yield



Lowland rice requires well prepared soil and a weed-free and soft seedbed for good seedling establishment A well prepared field is also required to facilitate easy transplanting, mix organic residue uniformly with the soil, uniform distribution of water, fertilizer and pesticides, and even weed control In 1985 and 1986 we compared land preparation with a cage wheel tractor, a power tiller and hand hoe at three levels of applied N Land preparation with tractor was superior to other methods for rice yield Rice yields were higher at all N levels when the land was prepared with a tractor Land preparation with hand hoe was not quite effective for water retention in plots which influenced weed growth Power tiller did a better job than hand hoe but was not as good as cage wheel tractor (Fig 12)

3.2 4 6 Weed Control in lowland rice

Weed control in lowland rice is one of the main tools in satisfactory rice production Ease of weed control of course, depends on weed species and level of weed infestation At Ndop Plain, Scirpus jacobi, and Cyperus difformis are the two major weeds of lowland rice Cyperus weeds are easy to control in lowland rice but it is very difficult to eradicate Scirpus spp In 1988 and 1989, we tried 2, 4-D application at different growth stages of weeds to combat Scirpus sp at Ndop Plain and compared 2, 4-D treatments with hand weeding and Basagram

application Treatment details are given in table 4 Hand weeding was the best for rice yield and weed control Application of 2, 4-D at 2- and 5- leaf stages of weeds were quite effective in weed control but rice yields were inferior to that of hand weeded plots Basagram application was not effective in improving rice yield or controlling weeds

Table 4 Effect of different weed management treatments on weed population and grain yield of IR 7167-33-2-3 under lowland condition Ndop Plain (1988-89[1]

	1988	1989	mean	1988	1989	mean
1 Weed-free (hand weeded)	5254	4790	5022	17	24	21
2 One hand weeding 30 DT[2]	4445	4240	4342	62	204	133
3 Unweeded check	777	2451	1614	385	369	377
4 2,4-D applied at 2-leaf stage of weeds	4381	2986	3683	53	201	127
5 2,4-D applied at 5-leaf stage of weeds	3189	3285	3237	47	155	101
6 2,4-D applied at 10-leaf stage of weeds	2977	2731	2854	245	225	235
7 2,4-D applied at 2 and 10-leaf stage of weeds	4815	2807	3811	56	173	144
8 Basagran applied at 2-leaf stage of weeds	3350	2833	3091	177	348	262

[1] Average of four replications [2] Days after transplanting

3.2 4.3.7 Harvest Date Effect on Milling Quality of Rice

Harvesting rice at different maturity stages affect quality of milled rice We investigated the effect of harvest time on milling recovery of selected rice cultivars at Ndop Plain during 1987 to 1989 Treatment details and data on milled rice quality are given in table 5 Cultivars differed with respect to milling qualities as a function of harvest time Detail results were presented in 1988 and 1989 Annual Reports Summary results presented in this report indicate that grain breakage at milling is more with late harvests Cultivars with long and slender grain (Tox lines) are more prone to breakage at milling than the medium-bold cultivars like IR 7167-33-2-3 To maximize headrice out-turns cultivars with medium-bold grain, therefore, should be harvested within 50 days after heading while those with long-slender grain must be harvested within 40 days after heading.

Table 5 Effect of harvest time on milled quality of rice Ndop Plain (1987-88)

Rice cultivar	harvest time (DAH)[1]	grain moisture (%)[2]	percent rough rice			
			brown rice	clean rice	head rice[3]	broken rice[4]
IR 7167-	35	32 5	85 4	73 8	65 8	8 0
33-2-3	40	30 4	82 0	73 6	50 9	22 7
(med -bold)	45	26 5	80 0	73 9	45 4	28 6
	50	24 5	79 0	69 6	28 5	41 1
	55	22 5	80 0	69 6	17 2	52 4
	60	12 8	80 1	72 9	11 9	61 0
Tox 3145-	35	25 0	80 8	65 4	54 2	11 1
34-3-4[5]	40	22 0	75 4	71 0	48 3	22 7
	45	20 5	75 9	64 4	5 6	58 8
	50	18 0	77 2	64 0	12 0	52 0
	55	14 5	83 0	68 0	23 7	44 3
	60	11 5	76 0	69 0	5 5	63 5

[1] Days after heading [2] garin moisture at harvest, [3] One-hundred percent whole milled rice, [4] Include all broken grains [5] One year data

3 2.4.4 Cropping System and Component Development

3 2.4.4 1 Grain Yields and Gross Income From Two-Cycle Rice-Based Cropping Patterns

This investigation was carried out at Mbo Plain during 1985-1989 and at Ndop Plain during 1988 and 1989 The trial at Mbo Plain was upland rice-based while that at Ndop Plain was irrigated rice-based Treatment details are given in tables 6-8.

In the first trial at Mbo Plain (1985-1987) we compared three patterns - maize followed by rice, soybean followed by rice, and maize/rice (intercrop) followed by rice (table 6). Maize yield was 3 6 t/ha in the pure crop and 3 4 t/ha in association with soybean Soybean yields were 1 15 and 0 63 t/ha as pure and intercrops respectively Rice yields were close to 2 1 t/ha in all treatments Gross income was highest (477 000 CFA /ha) from the maize/soybean - rice pattern.

Table 6 Grain yields of crops and gross income in an upland rice-based two cycle cropping pattern trial Mbo Plain (1985-1987)[1]

Cropping pattern 1st cycle	2nd cycle	maize yield (kg/ha)	soybean yield (kg/ha)	rice yield (kg/ha)	gross income (CFA/ha)
Maize	rice	3633	-	2119	358 000
Soybean	rice	-	1147	2198	450 000
Maize/soybean	rice	3440	633	2124	477 000

[1] Average of six replications per year

In the second trial at Mbo Plain (1988-89), we compared 12 different patterns involving maize, soybean, cowpea, bean, peanut and rice In respect of gross income, maize/bean - rice, soybean - rice and cowpea - rice patterns appeared to be the best. Gross income from these patterns were over 450 000 CFA/ha while gross income from other patterns varied from 118 000 to 336 000 CFA/ha (table 7) However, better varieties of bean and cowpea are needed to be identified to improve profits from these patterns as grain yields of the presently available cultivars are unstable because they are prone to severe disease attacks under Mbo Plain soil-climatic conditions

Table 7 Grain yields of crops and gross income from two cycle rainfed rice-based cropping patterns Mbo Plain (1988-1989)[1]

Cropping pattern 1st cycle	2nd cycle	yield of main crop (kg/ha)	yield of inter crop (kg/ha)	yield of rice (kg/ha)	gross income 1st cy (CFAx 1000)	gross income 2nd cy (CFAx 1000)	gross income total (CFAx 1000)	Rank
Maize	rice	3205	-	692	128 1	69 6	197 7	9
Soybean	rice	1824	-	878	364 8	88 2	453 0	2
Peanut	rice	774	-	947	99 6	95 1	191 7	10
Cowpea	rice	504	-	977	294 9	156 0	450 9	3
Bean	rice	1180	-	1767	126 0	98 1	224 1	6
Rice	rice	1610	-	530	161 7	53 1	214 8	7
Maize/soybean[2]	rice	2113	845	808	253 5	81 3	334 8	4
Maize/peanut[2]	rice	1722	234	907	83 7	98 1	181 8	11
Maize/bean[2]	rice	2104	435	906	192 6	90 9	458 4	1
Maize/cowpea[2]	rice	1386	304	925	131 4	93 0	224 4	5
Mixed crop(Trad)	rice	880	365	978	104 4	97 8	201 6	8
Grass fallow	rice	-	-	1170	-	117 6	117 6	12

[1] Average of four replications per year Market price of produce (CFA/kg)
Maize 40 rice 150 soybean 200 cowpea 250 peanut 250 bean 250
[2] Intercrop

In the irrigated lowland rice-based trial at Ndop Plain, we compared 10 cropping patterns At this location, total crop yields were much higher than at Mbo Plain and this was contributed mainly by the second cycle rice At this location, total gross income, ranged from 460 000 to over 860 000 CFA/ha The best three patterns in respect of gross income earner were soybean-rice > maize/bean-rice > maize/cowpea-rice Mixed crop-rice pattern was the 4th The second cycle rice yields varied from 4 15 to 5 05 t/ha between patterns and contributed most to total gross income earnings (table 8)

Table 8 Grain yields of crops and gross income from two cycle irrigated rice-based cropping patterns Ndop Plain (1988-1989) [1]

Cropping pattern		1st cycle yield		rice yield (kg/ha)	gross income 1st cy (CFAx 1000)	gross income 2nd cy (CFAx 1000)	gross income total (CFAx 1000)	rank
1st cycle	2nd cycle	main crop	inter crop					
Maize	rice	2920	-	4738	116 7	476 1	592 8	5
Soybean	rice	2032	-	4244	406 5	444 6	851 1	1
Peanut	rice	680	-	4757	84 9	477 9	562 8	7
Bean	rice	166	-	4164	41 4	418 5	459 9	10
Cowpea	rice	160	-	4206	39 9	421 5	461 4	9
Maize/soybean[2]	rice	1832	1310	4303	135 0	432 0	567 0	6
Maize/peanut[2]	rice	1704	494	4248	129 9	426 9	556 8	8
Maize/bean[2]	rice	2216	110	4878	116 1	490 2	606 3	2
Maize/cowpea[2]	rice	1754	76	5052	68 7	510 6	600 3	3
Mixed crop(Trad)	rice	1777	415	4700	124 2	472 2	596 4	4

[1] Average of four replications Market price of produce (CFA/kg) Maize 40 Rice 150, soybean 200, cowpea 250 peanur 250, bean 250 [2] Intercrop

These data obtained from three different trials over a 5-year period, clearly show that two-cycle rice-based cropping systems involving rice (irrigated or rainfed), maize, soybean , bean and cowpea would be quite viable for Western Cameroon rice farms provided appropriate crop cultivars and planting time are used by the farmers in selecting their cropping patterns.

3 2 4 4.2 Component Development

In component technology development for cropping systems we studied varietal evaluation for cowpea, sweet potato and cassava, and fertilizer response in maize, soybean, cowpea and sweet potato Detail results for individual crop species were reported in NCRE Annual Reports Summary results are as follows:

3 2.4.4.2.1 Fertilizer response in maize

We studied fertilizer response in kasai-I, Ekona yellow, CMS 8501 and CMS 8704 at Mbo Plain during 1986-90, and of Bacoa, kasai-I and Early White at Ndop Plain during 1989 and 1990. At Mbo Plain, all test varieties responded to applied fertilizer. The highest yields of Kasai-I and Ekona yellow were 4.9 and 4 7 t/ha at 90-60-60 fertilizer level (mean over 3 years). Application of 200 kg Sulpomag/ha increased maize yield by 400 -500 kg.ha over NPK fertilizer alone In 1990, similar results with Sulpomag were obtained with CMS 8501 and CMS 8704 Inspite of high check plot yields (3 2-4 75 t/ha) these two varieties responded well to sulpomag application and the highest yield in Sulpomag treated plot was 8 4 t/ha at 90-90-60 fertilizer level. These data clearly show that Mbo Plain soils are deficient in Mg and/or S, and soil ammendments to correct Mg and/or S deficiency would be essential for maximizing maize yield in Mbo Plain (table 9)

Table 9 Fertilizer response in maize Mbo Plain (1986-1989)[1]

Fertilizer (kg/ha)				grain yield (kg/ha)					
				1986-89 mean			1989	1990	
N	P_2O_5	K^2O	Sulpomag	Kasai-I	E Yellow	Kasai-I	E Yellow	CMS 8501	CMS 8704
0	0	0	0	4048	3733	2408	4222	4749	3205
60	60	40	0	4308	4118	3422	4430	5528	4325
60	60	40	200	-	-	3800	5581	7088	5072
90	60	60	0	4867	4662	-	4673	5797	5690
90	60	60	200	-	-	-	5676	8480	6100
120	120	60	0	4540	4595	4240	-	-	-
120	120	60	200	-	-	4680	-	-	-
150	120	60	0	4650	4137	-	-	-	-

[1] Average of four replications per year

At Ndop Plain, two year results indicate that maize grown to lowland rice soil following the harvest of the rice crop need to be adequately fertilized to maximize maize yield At this location, maize yield in two cycle rice-maize pattern increased from 2 9 to 4 4 t/ha (53% over check) by the application of 120-90-60 fertilizer rate (table 10)

Table 10 Fertilizer response in maize in an irrigated rice based two cycle cropping system Ndop Plain (1989-1990)[1]

Fertilizer (kg/ha)			maize yield (kg/ha)		
N	P_2O_5	K_2O	1989	1990	mean
0	0	0	2988	2810	2899
30	30	20	2878	3322	3100
60	60	40	3133	3764	3448
90	90	60	4122	4310	4216
120	90	60	4611	4269	4440

[1] Average of four replications per year

3 2 4 4 2 2 Fertilizer Response In Soybean, Cowpea and Sweet Potato

We investigated fertilizer response in soybean, cowpea and sweet potato in replicated yield trials at Mbo Plain during 1986-87 The test varieties were Sj 299 (soybean) V 576 (cowpea) and Tibl (sweet potato) Maximum yield increase in soybean was about 48% over check (1090 kg/ha) by the application of 60-150-30 fertilizer Application of 1 t/ha of organic manure effected yield increase over check by about 40% In cowpea, maximum yield increase over check (1010 kg/ha) was about 27 % by the use of 60-150-30 rate of fertilizer Application of organic manure alone had a negative effect on grain yield (due to too much vegetative growth) In sweet potato, increases in fresh tuber yield due to fertilizer application was marginal

3 2 4 2 3 Varietal Evaluation in Cowpea, Sweet Potato and Cassava

We evaluated selected cowpea lines in observational yield trials at Mbo Plain Ndop Plain and Babungo during 1988 and 1989 crop season The best selections from the OYT were put into replicated yield trials in 1990 Comparative yield performances for the cultivars in replicated yield trials are given in table 11 The first three best cultivars at each location performed well over the past consecutive three years These can now be multiplied and extended for mass cultivation as pure crops Their performance in association with maize, however, need to be evaluated before they are recommended for cultivation in maize based associations crops

Table 11 Grain yields (kg/ha) of selected cowpea lines in replicated yield yield trials at three locations (1990)[1]

Mbo Plain (Santchou)		Ndop Plain (Bamunka)		IRA-Babungo	
cowpea line	yield	cowpea line	yield	cowpea line	yield
Mutant Giant 31-1-2	1382	Mankon local	1928	Mankon local	1731
IT 85D-219	1255	TVX 1850-OIE	1832	TVX-OIE	1350
IT 82E-32	1160	Mutant Jaune Claire	1332	Tardif 22	1262
IT 85F-2020	977	Tardif 22	1106	Vita 7	1225
IT 85F-953-3	627			Mutant Precoce	1150
				IT 85F-2020	904
				IT 83D-219	880
				IT 82E-3	662

[1] Average of four replications per location

Sweet potato clones Tibl, 1112 and local Santchou were compared in replicated yield trials at Santchou during 1988-1990 Results are given in table 12 The clone, 1112 out yielded Tibl and the local clone with a very big margin This clone, therefore, could now be extended to farmers of Mbo Plain for mass cultivation We compared five cassava varieties in replicated yield trials at Mbo Plain during 1988-1990 Results are given in table 13 The variety, 8034 was the highest yielder (43 t/ha) as compared to 32 t/ha produced by the local Red Varieties 8061 and 8017 also outyielded the presently grown variety on the Plain All the three 80-lines were free from cassava mosaic virus while local Red and Sangele was moderately susceptible to CMV at Mbo Plain

Table 12 Fresh tuber yields of three sweet potato clones in replicated yield trial Mbo Plain (1988-19990)[1]

Clone	fresh tuber yield (t/ha)			
	1988	1989	1990	mean
1112	48 5	35 7	32 5	38 9
Tibl	13 9[2]	26 0	23 7	21 2
Santchou local	36 4	9 9	23 3	23

[1] Average of four replications per year [2] Plant establishment was poor due to poor planting materials

Table 13 Fresh tuber yields in five cassava varieties in replicated yield trail Mbo Plain (1989-1990)[1]

Variety	Fresh tuber yield (t/ha)		
	1989	1990	mean
8061	40 4	39 3	39 8
8034	34 4	51 8	43 1
8017	35 9	38 6	37 2
Sangale	29 9	32 1	31 0
Local Red	26 0	37 2	31 6

[1] Average of four replications Plot size 50 sq m per variety

3 2 4 5 Technology Transfer to Farmers

Development of appropriate agronomic practices is an integral part of varietal improvement program Once a variety is released for production, associated agronomic practices are automatically transferred to the farmers Superior agronomic practices developed on-station by this unit for different cultivars were thus extended to the farmers for adoption along with the released varieties This has been possible through immense collaboration of the rice research team with the rice parastatals, like SODERIM, UNVDA, Tingo Coop and others. However, it should be borne in mind, that actual farmer adoption of recommended production practices are restricted by elements beyond farmers control, and in many instances one would encounter farmers growing a recommended variety without adequate inputs required for maximizing varietal performances More extension efforts, therefore are needed to motivate rice farmers in adoption of important agronomic practices like time of planting, seedling age, timely weed control, better land preparation, timely application of adequate fertilizer, proper water control in plots and timely harvest and post-harvest operations to improve grain yield and quality of harvest

3 2.4.6 Co-operation with National and International Organization

In the course of development and execution of the research program this unit have worked in close cooperation with some international agricultural research centers like IRRI and IITA, and most national Rice Development Associations in Cameroon, including SODERIM, UNVDA, SEMRY, AGRILAGDO, Tingo Coop and others, in joint annual planning and evaluation of research program and research findings, primarily through the annual research program and planning meetings and field visits during the growing season

3 2.5 IN-SERVICE TRAINING

In-service training was an integral part of the program from the very beginning The following types of in-service trainings were offered during the past five years

- Four junior scientists (counterparts), technicians and observators received on-the-job training at work
- Four degree and diploma related University students received laboratory and field training in preparation of their Memoire or Thesis as a part of their academic requirements
- A counterpart agronomist received higher training leading to Ph.D degree in agronomy at the Texas A & M University.
- Two Field Technicians received 4-month intensive training at IRRI, Philippines in INSPFER and GEU courses
- Informal Field Days were organized for farmers, researchers, administrators at Mbo and Ndop Plains in 1988 and 1989 to acquaint them with the latest development in rice research in Western Cameroon

3.2 7 PRIORITIES FOR FUTURE RESEARCH

The search for newer varieties and associated production practices should be a continuous process in food crop research Rice research, therefore, should continue in the future with the goal of identifying/developing superior genotypes and appropriate production practices Agronomic research, therefore, shall run hand in hand with rice varietal improvement effort Priorities for future research, however, may be directed to the following

- Continue investigation on nutritional problems of rice with special emphasis on nitrogen management to increase N-use efficiency
- Determine available P status of various rice soils and estimate their actual P needs to support good rice crops in an effort to avoid unnecessary expenditure in P fertilization with each crop of rice
- Emphasize investigations on organic recycling in rice soils including green manuring and rice straw incorporation to economize inorganic fertilizer use
- Devise alternative appropriate cultivation practices to minimize cost of rice cultivation and make locally produced rice available to the consumers at a lower cost
- Continue investigations on post-harvest factors associated with poor quality of milled rice and define appropriate harvest time and post-harvest practices to improve milled rice quality
- Identify superior crop species and crop cultivars to fit into the rice-based cropping systems of Western Cameroon to make such systems more attractive and productive

4 CEREALS AGRONOMY RESEARCH UNIT

4 1 INTRODUCTION

The NCRE Cereals Agronomy Unit, based at IRA/Garoua, is composed of three researchers (Dr H Talleyrand, Ing T Ngoumou, Ing A Ebete), and one technician (Wabi Katsala) Our Unit devotes 70% of its research efforts to maize agronomy and 30% to sorghum and millet agronomy Our research program is mainly a production -oriented program - which includes the maize - growing regions of the three provinces of Northern Cameroon, and the sorghum - growing regions of two provinces (North and Adamaoua) For research purposes, Northern Cameroon (6^0 - 13^0 latitude N, 160 000 km^2) is divided into three main regions (each one subdivided into zones) the highland savanna of Adamaoua, the subhumid lowland savanna, and the semi-arid lowland savanna The area planted with maize in Northern Cameroon is estimated to be around 70 000 ha while that of sorghum (rainy and off-season) is about 400 000 ha

Relatively little agronomic research with maize and sorghum was carried out in the North and Adamaoua provinces before the start of the NCRE Project Since 1982 our Unit has intensified our agronomic research on maize and sorghum in close cooperation with the NCRE breeders and the development agency SODECOTON We conduct on station and on-farm trials in the lowland and highland savannas of Northern Cameroon From 1986 to 1990, we have conducted more than 150 field trials The major emphasis of our research work has been to develop practical conservation farming technologies for improved and sustained cereals - based cropping systems in the savanna of North Cameroon We use a teamwork approach - involving scientists, extension and development agents, as well as farmers in the process of planning and implementation of the research work Furthermore, our section provides technical assistance in agronomy and soils to different agricultural agencies of the region At the request of the NCRE maize breeders we have done several seed multiplications of the newly available maize varieties in the lowland savanna.

4 2 OBJECTIVES

The Main Objectives of the NCRE Cereals Agronomy Unit are :

1 To develop improved and adapted packages of cultural practices for maize and sorghum farmers in the context of the different cropping systems used in the main zones of North Cameroon

2 To participate in the extension of the improved agro-technologies in close cooperation with the agencies in charge of rural development

3. To evaluate the impact and interaction of the main agroclimatic and management constraints on the production of maize and sorghum-based cropping systems, and test different agronomic techniques in order to alleviate these constraints

4 To train and work with national counterparts and technicians in agronomic field research

4.3 CONSTRAINTS

Among the major problems affecting our work over the past five years, it can be mentioned a) lack of work space and research equipment, b) lack of appropriate seed storage facilities, c) inadequate support staff, e) inadequate transport facilities for counterparts and technicians; f) inadequate communications between our office and NCRE office at Nkolbisson; g) pre-financing of our research operations

4 4 ACCOMPLISHMENTS.

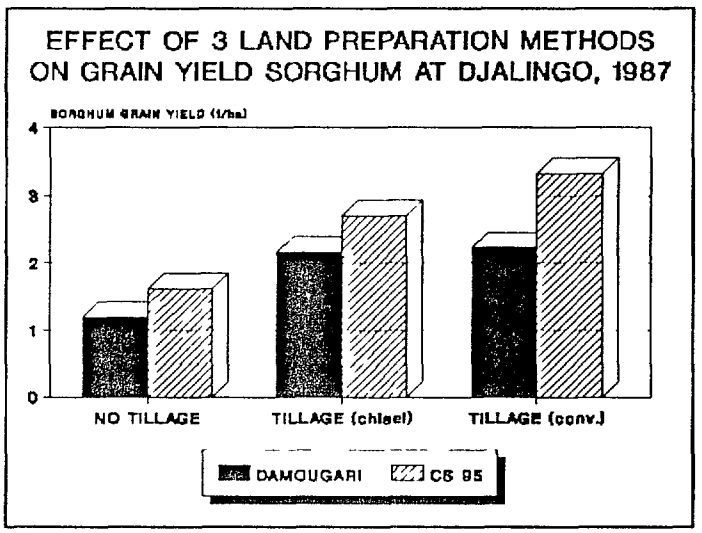
Main Research Operations Conducted in the lowland and highland savannas of Northern Cameroon and Highlights of Findings (1986 - 1990)

I- Soil and Water Management and Conservation in the Lowland Savanna of Northern Cameroon.

The ultimate objective of this research operation is to develop practical conservation farming technologies (like minimum tillage) for maize and sorghum production in the lowland savanna

A- Land Preparation studies on maize and sorghum

A set of experiments with maize and sorghum have been conducted since 1987 comparing three methods of tillage for land preparation a) conventional (plow and harrow) as recommended by SODECOTON, b) chisel tillage, c) no-tillage An additional treatment (seed treatment versus no seed treatment) was used to evaluate the possible interaction between crop establishment and land preparation



In 1989 - no tillage was used in all the plots in order to study the possible carry-over effects of conventional and chisel tillages (used in previous year) on grain yield of maize and sorghum

It was found - among other things - that 1) conventional and chisel tillages usually produced higher grain yield as compared to no tillage 2) However when conventional and chisel tillages were applied the previous year, there was no significant difference with no tillage - therefore there was no carry - over effects of both tillages 3) There was no significant interaction between seed treatment and land preparation 4) Sorghum responded on the average more to tillage than maize For sorghum, the interaction between varieties x tillages was significant

A series of 15 on-farm trials conducted in 1989 in the subhumid lowland savanna comparing several varieties of maize under two methods of land preparation (conventional tillage versus no land preparation) showed a yield superiority of the conventional tillage in most of the locations The extra yields were related to a better weed control, better crop establishment and N fertilizer management under conventional tillage.

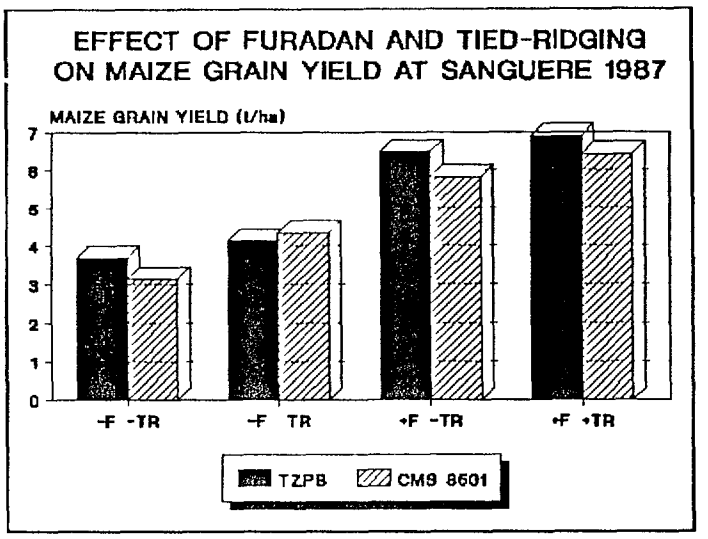
Based on these results and observations of the last 3 years, it seems that a system of minimum tillage with no land preparation could be relatively productive for maize and sorghum However a good weed control, appropriate N fertilization and a good crop establishment (with the use of effective seed treatment (like Marshal 25 ST) are necessary to make the system practical and sustainable Furthermore, this minimum tillage system reduces the erosion problem in the Alfisols and seems more economical

More on-farm and on-station research is being conducted on minimum tillage

B- Effect of tied-ridging on maize and sorghum performance and yield on the lowland savanna of Northern Cameroon.

A set of trials were conducted with maize and sorghum at six locations of the lowland savanna The main objectives of this research work were a) to study the impact of tied-ridging on maize and sorghum grain yield, b) to determine the optimum spacing for tying the ridges, c) to evaluate the varietal response to tied-ridging It was found - among other things that 1) In most cases, there was a positive impact of tied-ridging on performance and grain yields of both crops - more so for maize than for sorghum Yield increases (above the checks) of up to 1 8 t/ha with maize, and up to 1 2 t/ha for sorghum have been obtained, 2) It was observed that tied-ridging often reduced rainfall water run-off losses, improved water infiltration and retention - and thereby reducing soil moisture stress as well as soil erosion in the lowland savanna, 3) The impact of tied-ridging varied with years, locations soil texture, slope of land, and rainfall regimes This technology showed more advantage in slopy land, predominantly sandy soils, and in case of prolonged

drought or frequent dry spells during the season In the heavier textured soil, use of tied-ridging was associated with a depressive effect on crop growth and yields (due to waterlogging and lack of aeration of plants roots), 4) Tying the ridges 3-4 weeks after planting gave better results than at planting, 5) Spacing the ties at 5 m apart appeared to be in many cases the best spacing, 6) There was no difference between the varieties used with regard to tied-ridging, 7) The use of this technology appeared in most cases, to be an efficient security method against crop damage associated with erratic rainfall pattern, 8) When used together with the seed treatment Furadan 10G, it appears that plots treated with Furadan **only** outyielded those with tied ridging **only** The combination of both technologies produced a better crop establishment and growth in maize and sorghum as compared to the checks, and resulted in greater yield impact (3 3 t/ha, +98%) over the checks for maize while for sorghum (3 4 t/ha, +250%) The Interaction tied-ridging x Furadan was significant for sorghum but not for maize In summary, both strategies used in combination could help achieve in many locations relatively good and stable yields of both crops in the high risk environment of the lowland savanna of North Cameroon



II FERTILIZATION MANAGEMENT ON MAIZE AND SORGHUM IN THE LOWLAND SAVANNA

A- Fertilization with micronutrient and secondary nutrient elements

Preliminary surveys conducted in many locations (on station and in farmers' fields) in North Cameroon reveal **an increasing** occurrence of deficiencies of secondary and micronutrients on both crops - moreso in maize than in sorghum, and particularly in the lowland savanna Although the causes of these deficiencies have not yet been completely established, it is believed that they are partially related to crop intensification, the use of high - yielding varieties,the use of unbalanced fertilizers, a decreased level of soil organic matter, and the severe erosion problems prevailing in the main zones of the lowland savanna. From 1987 on, several fertilization experiments were undertaken to evaluate the effect of different rates and interaction of zinc and sulphur with phosphorus, and different rates of magnesium on maize and sorghum yields in the lowlands and highlands.

Preliminary results indicate 1) There is in most cases a positive response to sulphur, zinc and magnesium for maize and sorghum in our research work These 3 deficiencies occurred sometimes simultaneously in some locations, 2) Interaction of zinc x Phosphorus was significant while the interaction of Sulphur x Phosphorus was not, 3) **In the case of Sulphur deficiencies** For maize the best rate of Sulphur seem to be 22 kg S/ha while for sorghum it seems to be around 11 kg S/ha; 4) **In the case of Zinc deficiencies** For zinc, the optimum rate seems to be 1 - 2 kg zinc/ha (5 - 10 kgs Zn S04/ha). To correct zinc deficiencies in young maize and sorghum plants, a solution of 5g/litre of zinc sulphate could also be applied up to 3 times (once every week), 5) In the cases of magnesium deficiencies, it is suggested to use a rate of 50 kg of magnesium sulphate (kieserite) per hectare for both maize and sorghum Foliar applications of a solution of 10 g/litre of kieserite could also be made to correct magnesium deficiencies on young maize and sorghum plants
More research will be conducted on this important subject

B- **Fertilization of N with early maize.**

A series of fertilizer trials involving different rates and timing of N fertilizer are being conducted with early maize varieties in the lowland savanna of North Cameroon
Results are not yet available

C- **Effect of "Dreche" (Brewery Residue) and Cotton Cake (Tourteau de Coton)**

Research conducted with different levels of "sun dried" dreche used as a supplementary source of fertilizer on maize and sorghum along with a moderate amount of fertilizer(90 N - 40 P_2O_5 - 40 K_2O kg/ha for maize, and (45 N - 40 P_2O_5 - 40 K_2O kg/ha for sorghum) reveals that 1) the use of fertilizer alone increase grain yield of up to 113% for maize and up to 115% for sorghum over checks, 2) the combined use of fertilizer plus dreche increased yield of up to 210% for maize and up to 307% for sorghum, 3) The best rates of dreche seem to be between 400 - 800 kg (applied banded with fertilizer at planting)

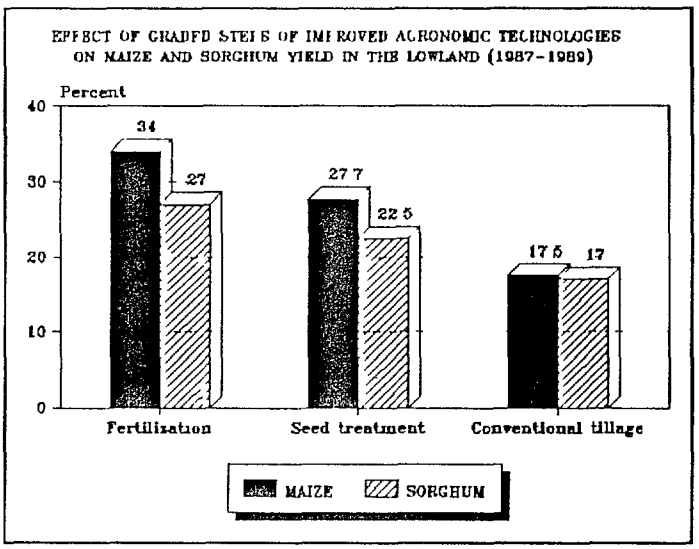
Other experiments are being conducted comparing dreche and cotton cake So far both materials appeared to be promising sources of supplementary fertilizer for some locations of the lowland savanna

III EFFECTS OF DIFFERENT SEED TREATMENTS ON IMPROVED MAIZE AND SORGHUM VARIETIES IN THE LOWLAND SAVANNA OF NORTH CAMEROON

A set of trials on chemical seed treatment was conducted with improved maize and sorghum varieties at 6 research substations and in farmers' fields from 1986 - 1989 The main objective of this research work was to determine the response of improved maize and sorghum varieties to different seed treatments in the lowland savanna of North Cameroon Experimental evidence accumu- lated in this study indicates that 1) in the lowland

savanna zones of North Cameroon, because of high levels of soil insect pests infestations, an **effective seed treatment** is very important in many cases in order to have an adequate crop establishment and relatively good and stable yields of the improved maize and sor- ghum varieties The use of seed treatments gave maximum yield increases of 101% (4.2t/ha) for maize, and 130% (2 5t/ha) for sorghum (over the untreated plots) in these trials, 2) In general, maize and sorghum crops treated with Marshal 25 ST and Furadan 10G produced significantly higher yields than those of the un- treated plots or those with Thioral (widely used by the farmers of this region) This is partly due to a greater plant stand establishment obtained with the use of these 2 chemicals There were usually significant differences as to plant stands, due to seed treatments, 3) The interaction between varieties x seed treatments was not significant in these trials, 4) The improved sorghum varieties seemed to respond, on the average, more to seed treatments than the improved maize varieties; 5) The results obtained in farmers fields on the positive impact of seed treatment Marshal confirmed those obtained on-station, 6) Preliminary economic consideration based on on-farm trials suggested a 33 1 benefit/cost ratio in favor of the use of Marshal as seed treatment over Thioral.

IV EFFECT OF GRADED STEPS OF IMPROVED AGRONOMIC TECHNOLOGIES ON MAIZE AND SORGHUM IN THE LOWLAND SAVANNA OF NORTH CAMEROON.



A set of trials were conducted in this subject from 1987 to 1990 to evaluate the impact and interactions of 3 improved technologies (fertilization, seed treatments, and conventional tillages) on yields of different maize and sorghum varieties It was found - among other things that 1) Both crops showed significant yield responses to the three technologies when applied singly or in combination, 2) the magnitude of the responses varied with crops, varieties, years and rainfall regimes, 3) the maximum grain yield increases for maize (+ 289%) and for sorghum (+308%) over the control treatments were obtained with the combined use of these strategies, 4) the average relative contribution (with respect to total grain yields) of fertilization (27-34%) was greater than that of seed treatments (22 5 to 27 7%) - which was greater than conventional tillage (17 5-17%) For each crop, there was - in many cases - some significant and positive interactions among the improved technologies - as well as between these factors and the varieties, suggesting different packages of cultural practices for the different varieties

V- MANAGEMENT OF WEED AND STRIGA IN THE LOWLAND SAVANNA OF NORTH CAMEROON

A- Weed Management studies

Several trials were undertaken in an effort to manage weed on maize under conventional tillage and minimum tillage (with no land preparation) The main weeds species identified in our research plots so far were Spermacoce sp, Commelina sp, Mitracarpus sp, Leucas sp, Ipomoea sp, Digitaria sp, Pennisetium sp, Cassia sp, Cleome sp, Celosia sp, Kyllinga sp In our test plots and on many farmers fields, Primextra and LASSO GD (4 - 6L/ha have been quite effective as pre-emergent herbicides on many cases However, some weeds (like Commelina benghalensis) are becoming dominant in farmers' fields and on station causing severe damage to maize and sorghum The management of these difficult weeds is a burden on the farming operation Regarding our study with post-emergent herbicides it was found that BASAGRAN and LADDOCK (4 l/ha) were quite effective for weed control on maize

A set of trials have been recently conducted to evaluate different methods of weed management on minimum tillage So far the use of Grammoxone or BASTA (3 l/ha) applied in combination with Primextra or LASSO GD (4 l/ha) had a satisfactory performance in many cases More research should be conducted in this important and complex subject

B- Striga Management

Striga (particularly Striga hermontheca) is an important constraint to maize and sorghum production in many locations of the lowland savanna Since 1988 our team has carried out a series of experiments on striga in the lowland savanna in order to find practical techniques to prevent or alleviate striga damage on maize and sorghum

The integrated approach used involved the testing of maize variety (inbred lines, open pollinated and hybrids) from IITA and the NCRE Breeding Programs, the testing of agronomic practices (such as herbicides, intercropping, planting dates, minimum tillage, N x plant populations, hand pulling)

In addition, 2 surveys were conducted on the subject with some SODECOTON Chiefs of zones and some farmers in the regions of North East West and South East Benoue Out of 30 Chiefs of zones, 28 stated that Striga is an important constraint for maize production in their zones of action Fifty percent (50%)requested help from IRA on this matter

The preliminary survey conducted with 35 farmers in three sectors, Touboro, Tchollire, and Ndock reveals that most of them consider Striga as a serious threat for sorghum and maize production in their villages To avoid Striga, they suggested the following practices early planting, good weeding, or to let the field under fallow They have observed Striga incidence in the

field after 3 - 5 years of cropping, and mostly in the sandy soils. They observed that the following crops tend to alleviate the Striga infestation cotton, groundnuts, cowpea and sesame All the farmers are interested in having information on control Striga in their field.

Regarding the prevention methods tested in our research program it seems that the most promising ones are :
hand pulling, and use of solution of 20% Urea. These methods are being extended to farmers' fields.

Concerning methods of reducing the striga damage in the field, some encouraging preliminary results were obtained with minimum tillage, use of Crotalaria as trap crop, crop association maize or sorghum /cowpea , and early planting

VI- TASTE TESTS WITH MAIZE AND SORGHUM (1986 - 1990)

A series of preliminary taste tests were carried out successfully with different newly available improved maize and sorghum varieties in several villages of the lowland savanna of Northern Cameroon **For Maize :** concerning the maize variety CMS-8501 (for dry maize), out of 80 families who participated in this test in the 1987 cropping season 89% of them like it very much CMS-8501 is the variety most widely cultivated in the 1990 cropping season Regarding the yellow maize CMS-8704 (for fresh consumption) out of 150 families who tested it in 1988, a group of 85% like it very much and requested seeds for planting As for the early yellow maize CMS-8806 (for fresh consumption) out of 110 families who tested it in 1989 a group of 90% liked it very much These 2 yellow maize are being extended to the farmers as "green maize for hunger period" **For sorghum** - the improved variety CS-61 was tested in 1987 by 55 families, 77% stated they like it very much As for sorghum CS-95, out of 62 families who participated in this test in 1988, 69% stated they like it very much

II- ON-FARM ACTIVITIES AND IMPACT OF THE NCRE CEREALS AGRONOMY UNIT (1986 - 1990)

- Preparation of 5 **production guides on maize and sorghum** for the extension agents of North and Adamaoua Provinces
- On-farm tests/demonstrations of NCRE varieties and agronomic practices with SODECOTON More than **60 tests/demonstrations** were conducted during this period on farmers fields located in different villages (using plots size of 2500 m^2) More than 50 farmers in each village came to visit these test plots These tests are also used as a training opportunity for the extension agents as well as for the farmers
- A set 21 **on-farm tests/demonstrations** were conducted with MINAGRI extension agents in the Adamaoua Province
- Five **demonstration plots** were set up at ENIA Pitoa, near the market during the last 5 years More than 200 farmers came to visit these plots
- Organization of 6 field days for the farmers and Extension gents

- As requested, we have provided direct technical assistance to many farmers
- Five taste tests have been conducted with the NCRE Maize and Sorghum varieties involving more than 300 farmers families
- "Operation green maize for the hunger period" (mais de case pour periode de soudure) conducted in cooperation with TLU/Maroua involved more than 500 farmers families. The operation was quite successful and will continue in the near future with more than 1000 farmers families

III- AGRONOMIC TECHNOLOGIES AND VARIETIES RECOMMENDED BY THE NCRE CEREALS AGRONOMY UNIT - WHICH HAVE BEEN OR BEING EXTENDED TO THE FARMERS AND IMPACT (1986 - 1990)

I A- Agronomic Practices

A set of improved cultural practices have been tested by our team in several IRA substations and in farmers' fields at different locations They are included in 5 production guides on maize and sorghum which have been prepared by our team Among the technologies extended to the farmers for improved and sustained maize and sorghum production, it can be mentioned.

-Planting in line
-Appropriate plant densities (intra-rows and inter-row spacing)
-Appropriate planting dates for different zones
-Fertilization recommendation for different yield goals
-Weed control and herbicide recommendation
-Seed treatments
-Tied-ridging
-Land preparation methods
-Recommendation for crop rotation
-Methods for Striga prevention (hand pulling, use of Urea solution)

I B - Varieties selected by NCRE breeders in cooperation with our team and extended in North Cameroon.

1- NCRE Maize Varieties .

(a) lowland maize :

- CMS-8501, TZPB SR and CMS-8503 for dry grain consumption
- CMS 8704, CMS-8806 and POOL 16 DR SR for "green maize consumption

(b) Highland Maize

SHABA I for fresh and dry maize consumption

2- Sorghum Varieties .

- CS-95, CS 61 and Damougari

3- **Other crops :**

- Crotalaria caricea - recommended as a leguminous green manure for soil fertility improvement and weed suppression This species is being used successfully by MAISCAM and IRA in a crop rotation pattern
- Pigeon peas and soybeans : two leguminous grain crops for grain consumption and for soil improvement

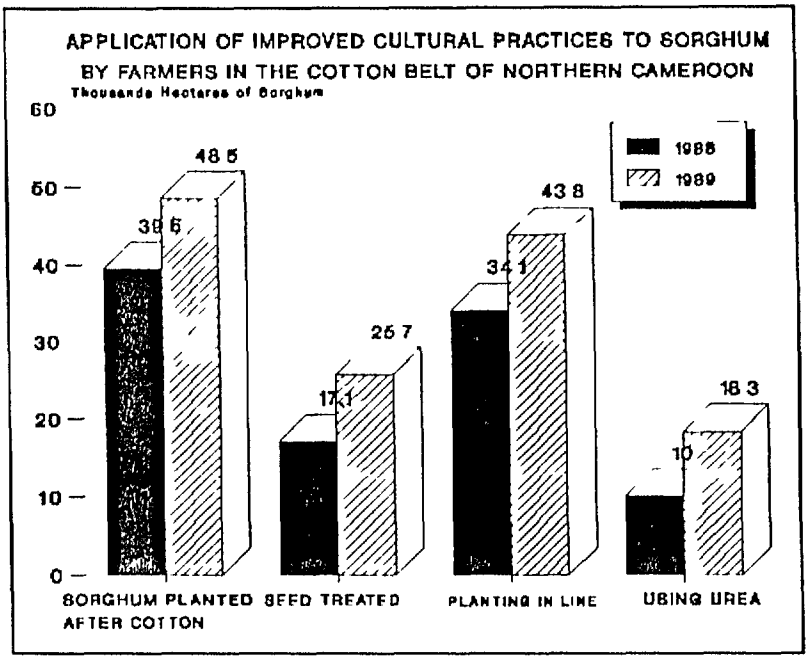
II IMPACT WITH MAIZE

In North Province, it is estimated that **more than 15 000 farmers** (including SODECOTON farmers) **are using the NCRE maize varieties** as well as **most of the recommended agronomic practices for maize.** The region involved are mostly The South East Benoue, the West Benoue, and North East Benoue areas During this period (1986 - 1990) and in the whole region, the **average yield of maize per hectare** (productivity) is estimated to have about tripled (around 3 t/ha) Some farmers' have reached up to 6 t/ha of maize in the south east Benoue area It is estimated that during this period the **area under maize production** (under SODECOTON and non SODECOTON supervision) has **nearly doubled in the North Province** (around 30 000 hectares) Furthermore due to the use of streak resistant varieties of maize - along with improved agronomic practices, the **maize yield have** been relatively **stable** in spite of some erratic rainfall patterns It is believed the maize production in the lowland savanna will further increase - partly because of favorable agroclimatic marketing conditions (New maize processing plant at MAISCAM near Ngaoundere is using also lowland maize) In summary, the prospects for maize **area expansion** and **increased** productivity are quite good for the near future - if there is some **improvement in the supply of maize seed of NCRE varieties** and the **necessary agricultural inputs** (fertilizer, herbicides and seed treatments)

In the Adamaoua province, it is estimated that more than 1000 farmers are using the recommended maize varieties SHABA I and following some of the improved cultural practices The major constraints to maize expansion in this Province are lack of seed and an efficient extension and development agency There is a great interest among the farmers to grow maize, partly because of favorable marketing conditions Since 1986, the average, the average maize yield per hectare has doubled (around 2 t/ha) in this Province

B- Impact with Sorghum

According to SODECOTON, the rate of adoption of improved practices in sorghum production in the Extreme North and North Province has increased significantly It can be seen in the figure below



4 5 IN SERVICE TRAINING

On-the-job training of IRA counterparts technicians, and other personnel in agronomy and research management has been a continuous process

- a total of 16 IRA technicians and recorders have been trained by our team during this period (1986 - 1990)
- a group of 45 extension agents of SODECOTON and MINAGRI have been trained in intensive cereals crops production
- One counterpart completed an M Sc degree in agronomy at the University of Arkansas (U S A) in 1988
- Another counterpart - went to CIMMYT (Mexico) to attend a 5 months course on maize agronomy He has been selected to study for a M Sc degree in agronomy in the U S A.
- Organization of 6 field/training days for development and extension agents

4 6 PRIORITIES FOR FUTURE RESEARCH

The following research themes should receive priority in the future

1- Continue the development of **practical conservation farming technology** for improved and sustainable cereal-based cropping systems in the lowland savanna of Northern Cameroon Based on the encouraging results obtained so far in our study, emphasis should be put on testing the minimum tillage system in farmers' fields located in different agroclimatic conditions Development of cultural practices related to minimum tillage like weed control, insect pest control mulch and residue management, fertilizer management should receive greater attention

2- Continue the study of improved fallow management including a wider range of shrubs leguminous species - which have potential for incorporation in cereal-based cropping systems Leguminous fallow as a relay crop as well as in rotation system can assist in improving nutrient cycling, organic matter, soil structure, weed suppression, biologically fixed nitrogen and mulch - and maybe striga suppression Therefore they can help achieve greater sustainability of the maize based cropping systems

3- Continue the crop rotation research (legumes grain and green manure with cereals) with and without incorporation of crop residues as a practical way to reduce chemical fertilizer input and maintain soil fertility This rotation study should also be conducted in farmers' fields under different agroclimatic conditions Economic evaluation of the different rotation patterns should be done

4- Continue to monitor the problem of secondary and micro-nutrient deficiencies in maize and sorghum on station and in farmers fields So far there has been an increas occurrence of secondary and micronutrients deficiencies (Sulphur, Magnesium, Zinc), in the cereal crops More research should be conducted in order to determine practical and economic ways to alleviate these deficiencies

5- More agronomic research should be conducted on **Striga** with maize and sorghum Emphasis should be put on testing **trap crops** (leguminous) as well as the addition of organic matter to improve soil fertility, and physical conditions and eventually suppress striga Survey on striga incidence and impact in farmers's fields in the lowland savanna should be intensified Methods of prevention against Striga like hand pulling, use of urea solution should be extended to the farmers.

5 SORGHUM AND MILLET RESEARCH UNIT

Sorghum and pearl millet are the major cereals cultivated throughout the three provinces Northern Cameroon The importance of these cereals within the region increases as one moves from south to north corresponding closely with the decrease in rainfall and shorter growing season The combined production of these crops in 1988-89 was estimated to be more than 515,620 metric tons from an area of more than 650,000 hectares in the North and Far North provinces Sorghum is grown during the rainy season (June-October) on light textured soil and constituted about 65-70% of the total production The post rainy season sorghum, locally known as "Muskwari", is a transplanted sorghum grown in heavy soil (Vertisols) during (Oct -Feb) on the residual soil moisture which constitutes about 25-30% of the total production Pearl millet is grown in the rainy season and constitutes only 5% of the total production Yield of these crops in traditional systems is very low, sorghum yielding about 750 Kg/ha and millet about 540 Kg/ha These crops are mostly cultivated by subsistence farmers who have limited resources and they rarely apply chemical fertilizers These crops are grown in rotation with cotton or groundnut, and often mixed with small proportions of cowpea or groundnut or early and late type sorghum or millet The objectives, constraints, accomplishments, training program and others are explained under 5 1 for sorghum and pearl millet breeding and under 5 2 for sorghum and millet agronomy

5 1 SORGHUM AND MILLET BREEDING

5.1 1 INTRODUCTION

The NCRE Sorghum and Pearl Millet Improvement Program was established in 1982 which stimulated the reactivation of sorghum and pearl millet breeding program after a hiatus of about eight years due to shortage of national staff Efforts from the beginning till have been directed toward development of a solid national program through short and long term breeding strategies, taking into consideration the constraints identified for the production of both sorghum and pearl millet crops in North Cameroon

The research activities during this period (1985-1990) were carried out over an area of 130,000 Km^2 ranging from 8^0 to 13^0 latitude north and covering two broad ecological zones as determined by rainfall Zone I has a rainfall range of 300-800 mm/year where both sorghum and pearl millet are grown Zone II has a rainfall range of more than 800 and less than 1000 mm/year where sorghum and maize are grown In general Zone II has more area under sorghum than maize In these zones, white grained varieties are preferred, although yellow grain varieties are important in some areas All sorghum is produced for human

consumption mainly as porridge or "fou-fou" Red grained varieties are extensively grown and mainly used for making local beer known as "Bili-Bili"

5.1.2 OBJECTIVES

The primary objective of the program is breeding of suitable cultivars/hybrids of sorghum and pearl millet that would give higher yields with greater stability across a range of enviroments These cultivars should be resistant to diseases, and pests and should have a grain quality acceptable to farmers and tolerant/-resistant to Striga and drought stress. They should also fit into the mono and mixed cropping (cowpea, peanut) pattern found in northern Cameroon

The secondary objective is the development of national man power through higher education and training abroad as well as on-the-job training in the discipline of sorghum and millet breeding

The following priorities were established in order to achieve the primary objectives

- Screening available germplasm within Cameroon to identify suitable lines to be released as cultivars or used as parents for desirable traits for future breeding programs
- Introduce and screen developed materials from international and national programs to identify suitable lines to be released as cultivars or used as parents for future breeding programs
- Screen segregating materials introduced from other research institutions where appropriate parents have been used
- Develop segregating materials from the introduced and local germplasm to identify suitable lines to be released as cultivars for different ecological zones of northern Cameroon
- To evaluate the identified cultivars for wider adaptability and stability for yield performance in the different ecological zones in north-Cameroon through multilocational testing

5.1.3 CONSTRAINTS

5.1.3.1 Sorghum Breeding

The major constraints being addressed through sorghum breeding are as follows (in order of priority)

- Lack of suitable varieties and hybrids with desirable quality and agronomic traits like early duration and resistance to drought stress (90 days maturity cycle in semi-arid zone), or medium duration (110-130 maturity cycle in sub-humid zone) with high and stable yield potential
- Development of suitable varieties resistant to Striga hermonthica for different ecological zones of northern Cameroon as most of the local varieties are susceptible to this parasitic weed

- Lack of suitable varieties and hybrids with desirable agronomic traits and resistant to various foliage diseases--like grey leaf spot (Cercospora sorghii), oval leaf spot (Ramulispora sorghicola), shooty strip (Ramulispora sorghii) and anthracnose (Collectrichum graminicola)-- and grain diseases--particularly long smut (Tolyposporium ehrenberghii) for the semi-arid zone and grain mold for the sub-humid zone of northern Cameroon
- Improvement in local varieties with desirable agronomic and quality traits (bold seed, without brown sub-coat and medium flint vitrosity) as most of them are lacking in these traits
- Lack of suitable varieties/hybrids with desirable agronomic traits and resistant to various pests particularly head bugs, midge and stem borer in different ecological zones of northern Cameroon
- Lack of technology in the transplanting of muskwari sorghum in Vertisols and in the control of weeds before transplanting are major constraints in muskwari production

5 1.3.2 PEARL MILLET BREEDING

The major constraints being addressed through pearl millet breeding are as follows (in order of priority)

- Lack of suitable varieties with desirable agronomic traits like early maturity cycle (75 to 85 days) with higher levels of yield performance and stability across a wide range of environments
- Lack of suitable varieties with desirable agronomic traits and resistant to various diseases--particularly ergot (Claviceps fusiformis Loveless), head smut Tolyposporium penicillariae Bref) and downy mildew (Scelerospora graminicola)

5 1 3 3 CONSTRAINTS AFFECTING THE WORK OVER PAST FIVE YEARS

- A major problem is the inadequate number of scientists and technicans attached to the Sorghum and Millet Breeding Program The scientist attached needs more training and motivation to get real output in this program because this program deals with three crops and wide areas of north Cameroon
- Other problems includes the lack of good physical facilities for research, the lack of cold room for keeping breeding material and the lack of adequate research equipment

5 1 4 ACCOMPLISHMENTS

With the establishment of the NCRE Project, the IRA Sorghum and Pearl Millet Improvement Program has developed into a solid national program The achievements are presented below on the basis of each sub-goals of Work Plan for the period (1986-1990)

5.1.4.1 Germplasm Collection, Evaluation and Introduction:

The breeding materials of rainy season sorghum, muskwari sorghum and pearl millet have been introduced from ICRISAT and its on-going program in Africa, other national program such as India, Ethopia, Nigeria, Zimbabwe, Zambia, Senegal, Niger, Mali, Burkina-Faso, Sudan, Chad, France, USA and Mexico to develop a solid base for the national program In all 3480 accessions of rainy season sorghum, 142 accessions of muskwari sorghum and 741 accessions of pearl millet were introduced from these resources.

The national breeding program in collaboration with ICRISAT Genetic Resources Unit evaluated 1827, 210 and 850 accessions of local Cameroon germplasm rainy season sorghum, muskwari sorghum and pearl millet, respectively during different crop seasons The muskwari and pearl millet local germplasm were also collected throughout the North-Cameroon Data were collected on morphological, taxonomic and agronomic traits and sent to ICRISAT for computer analysis to identify a range of genetic variability for various characteristics A detailed classification of these germplasm collection will be published later but at present computer data is available for reference The local germplasm is also utilized in our national sorghum hybridization program.

5.1 4.2 VARIETAL DEVELOPMENT AND TESTING PROGRAM:
5.1 4.2 1 Selection and Hybridization Program

The introduced and local materials helps us to identify genotypes with desirable traits The genotypes resistant/tolerant to Striga hermonthica (CS-95, CS-54, Framida, 82-S-51 and ICSV-1008), resistant to diseases such as grain mold (M35610, IS 3547, IS2385, IS24955, CS-251, CS-278, CS-95, MR905 and Yolobri), grain smut (MR836, MR905, S-35, CS-54, CS-63, CS-95, CS-61, CS-218, CS-210 and Damougari) and various foliage diseases (CS-34, CS-63, S-35, CS-95 CS-54, CS-130, CS-210, CS-218, MR905, MR836 and Gambella 1107) and various pests such as stem borer (IS5469, PB83661-1, IS18584, IS10795, S-35, CS-95, CS-141 and Wongtosho) have been identified through the evaluation of international grain mold, multiple diseases, stem borer and Striga hermonthica nurseries during last five years These genotypes have been used in our national hybridization program to achieve the long term objectives

In all, 327 crosses have been attempted involving local x local, local x exotic and exotic x exotic by hand emasculation and pollination and are presently in the F1 to F5 generations. The selections CS-51 to CS-338 of different maturity cycles have already been tested under Preliminary and Multilocation Trials in different zones and years in the North and Far North provinces

5.1 4.2.2 Varietal Testing Program.

In all, 172 sorghum replicated yield trials were conducted during rainy season of 1982-1990 The details, number of replications, plot size, locations, soil analysis, amount of

fertilizers used, plant density and other intercultural operations are presented in the NCRE Annual Reports, 1982-1989 The data on days to 50% flowering, plant height, plant and panicle count at harvest, panicle length, 1000 grain weight and grain yield were recorded and statistically analyzed The data on other traits like early vigour, plant count after final thinning, scores on diseases, pest, peduncle exsertion, lodging, senescence, grain traits and overall plant aspects were also recorded for all the trials The significant achievements are presented below

5 1 4.2 2 1 West Africa Sorghum Variety Adaptation Yield Trial (WASVAT-Early Duration)

Trials were conducted during 1986 to 1989 crop seasons at Guiring Research Station, Maroua and promising genotypes, namely S-35 and CS-54 a contribution of our national program were included as check varieties during 1986 to 1989 crop seasons The data on grain yield (Kg/ha) of selected entries for different years are presented in Table 1 The F test was found significant at the 1% level indicating wide genetic variability for these traits None of the entries out-yielded the check variety S-35 tested under this trial during 1985 and 1986, whereas genotype ICSV-111 IN and Nagawhite out-yielded the local check CS-54 during 1987 and 1989 crop seasons, respectively During the 1988 crop season, four genotypes namely Nagawhite, ICSV-1054, ICSV-1078 and ICSV-210 outyielded the local check variety CS-54 (Table 1)

5 1 4 2 2 2 West Africa Sorghum Variety Adaptation Yield Trial (WASVAT-Medium Duration)

The trial was conducted during 1986, 1988 and 1989 crop season at Karewa in Zone-II (North province) The local check varieties included were S-34 during 1986 and CS-95 a contribution from our nation at program in Cameroon during 1988 and 1989 crop season The data on grain yield (Kg/ha) of selected entries are presented in Table 1 During the 1986 crop season, four genotypes outyielded the local check variety S-34 but there was no significant difference in grain yield These genotypes were IS 915, ICSH-1, ICSV-1004, and ICSV-1063 These were observed to be resistant to foliage diseases but were susceptible to lodging and grain mold During 1988 and 1989 crop seasons, none of the introduced varieties outyielded the check variety CS-95 (Table 1)

5 1 4 2 2 3 Multilocation Sorghum Variety Adaptation Yield Trial (MSVAT-Early Duration-Extreme North Province)

This trial was conducted at seven locations over four years (1983 to 1986) in the semi-arid zone of North-Cameroon The mean performance of grain yield (Kg/ha) over locations and years are presented in Table 2 The selection S-35 ranked first and gave 27 14% higher yield than the local improved check variety IRAT-55, indicating a higher level of yield performance and stability across a wide range of semi-arid zones (300-800mm) of North-

Cameroon. The selections CS-54 and CS-61 also ranked second and gave 22.2% higher yield than the local check IRAT-55 and indicated a higher level of yield performance and stability across a range of semi-arid zones These selections are not only high yielders and stable in yield performance but also good from the point of view of plant type, grain quality, diseases, pests, and Striga aspects as well as for drought tolerance. These selections have already gone through agronomic studies and on-farm testing since 1986 and are presently grown by farmers.

The variety S-35 is presently grown by farmers of Extreme North province on about more than 5000 hectares in Cameroon and more than 15000 hectares in the Sahelian zone of Tchad.

This trial was again conducted during 1988 and 1989 with twenty five entries having improved selections developed by our national program including S-35 and CS-54 as check varieties at three locations with two different dates of sowing in the Far-North province. The pooled analysis of variance followed and the results are presented in Table 3. It is evident from the table that genotype C-210, Zouaye, CS-181 and CS-144 gave consistently higher yield performance over locations irrespective of date of planting, whereas the genotypes Barlang, Guedeng-Guelling, ongtosho and Gueling gave higher yield only if planted before June 10th over locations. This trial was repeated during this crop season to reconfirm the previous results for final recommendation of superior varieties S-35 and CS-54 for the semi-arid zones of north-Cameroon.

5.1.4.2.2.4 Multilocation Sorghum Variety Adaptation Yield Trial (MSVAT-Medium Duration):

The objective of this trial was to find ideal type of cultivars in sub-humid zone of (more than 800 mm) which will perform reasonably well across different locations. The trial was conducted with medium duration promising selections contributed from our national program and the local check variety YOLOBRI of the zone as well as E35-1, a check variety, over four locations in each year and over four years (1983-1986) The mean performance of grain yield (Kg/ha) of promising selections along with exotic check E35-1 over years and locations (seventeen in Benoue zone) are compiled and presented in Table 4.

The selections S-34, CS-84 and CS-95 gave more than 21% and 7% higher yield compared with the best exotic check over locations and years which indicated the higher level of yield performance and stability across a range of Benoue zone in the north province The selections S-34 and CS-95 are not only high yielders and stable in yield performance but also good from the point of view of plant type, grain quality, foliage diseases and pest aspects The selection CS-95 also proved to be resistant to Striga hermonthica (see table 6). These cultivars are presently under agronomic and on-farm testing since the 1987 crop season and offer scope for further increases in sorghum production in this zone provided the extension service will be effective to reach to the farmers

This trial was reactivated during the 1989 crop season after development of new selections Fourteen new selections along with check variety CS-95 were evaluated at three locations in the zone of the north province The pooled analysis of variance for various traits revealed that variance due to genotype and variety x loca-tion was significant at the 1% level indicating differences among genotype as well as between the locations The mean performance of grain yield and other traits of selected entries are presented in Table 5 Considering the grain yield (Kg/ha) over locations, the genotype DCSH-24 ranked first with 2402 Kg/ha followed by CS-251 (2265 Kg/ha), CS-95 a check variety (2143 Kg/ha) and CS-278 (1961 Kg/ha) These selections were observed to be resistant to foliage diseases and pests, low in grain mold scores as compared with CS-95, more than 90 days in maturity cycle, medium in plant height, at par in grain aspects with CS-95 and good in panicle exsertion

In addition, the selection CS-251 has white pericarp, whereas CS-278 has brown pericarp with white endosperm The trial was repeated during the 1990 crop season to confirm the results but data collection are still in progress

5 1 4.3 Striga Resistant and Screening of Advanced Sorghum Lines for Resistant to Striga Hermonthica

Cameroon is probably more severely affected by Striga than any other West and Central African country due to the importance of S hermonthica as a parasite of subsistance sorghum Considering its importance as a major sorghum yield reducing factor, resistant breeding programs were initiated following the crossing program among local low root stimulant genotypes and agronomically elite breeding materials during the 1983 crop season The breeding materials for this objective are presently under selection and evaluation process The results are presented in brief

Field screening is very reliable provided the Striga infestation is regular over time, the experimental area homogenous, the experimental design and criteria of evaluating resistance are appropriate Taking into consideration these factors, a farmers' field heavily infested with Striga was selected at Ndonkole near Maroua to initiate the screening of advanced sorghum lines resistant to Striga hermonthica To create a suffi-cient Striga population, Striga seeds collected from outside of this trial were added every year (1983 to 1990) before planting sorghum The national sorghum Striga nursery were evaluated in this field following the checker board design developed at ICRISAT

The performance of selected cultivars over years against Striga hermonthica are presented in Table 6 The Striga count taken at harvest for example in susceptible check CK60B indicated that the level of Striga infestation increased overtimes The population increased from 307 plants/8 m^2 plot in 1983 to 651 plants/m^2 plot (mean over seven years) in the susceptible check (Table 6) This shows that each year there was fairly a high

level of Striga infestation and identification of certain genotypes as resistant can be regarded as due to their genuine effect of tolerance and not due to the irregular appearance of Striga

Considering the overall performance over years the genotypes like CS-95, CS-35 and CS-54 confirmed their better resistant to Striga hermonthica than the known resistant check Framida (Table 6)

Out of thirty four crosses attempted between local x exotic, exotic x exotic and local x local, nine crosses presently in F6 generation have shown their superiority in high 1000 grain weight, longer panicle length and bold seed size compared with resistant check Framida during the selection program followed under this infested Striga field These are presently evaluated under the national Sorghum Striga Nursery during this crop season and results will be available by end of Jan., 1991.

5.1.4.4 Hybrid Development and Testing Program:

The objective of this program is to identify male sterile lines as well as restorers to develop superior hybrids to open pollinated varieties suitable for rainfed as well as irrigated conditions in the different ecological zones of north-Cameroon. To meet this objectives, 45 B/A pairs and 16 B/A pairs of sorghum recently bred by ICRISAT and Texas A&M University, U.S A. were introduced during 1986 to 1989 crop seasons During the crop season, 30 B/A pairs of sorghum which are adaptable and resistant to diseases and pests were maintained by selfing and artificial pollination Moreover, **125 new hybrids** were developed using these male sterile lines and restorer lines from the national program

5.1.4.4.2 Hybrid Testing Program·

Under the hybrid testing program, 12 sorghum hybrid replicated trials were conducted during the 1986 to 1989 crop seasons. The achievements are presented in brief

5.1.4.4.2.1 Cameroon Sorghum Hybrid Observation Nursery (1987-1988):

The 125 newly developed hybrids were evaluated under this nursery at Guiring, Maroua in Zone-I and at Karewa in Zone-II locations during 1987 to 1989 in different trials Four hybrids, namely DCSH-15, DCSH-34, DCSH-24, and DCSH-13 gave **13%** higher yields than check variety S-35, whereas, they gave more than **9%** higher yield than check variety CS-95 at Karewa locations over the last three years These hybrids were observed to be early in maturity, semi-dwarf to medium in plant height, possessed longer and semi-loose panicle, smaller in 1000 grain weight and at par resistant to diseases, pests, lodging and overall plant aspects compared with check varieties S-35 and CS-95

5 1.4.4 2.2 West Africa Sorghum Hybrid Trials (WASHT):

This trial was conducted from1986 to 1989 at Guiring, Maroua (Far-North) and Agri-Lagdo, Karewa (North) to find ideal type of hybrids The data on grain yield are presented in Table 1. The varieties S-35 and S-34 or CS-95 were included as local checks at Guiring and Karewa locations, respectively During the 1986 crop season, three hybrids namely ICSH-311, ICSH-5 and ICSH-159 gave more than 15% higher yields than check variety S-35 at Guiring, whereas, ICSH-228 and ICSH-231 gave more than 5% higher yield than check variety S-34 (Table 1) During the 1987 crop season, the hybrid ICSH-479 outyielded the check variety S-35 and gave only 5% higher yield at Guiring None of the hybrids outyielded the local check variety CS-95 at Karewa location (Table 1) Similarly, three hybrids namely ICSH-89002, ICSH-507 and ICSH-780 gave more than 15% higher yields as compared with local check variety S-35 during the 1989 crop season at Guiring (Table 1)

5 1.4.4 2.3 International Sorghum Variety and Hybrid Adaptation Trial (ISVHAT)

This trial was conducted at Guiring during the 1989 crop season The data on grain yield of the best entries are presented in Table 1 Considering the grain yield (Kg/ha), four entries namely Naga-white, ICSH-798, ICSH-310 and ICSH-401 gave more than 25% higher yield than the check variety CS-54 In conclusion, ten hybrids outyielded local check variety CS-54 in this trial, whereas it ranked among four best varieties

5 1.4.5 Development of Nucleous/Breeder's Seed of Promising Sorghum Lines:

- The nucleous seed of selections CS-51 to CS-338 were developed and maintained in the seed store for future use during the last five years (1986 to 1990).

- The breeder seeds of S-35, CS-54, CS-61, S-34 and CS-95 were multiplied in every crop season since 1986 and were available to all sorghum researchers as well as seed multiplication agencies in Cameroon and Tchad In all, more than 15 tons of seed were produced during last five years (1986-1990) and were supplied to all above sources as well as to farmers

5 1 4 6 Muskwari Sorghum Variety Development and Testing Program·

Muskwari cultivation is only possible in the area of Vertisols, a black clay soil which has higher water holding capacity called Karral in local language in northern Cameroon It belongs to the Durra and Caffra snowden sub-series and include many varieties The broad classification as Safrari (SAF.), Madjere (Madj), Bourgouri (Bourg), Adjagamari (Adj), Soukatari (Souk), Mandourwiere (Mand) and Soulkeire (Soulk) In all, 350

collections of these group of varieties as well as collection from Mali, Nigeria and Mauritania were evaluated and selection program were followed during off-season (Oct -Feb.,) from 1982 to 1989

In all, 14 trials were conducted during 1982 to 1989 crop season and total of 350 different selections were evaluated under different trials over eight years. The grain yield (Kg/ha) over years of selected muskeari selections are presented in Table 7. It is evident from the table that the selection Bourg.-28 gave more than 12% higher yield than the check variety SAF -40 followed by SAF 2 (8 15%), SAF -6 and SAF 7 (4 82%), Bourg -19 (3.32%) and Bulk Madj (2 69%) without any input use. These selected cultivars were observed to be early in maturiety after transplanting (85-95 days), medium in plant height (130-150 cm), medium in panicle length (15-20cm), and width (18-25cm), good in grain quality aspects, bold seed size (1000 grain weight ranged 28-42 gms) and resistant to various diseases and pests Therefore, these genotypes offer scope for further genetical and agronomic studies to enhance the muskwari sorghum production in this regions

5 1.4 7 <u>Pearl Millet Varietal Development and Testing Program</u>

Under varietal development program, in all, 741 crosses/progenies in F1, F2 and advanced generations from diverse germplasm involving local Cameroon and other West and Central African countries were introduced through ICRISAT, Hyderabad, India and Sahelian Centre, Niamey, Niger as well as directly fron University of Georgia, U S.A This material are presently under selection in different generations The selections CPM-1 to CPM-25 has already been evaluated under preliminary yield trials in different years (1987 and 1988). The best performing selections along with local cultivars have been evaluated under multilocation variety adaptation yield trials during the 1989 crop season and are under evaluation to confirm the results during the 1990 crop season.

In all, 24 replicated yield trials were conducted at Guiring Research Station, Maroua and other locations under the varietal testing program The data on various quantitative triates were recorded and statistically analysed for each experiment The achievements from these results are presented in brief

5.1.4.7.1 <u>International Pearl Millet Zone-A Trial (1983-1986)</u>:

Sixteen entries including local check Mouri were evaluated at Guiring, Maroua during 1983 to 1986 The detailed results were presented in the NCRE Annual Reports, 1983 to 1986. The varieties IKMV-8201 and INMV-8212 yielded <u>four times</u> more than local check varieties Mouri These varieties are not only high yielders but also good from the point of view of plant type, earliness and disease (downy mildew, ergot and smut) aspects and offer scope for further adaptation and agronomic studies in millet growing zones of north-Cameroon.

5 1.4 7.2 Multilcation Pearl Millet Variety Adaptation Trial (MPMVAT)-1989:

On the basis of encouraging results from 1985 to 1988 preliminary yield trials at Guiring, eighteen entries including new check varieties namely IKMV-8201 and Mouri were grown at hree locations namely Tchatibali, Yoldeo and Guetale in the rainfall zone of 300-800mm in the Far-North province The data on quantitative traits were statistically analyzed for each of the three locations as well as over locations The F test was significant. The data for grain yield and other traits over locations of selected varieties are presented in Table 8 Taking into consideration grain yield (Kg/ha), the improved short cycle selections yielded lower than local collections at Tchatibali and Yoldeo, whereas they yielded highest at Guetale location The genotype Gouzouma ranked first and yielded 1907 Kg/ha followed by Mbankara (1835 Kg/ha), Tchaaredari (1831 Kg/ha), CPM-17 (1630 Kg/ha) and CPM-24 (1679 Kg/ha) Both local checks IKMV-8201 and Mouri ranked 12th and yielded 1564 Kg/ha Most of local varieties tested in this trial are more than 95 to 110 days in maturity cycle whereas newly developed varieties were early in maturity (85 to 90 days), tolerant to ergot, smut and downy mildew These trials were repeated during the 1990 crop season on the same locations to reconfirm the results

5 1.5 IN-SERVICE TRAINING

5 1.5 1 Long Term In-Service Training (1986-1990)

1 Ten national staff members of IRA, Maroua, mostly temporary workers, have been trained in the artificial hybridization by hand emasculation and pollinating to generate national segregating materials involving local cultivars of sorghum They have also been trained in handling the breeding materials at different stages of development of varieties or hybrids
2 Mr Kenga Richard went to Texas A&M University, U S.A to complete his Master degree in Sorghum Breeding in Jan ,1986. He joined the Sorghum Program after his Masters completion in June, 1989
3 Mr Ngoko Zachee, Cereal Pathologist, left during April, 1988 to complete his Masters degree in Sorghum Pathology in Taxas A&M University, U S A He isbe expected to return by the end of December, 1990
4 Mr Djonnewa Andre left for his Masters degree in Sorghum Breeding at the University of Colombia, U S A. in Jan , 1989.

5 1.5 2. Short Term In-Service Training

1 Mr Nzoning Jean attended short term training at ICRISAT on Sorghum and Pearl Millet crops from March, 1986 to November, 1986
2 Mr Asanga Cletus, Cereal Entomologist attended the International Stem Borer Workshop at ICRISAT Headquarters during, 1987

3 Mr Djonnewa Andre, Sorghum Breeder visited West African countries during a field tour organized by ICRISAT in Sept , 1987.
4 Mr Djonnewa Andre, Sorghum Breeder attended the Regional Pearl Millet Workshop organized by ICRISAT at I.A R. Samaru in Sept , 1988
5. Mr Kenga Richard Sorghum Breeder attended the Regional Meeting on Sorghum at ICRISAT, WASIP, Kano, Nigeria in 10-12 Sept.,1989
6 Mr Bilangsou E Agric Technician attended a short term training course on sorghum and Millet Breeding at ICRISAT, India from March 22, 1990 to 22 Nov , 1990
7 Mr Beyo Jacques, Cereals Entomologist, attended a one week short training program at ICRISAT/WASIP, Kano, Nigeria during 15-22 March, 1990
8. Mr Kenga Richard, Sorghum Breeder attended a Regional Sorghum meeting at ICRISAT, WASIP, Kano, Nigeria from 10-12 Sept , 990
9. Mr. Kenga Richard, Sorghum Breeder attended the Regional Pearl Millet Workshop at ICRISAT Sahelian Centre, Niamey from 18-22 Sept , 1990

5.3. WORKSHOPS ORGANIZED BY SORGHUM AND MILLET BREEDING PROGRAM:

1 Organized the "Regional Sorghum Research Workshop for West and Central African Countries" from 20-24 Sept ,1988 at IRA, Maroua sponsored by ICRISAT/SAFGRAD We all participated and presented research papers
2. Organized the "UDEAC Sorghum and Millet Research Workshop" from 24-26 Oct , 1988 at IRA, Maroua We all participated and presented research papers for different disciplines.

5.1.7 PRIORITIES FOR FUTURE RESEARCH

At present, the Sorghum and Millet Breeding Program has been developed to a level where it can supply different types of breeding materials for different objectives throughout the semi-arid zone of West and Central Africa for rainy season sorghum as well as muskwari sorghum The following priorities should be continued

- The varietal development and testing program should continue to overcome the production constraints of sorghum and millet production like higher yield performance under drought stress conditions, resistance to Striga hermonthica, various foliage and grain diseases and pests
- The varietal development program should be also diverted to develop varieties for grain quality aspects for industrial utilization purposes such as bread, biscuits and use in breweries
- The varietal development program should be continued to develop varieties suited to both mono and mixed cropping (cowpea, peanut) patterns appropriate to different ecological zones in the north Cameroon

- Seed production and maintenance of cultivars should be continued for both sorghum and millet crops.
- The sorghum hybrid development program should be given low priority as compared to varietal development because the sorghum and millet crops are grown by traditional farmers where inputs are limitated
- The breeding program should be continued for both Zone-I and Zone-II separately as the major constraints of production are different in each zone
- To maintain this program at the present status, a senior breeder should be consulted during the crop season for three months as the national breeder is alone.

Table 1 West Africa and International Sorghum Variety and Hybrid Adaptation Yield Trials (1986-1989)

Trials	Years/ Locations	Selected Entries	Source	Grain Yield (Kg/ha)	% Increase Over best Check
WASVAT (Early)	1986 (Guiring)	ICSV-1078	ICRISAT	6750	-
		ICSV-1054	ICRISAT	6702	-
		ICSV-1065	ICRISAT	6070	-
		ICSV-82-2	ICRISAT	5706	-
		S-35 (L Check)	CAMEROON	6843	-
		Mean		5308	
		L S D at 5%		912	
		C V (%)		10 4	
	1987 (Guiring)	ICSV-111	ICRISAT	5791	7 0
		S-35	CAMEROON	5300	-
		ICSV-1083	ICRISAT	4595	-
		SPH-263	ICRISAT	5245	-
		CS-54 (L Check)	CAMEROON	5370	
		Mean		3860	
		L S D at 5%		1398	
		C V (5%)		21 9	
	1988 (Guiring)	ICSV-1054	ICRISAT	6421	13 0
		NAGAWHITE	GHANA	6345	12 5
		ICSV-1078	ICRISAT	6291	11 6
		ICSV-210	ICRISAT	5921	5 0
		CS-54 (L Check)	CAMEROON	5637	
		Mean		5472	
		L S D at 5%		290	
		C V (%)		14 3	
	1989 (Guiring)	NAGAWHITE	GHANA	7496	14 2
		CS-61	CAMEROON	7070	7 7
		S 35	CAMEROOM	6762	3 4
		ICSV-1170	ICRISAT	6745	2 8
		CS-54 (L Check)	CAMEROON	6562	
		L S D at 5%		1053	
		C V (%)		10 8	

Table 1 (Continued)

WASVAT (Medium)	1986 (Karewa)	IS 915	ICRISAT	2847	38 7
		ICSH-1	INDIA	2548	24 1
		ICSV-1004	ICRISAT	2461	19 9
		ICSV-1063	ICRISAT	2251	9 7
		S-34 (L Check)	CAMEROON	2052	
		L S D at 5%		1091	
		C V (%)		35 2	
	1988 (Karewa)	MALISOR-84-1	MALI	3911	-
		S-34	CAMEROON	3422	-
		BF80-7-7-2-1	BURKINA FASO	3111	-
		ICSV-1088	ICRISAT	3111	-
		CS-95 (L Check)	CAMEROON	4444	
		L S D at 5%		180	
		C V (%)		16 2	
	1989 (Karewa)	CS-95	CAMEROON	4311	-
		ICSV-1089	ICRISAT	3867	-
		F2-20	ICRISAT	3244	-
		CS-61 (L Check)	CAMEROON	3244	-
		L S D at 5%		795	
		C V (%)		19 5	
WASHAT (Early)	1986 (Guiring)	ICSH-311	ICRISAT	6356	20 2
		CSH-5	INDIA	6225	17 7
		ICSH-159	ICRISAT	6133	16 0
		S 35 (L Check)	CAMEROON	5287	
		DAMOU (L Check)	CAMEROON	4931	
		Mean		5228	
		L S D at 5%		1706	
		C V (%)		18 9	
	1986 (Karewa)	ICSH-228	ICRISAT	4166	7 2
		ICSH-231	ICRISAT	4027	3 4
		CSH-6	INDIA	3888	-
		S 34 (L Check)	CAMEROON	3888	
		DAMOU (L Check)	CAMEROON	2916	
		Mean		3141	
		L S D at 5%		1246	
		C V (%)		24 3	

Table 1 (Continued)

	1987	ICSH-479	ICRISAT	5970	4 8
	(Guiring)	ICSH-643	ICRISAT	5504	-
		ICSH-645	ICRISAT	5545	-
		ICSH-647	ICRISAT	5295	-
		S-35 (L Check)	CAMEROON	5693	
		Mean		4274	
		L S D at 5%		1884	
		C V (%)		26 8	
	1989	ICSH-89001	ICRISAT	7987	20 1
	(Guiring)	ICSH-507	ICRISAT	7642	14 9
		ICSH-780	ICRISAT	7542	13 4
		S-35 (L Check)	CAMEROON	6650	-
		Mean			
		L S D at 5%		887	
		C V (%)		7 9	
ISVHAT	1989	NAGAWHITE	GHANA	6225	65 3
	(Guiring)	ICSH-798	ICRISAT	5229	31 3
		ICSH-310	ICRISAT	5204	30 6
		ICSH-401	ICRISAT	5108	28 2
		CS-54 (L Check)	CAMEROON	3983	
		Mean			
		L S D at 5%		1871	
		C V (%)		30 8	

Table 2 Mean Performance of Grain Yield (Kg/ha) of Various Promising Lines of Sorghum Over Years and Locations in the Semi-Arid Zone of North-Cameroon

ENTRIES	YEARS								OVERALL	RANK	% INCREASE
	1983*	RANK	1984**	RANK	1985**	RANK	1986**	RANK	MEAN		OVER CHECK VAR IRAT-55
S-35	4020	1	2118	1	4758	1	4098	3	3748	1	27 14
CS-54	-	-	1808	3	4679	2	4318	1	3601	3	22 15
CS-61	-	-	2088	2	4611	4	4109	2	3602	2	22 18
38-3 (EX CHECK)	3490	2	1558	6	4281	5	-	-	3109	5	5 46
IRAT-55 (L CHECK)	2790	13	1209	9	4031	9	3762	6	2948	7	-
DAMOU (L CHECK)	-	-	1316	8	4262	6	3775	5	3117	6	-
OVERALL MEAN	2840	8	1390	4	4133	0	3602	3	3357	7	
L S D AT 5%	805	1	761	1	301	1	682	7	-		
C V (%)	20	44	33	3	14	14	15	20	-		

* MEAN OVER TEN LOCATIONS, ** MEAN OVER SIX LOCATIONS *** MEAN OVER FIVE LOCATIONS

Table 3 Multilocation Sorghum Variety Adaptation Yield Trial-1989 (Early Duration) Grain Yield Performance of Promising Varieties Over Date of Sowing and Locations in Far-North Province

Varieties	LOCATIONS						DATE OF SOWING				Overall	Rank
	Yoldeo	R	Soucou-ndou	R	Tchati-bali	R	First	R	Second	R	Mean	
Barlang	3697	4	3485	2	3052	2	4619	1	2516	19	3338	1
Guedeng-Gueleng	3829	3	3002	8	2847	10	4301	2	2151	20	3226	2
Wongtosho	3562	5	2958	9	3027	3	4168	3	2197	15	3182	3
Gueling	3831	2	2750	18	2950	6	4019	4	2334	11	3177	4
CS-210	3245	11	2906	15	3227	1	3775	6	2477	4	3126	5
CS-141	3552	6	2477	25	2143	22	3794	5	1654	25	2724	21
CS-218	3106	17	2581	22	2852	9	3158	22	2536	1	2847	17
CS-144	3277	9	3200	3	2629	11	3584	12	2486	3	3035	7
Zouaye	4118	1	2622	21	2622	12	3741	7	2501	2	3121	6
CS-181	3264	10	2954	10	2866	7	3618	11	2438	5	3028	8
CS-54 (Check)	2943	20	3104	4	2522	14	3640	10	2093	22	2966	13
S-35 (Check)	3214	12	3039	6	2322	19	3530	14	2187	16	2859	15
Damou (Check)	2527	22	2879	16	2072	23	2548	23	2437	6	2493	24
D1	3412		4473		2766		3550		-		-	
D2	3033		1346		2396		-		2258			
Mean	3222		2910		2581		3550		2258		2904	

D1 = First Date of Sowing D2 = Second Date of Sowing R = Rank

Table 4 Mean Performance of Grain Yield (Kg/ha) of Sorghum Promising Lines Over Years and Locations in the Sub-Humid Zone of North-Cameroon

ENTRIES	YEARS 1983+	1984++	1985+++	1986+++	OVERALL MEAN	% INCREASE OVER BEST EXOTIC CHECK (35-1)
S-34	3150	2200	2997	2314	2665	21 69
CS-95	-	-	2719	1995	2358	7 61
CS-84	-	-	2520	2205	2362	7 85
CS-63	-	2203	2452	2279	2311	5 52
E35-1 (EXOTIC CHECK)	2510	1753	2198	2301	2190	
OVERALL MEAN	2436 3	1729 5	2331 4	1914 3	2351 3	
L S D AT 5%	633 2	501 8	276 8	1010 2	-	
C V (%)	18 75	20 2	24 17	28 90		

+ MEAN OVER THREE LOCATIONS ++ MEAN OVER FOUR LOCATIONS +++ MEAN OVER FIVE LOCATIONS

Table 5 Multilocation Sorghum Variety Adaptation Yield Trial-1989 (Medium Duration)

Selected Entries	Days to** 50% Flow	1000 Grain* Weight (Grams)	Grain Yield (Kg/ha) Karewa*	Sanguere**	Overall** Mean	% Increase Over Best Check
DCSH-24	71	21 2	2138	2665	2401	12 0
CS-251	67	20 8	2370	2159	2265	5 7
CS-130	68	21 4	2027	1962	1995	-
CS-278	69	23 7	1611	2312	1961	-
CS-95 (Check)	67	22 0	1718	2568	2143	
Mean	71	20 3	1583	1880	1732	
L S D AT 5%	2 8	2 0	295	226	738	
C V (%)	2 9	6 0	37 4	24 1	30 3	

* SIGNIFICANT AT 5% LEVEL ** SIGNIFICANT AT 1% LEVEL

Table 6 Mean Performance of Selected Cultivars Over Five Years (1985-1989) Against *Striga hermonthica* at NDONKOLE, Maroua, Cameroon

Selected Cultivars	Grain Yield (Kg/ha)	% Increase Over Best Check	Striga Count at Harv (No /ha)	1000 Grain Weight (Grams)
CS-95	3526	34 6	347,577	26 75
S-35	3201	22 2	283 061	25 98
CS-54	3127	19 4	297 968	25 70
FRAMIDA (RES CHECK)	2620	-	352 179	18 86
DAMOUGARI (L CHECK)	1027	-	742,453	19 92
CK60B (SUS CHECK)	535		567 296	17 82
OVERALL MEAN	1877		525,156	20 26

Table 7 Muskwari Sorghum Variety Yield Trial (1985-1989)
Location I R A Salak, Maroua

Selected Entries	Grain Yield (Kg/ha) 1984-85	1985-86	1986-87**	1987-88**	1988-89	Mean Over Years	% Increase Over Best Check
Bourg -28	1339	3475	1108	1328	1729	1796	12 60
SAF-2	1150	3105	1168	1416	1788	1725	8 15
SAF-6	1082	3304	1251	1140	1581	1672	4 82
SAF-7	1219	2858	1135	1276	1870	1672	4 82
Bourg -19	1103	2916	1024	1296	1902	1648	3 32
Madj (Bulk)	1747	2366	1299	1218	1569	1638	2 69
SAF-40 (Check)	724	3037	1279	1459	1476	1595	-
Mean	907	2699	1134	1198	1472	1678	
L S D at 5%	632	1359	190	66	776		
C V (%)	43 5	30 8	10 5	15 5	31 0		

** SIGNIFICANT AT 1% LEVEL

Table 8 Multilocation Pearl Millet Variety Adaptation Yield Trial-1989 (Far-North Province)

Selected Entries	Days to** 50% Flowering	Grain Yield (Kg/ha) Tchatibali-**	Guetale**	Yoldeo*	Overall Mean	%Increase Over Best Check
GOUZOUMA	75	1590	2675	1456	1907	21 9
MBANKARA	76	1440	2725	1340	1835	17 3
TCHAAREDARI	77	1481	2606	1406	1831	17 1
CPM-17	55	800	3468	771	1680	7 4
CPM-24	56	1078	3043	915	1679	7 4
IKMV-8201 (CHECK)	57	790	3078	825	1564	-
MOURI (CHECK)	66	1115	2653	925	1564	-
OVERALL MEAN	64	1076	2648	1081	1602	
L S D AT 5%	47	482	765	376	544 1	
C V (%)	8 5	31 5	20 3	24 5	24 3	

* SIGNIFICANT AT 5% LEVEL ** SIGNIFICANT AT 1% LEVEL

5.2 SORGHUM AND MILLET AGRONOMY

5.2.1 INTRODUCTION

Sorghum and pearl millet are the two most important staple cereals of northern Cameroon, which covers 160,000 sq. Km between 10^0 and 13^0 N parallels in the provinces of Adamaoua, North and Far-North The importance of these crops within northern Cameroon increases as one moves from South to North, corresponding closely with a decrease in rainfall and shorter growing season. Sorghum is cultivated on light textured soils in the rainy season and on heavier soils (Vertisols) in the post rainy season The later crop is a transplanted sorghum (locally known as Muskwari) grown on the residual soil moisture Pearl millet is grown only in the rainy season on light textured soils These cereals are often grown in rotation with cotton, groundnut or in association with groundnut and cowpea Farmers rarely fertilize these crops and yields in traditional systems are low, sorghum about 700-800 Kg/ha and millet about 500-600 Kg/ha The combined production of these two cereals is estimated to be about 0 4 million tons from 0 5 million ha out of which 5% comes from pearl millet and rest is from sorghum (Rainy season 65% and muskwari 30%).

Some good work was done on sorghum and millet during 1966-1974 but no work was been done during later years (1974-1980) by IRA. However, research on cereal crops gained momentum with the initiation of the National Cereals Research and Extension (NCRE) Project in 1981 with USAID assistance and executed jointly by IRA and IITA Limited agronomic work was carried out by a cereal agronomist located in Garoua (North Province) and SAFGRAD's extension agronomist located in Maroua (Far-North Province) during 1984 and 1985

In May, 1986 a full time Sorghum/Millet Agronomist was appointed by the NCRE Project based in Maroua and systematic agronomic work on Sorghum/Millet was started Agro-nomic work on these two crops was conducted at Mouda Farm of IRA, Maroua, Ndonkole on farmers' field, Tchatibali, Guetale and Salak (Sub-Stations of IRA, Maroua) Since 1986, the research activities were expanded considerably year after year to tackle some of the major production constraints of these two crops

5 2.2 OBJECTIVES

General To develop improved agronomic practices that would lead to increased and stable yields of sorghum and millet in northern Cameroon

Specific

- Conduct agronomic experiments in different sorghum and millet growing zones of Cameroon to develop improved packages of prac-tices involving higher levels of technologies

- Develop agro-technologies suitable for small and resource poor farmers having limited inputs
- Collaborate with extension agronomists and development agencies on on-farm evaluation and promotion of promising agronomic practices and obtain necessary feed back.
- Conduct on-the-job training of the national counterparts and technicians in sorghum and millet agronomic research.

5 2.3 CONSTRAINTS

Though several factors can be identified as limiting sorghum and millet production in Northern Cameroon, the major constraints for which agronomic solutions need to be worked out are as follows

a) <u>Rainy Season Sorghum and Millet</u>

i) Low inherent soil fertility and absence of use of fertilizer Deficiencies of N and P are widespread In most cases crop residues are removed and farmers hardly use any chemical fertilizers
ii) Low rainfall and its erratic distribution over a short rainy season results in frequent moisture stress to crop growth or periodic water logging in heavy soils
iii) Striga a parasitic weed causes considerable loss to rainy season sorghum and millet
iv) Weeds of several species pose problems to crop production. Farmers are unable to control weeds due to limited hand labor available during the peak period of farming.
v) Insect pests and diseases cause considerable loss to rainy season sorghum and millet
vi) Limited use of animal traction, restricts the area that can be cultivated in the short rainy season
vii) Post harvest handling losses

b) <u>Post Rainy Season Sorghum (Muskwari)</u>

i) Limited residual moisture in the soil profile restricts the crop response to inputs
ii) Keeping the land fallow during rainy season which encourages weed growth Not only a season (rainy season) is lost but also clearing for muskwari transplanting becomes difficult
iii) Manual transplanting requiring hand labor restricts the cultivated area

5.2 4 ACCOMPLISHMENTS

The present report covers the period of 1986-1990 during which several agronomic experiments on sorghum and millet were carried out at Guiring, Mouda, Guetale, Tchatibali, Salak and Ndonkole The total rainfall per annum was within the normal range of 700-900 mm which is common in this area except in 1987 when total rainfall was 465 mm In most of the year the distribution of rain was very erratic (some days a very high

rainfall of 130mm in 4 hours and some times no rain for 15-20 days) which hampers the crop growth and yield causes losses

Soils of the area are generally very low to low in available P, very low in nitrogen and medium to high in available potassium Soils are generally sandy to sandy loam having low clay content and poor buffering capacity except Vertisols which are used mainly for muskwari cultivation

Experimental Results

A. RAINY SEASON SORGHUM

i) Plant Population and Hill Planting. In traditional farming systems sorghum and millet are sown in hills, leaving 2 to 5 plants/hill Though this practice may reduce labor time for sowing but it is not known what effect this may have on yield The experimetal results indicate that a population of 62500 to 83333 plants/ha can be suggested in most cases which can conveniently be sown in 2 plants/hill i e 80 cm x 40 cm with 2 plants/hill (62500 plants/ha) or 80 cm x 30 cm with 2 plants/hill (83333 plants/ha) The higher plant population of 83333/ha gave only 8% higher yield over 62500/ha and the difference between the two treatments was not significant Sowing 1 or 2 plants/hill also did not make any difference in the final yield in both genotype (S-35 improved sorghum and Damougari a local sorghum)

ii) Evaluation of Tied Ridging We evaluated tied ridging as a possible land management system that can reduce runoff and erosion and improve profile water content In view of the short and erratic rainfall in the Far-North Province sorghum often experiences moisture shortage Our studies have not shown much advantage of tied ridging over the conventional flat planting or simple ridges and furrows These results are somewhat contrary to the results observed in the North Province Some possible reasons for the lack of response are that the soils are flat and light textured without any major infiltration problems Soil characteristics such as texture, depth, slope and rainfall distribution determine whether or not tied ridges will give any benefit Results of the trials conducted during 1985 to 1989 are self explanatory as presented in Table 1 and 2

iii) Graded Steps of Technology on Sorghum Yield: The technology package was divided into four components viz, variety, fertility, crop management and soil management The experiment was carried out for three years and the mean results are summarized in Table 3 The improved variety S-35 did not show any advantage over the local Djigari irrespective of how the soil and crop were managed and fertility level Only fertilizer application has brought out dramatic yield increases in both genotypes Based on the results obtained in Mouda over the past three years it can safely be con-cluded that given the improved package of cultural practices the local variety can produce as much grain as the improved sorghum variety

iv) Sorghum Response to Fertilizer Under Different Cropping Systems Different cropping systems where sorghum is involved in Northern Cameroon are 1) continuous sorghum 2) sorghum following cotton 3) sorghum following a sole crop of legumes (groundnut and or cowpea) and 4) sorghum intercropped with legumes such as groundnut and cowpea The experiment is still in progress and conclusive results will be available in 1991. However, the results of the past 3 years indicate (Table 4) that to get optimum yield of sorghum under continuous sorghum cultivation a relatively high dose of fertilizer will be required (40 Kg N + 20 Kg P2 05 and K20/ha) as compared to 20 Kg each of N, P2 05 and K20/ha needed for the same or little higher yield of sorghum if it is cropped after cotton or groundnut or in association with groundnut It is worth mentioning here that soil at the experimental site is very low in available phosphorous and hence the beneficial effect of N could be achieved only in combination with phosphorous

Soil analysis data indicate that there is no significant change in soil properties under continuous cultivation and fertilizer use However, the slight increase in available N and P were observed and possibly it is due to mineralization of undecomposed organic matter with cultivation as this piece of land was brought under cultivation in 1986-87 Exchangeable Mg is decreasing progressively under continuous cultivation but the value has not reached to a critical level

v) Sulpomag as Source of S,K and Mg Sulpomag was supplied by the International Mineral and Chemical Corporation (IMC), Mundelein IL 60060, USA and it contains 22S, 32K20 and 18 MgO. In conducting the trial these nutrients were supplied either through Sulpomag or a combination of potassium chloride and Keiserite The treatments were arranged in such a way that one or two of these nutrients were absent in each treatment to enable to estimate the effect of each of the nutrients A basal dose of 60 Kg N and 30 Kg P2 05 per hectare was applied to all the treatments except in the control where no fertilizer was applied.

Two years results indicate that sorghum yield increased significantly with 60 Kg N + 30 Kg P2 05/ha application over the control But there was no significant increase in yield due to K, S and Mg applied either singly or in combination The source of these nutrients also did not show any effect on yield (Table 5) Lack of response to K and Mg is understandable from the results of soil analysis which showed that the soil has reasonably high quantities of available K and Mg

vi) Studies on Crop Mixtures and Crop Association

a) Long and Short Cycle Sorghum Association with Groundnut, Cowpea and Millet Two sorghum cultivars (a long cycle cv Walaganari of 125 days maturity cycle and a short cycle cv S-35 of 90 days maturity cycle) were intercropped with pearl millet cv IKMV-8201 (80 days maturity cycle) groundnut cv IB 66 (100 days maturity cycle) and cowpea cv IT 81 D985 (80 days maturity cycle) The crops were sown at appropriate time as per recommendation Sorghum and millet were fertilized with 40 Kg N and

30 Kg each of P2 05 and K20/ha Groundnut and cowpea were fertilized with 100 Kg/ha of single superphosphate (18% P2 05)

It is evident from the results that the yield level in general is low primarily because of low inherent soil fertility and shallow soil depth at the experimental site at Mouda However, it is interesting to note that growing a short and long cycle sorghum in association is more productive than growing them separately. The best land equivalent ratio (LER) was obtained by growing cowpea with long cycle sorghum It could be due to the fact that cowpea was planted at least one month after sorghum which provided sufficient time for sorghum to get established and also the cow- pea was harvested at least 20 days before the sorghum was harvested providing some more time to sorghum towards maturity (Table 6).

Association of cowpea with short cycle sorghum was less effective possibly due to high competition among both crops as both have very similar maturity cycle Similarly, the association of groundnut and pearl millet with long cycle sorghum was more effective than with short cycle sorghum (Table 6)

b) Sorghum-Sorghum Mixed Cropping Six experiments at three locations were carried out in 1989 and again it is being repeated in 1990 There are two sets of experiments, in one set three sorghum varieties (Damougari a local short cycle, CS-54 an improved short cycle and Walaganari a local long cycle) were planted either pure or mixed in different ratios The detail of the treatments is given in Table 7 along with the results In a second set two sorghum varieties (CS-54 an improved short cycle and Walaganari a local long cycle) were planted at two different plant densities in different ratios using 40 Kg N and 20 Kg each of P2 05 and K20/ha The N was either applied in full at the time of planting or in split doses, half at planting and remaining half at 4 weeks after planting The treatment detail is given in Table 8 along with results Results indicate that there was significant increase in yield with the application of 40 Kg N and 20 Kg each of P2 05 and K20/ha at all the three locations as compared to no fertilizer application The best result at Mouda was obtained when Walaganari and CS-54 were planted in 1 1 ratios in rows whereas at Guetale and Tchatibali the best yield performance was obtained when all three varieties were planted in mixed form or in equal proportion However, the overall yield was better when at least one long cycle and one short cycle sorghum was planted together (Table 7)

In another set of experiments, split application of nitrogen gave better results at Mouda as compared to full application at planting The mean value of the three locations indicate that a plant population of more than 62500 per hectare is not advantageous (Table 8)

vii) Studies on Striga Management in Sorghum The parasitic weed Striga (Striga hermonthica) attacks many cereals in West and Central Africa It affects all the three major cereals (Sorghum, Maize and Pearl Millet) grown in northern Cameroon, though its

occurence on sorghum appears to be more common than on pearl millet Long term agronomic studies were initiated in 1987-88 season on Striga infested field near Ndonkole on a farmer's field with the objective of identifying chemical, cultural and mechanical methods that can reduce Striga and form a basis for developing an integrated package for recommendation to control Striga

Results obtained so far indicate that early (mid June) to normal (mid July) planting allow the sorghum crop (host crop) to establish well before Striga starts germinating Though early planting did not reduce the emergence of Striga significantly but crop yield was almost at its potential (Table 9) It was found necessary to have two weedings either manually or with herbicides (first weeding 3-4 weeks and second at 6-7 weeks after planting) in order to achieve good yields of sorghum

A plant population of 45-50,000 per hectare along with at least 40 Kg N + 20 Kg each of P2 05 and K20/ha gave better yields of sorghum as compared to no fertilizer application It was also observed that emergence of Striga was significantly higher in zero-N plots as compared to 40 and or 80 Kg N/ha plots (Table 10)

Intercropping of sorghum with cowpea was found to be effective in terms of total production and less emergence of Striga Planting a tolerant sorghum variety (S-35 or CS-54) along with cowpea in the same row (alternate pocket) or in the same hill (sorghum and cowpea seeds put together) was found very advantageous over alternate row of sorghum and cowpea planting (Table 11)

Most of the herbicides such as 2,4-D, Garlon, Buctril and Paraquat were very effective in killing almost 90% of Striga plants Even spraying of 20% concentrated solution of Urea fertilizer at the 8th week of planting was effective in killing 90% of Striga plants (Table 12) Although killing striga plants may not improve the current sorghum yield it will definitely prevent the production of new Striga seeds and thus after a few years the seeds and Striga plants will be reduced to a bare minimum or will be eliminated Whenever farmers can not afford to spray chemicals or urea, hand pulling or weeding Striga plants before seed setting will reduce Striga in the long run

B PEARL MILLET

Performance of Short Duration Pearl Millet: An improved pearl millet cv IKMV-8201 and a local cv Mouri were tested at 4 different dates of planting with three plant populations A moderate dose of fertilizer (20 10 10, Kg each of N, P2 05 and K20/ha) was applied at the time of planting

Results indicate (Table 13) that late June to early July planting is the best for both the cultivars If the planting of improved cultivar IKMV-8201 is delayed beyond 15 July, a high plant density is needed in order to compensate for the low number of tillers which are produced normally by late planted millet but

in no case it is going to produce a better or equally good crop like that of the normal planted crop

A plant population of 25000-30000 plants/ha when planted up to middle of July is adequate

C. Post Rainy Season Sorghum (Muskwari)

Muskwari sorghum is grown on Vertisols (heavy clay soils) during October-February and matures on residual moisture of the soil profile Systematic agronomic work on this unique crop of north Cameroon started in 1986-87 cropping season Since then several experiments were conducted and results are summarized below.

i) Response of Muskwari to Date of Transplanting: Muskwari transplanted in between last part of September to early October recorded the highest yield Delay in transplanting thereafter has resulted in significant reduction in yield The third week of October and first week of November transplanting produced only 76 and 63% yield of the first week of October transplanted crop respectively However, the stover yield did not differ significantly suggesting that vegetative growth was normal but due to moisture stress hear the reproductive phase, the grain yield was reduced Delayed transplanting produces smaller size heads which was evident from the head weights Two years of study confirm that late September to early October is most appropriate for trans- planting of muskwari (Table 14).

ii) Response of Muskwari to Plant Population: Results of three years studies indicated that increasing plant population beyond 20000/ha, the earhead size was reduced and thus affected the total yield per unit area (Table 15) However, the higher plant populations beyond 20000/ha produced higher stover yield but were statistically nonsignificant It has been observed that under low plant population, head size is bigger as compared to those with higher plant population The wide plasticity of this sorghum to produce similar yields across different plant populations is mainly because of changes in head size which is inversely related to plant population (Table 15) Three years study clearly indicate that plant population is not very critical for muskwari sorghum and that there is no advantages of planting higher than 20000 plants/ha In fact, this low density economizes labor which is a constraint at transplanting time

iii) Response of Muskwari Sorghum to Land Management. Results of three cropping seasons (Table 16) clearly indicated that there was no significant yield response to dikes as compared to flat land management The area where the experiment was conducted is nearly flat and water logged during rainy season with poor drainage and as such the moisture status in the profile under these two land management practices was almost the same Making dikes may be advantageous in sloping land where runoff is high and marginal Vertisol.

iv) Response of Muskwari Sorghum to Fertilizer and Supplemental Irrigation: It was observed that fertilizer application without irrigation was not very effective in increasing sorghum yield Application of one irrigation of 5cm after one month of transplanting with or without fertilizer produced significantly higher yields of sorghum as compared to a control plot (farmers' practices) Application of two irrigations (5cm each) at 1 month and 2 months after transplanting along with fertilizer (30 Kg each of N and P2 05/ha) increased the yield significantly (Table 17) It must be recognized, however, that response to fertilizer was always small and inconsistent but to irrigation was definitely high This observation indicates that if the moisture in the soil is limiting, then the use of fertilizer for muskwari sorghum may not be beneficial

v) Operational Scale Testing of Sequential Double Cropping on Vertisols The potential of sequential double cropping on Vertisols by growing a rainy season crop preceeding the traditional muskwari sorghum was studied at Mouda during the 1988-90 cropping seasons During the rainy season maize and cowpea were raised using either a flat or ridge and furrow method A farmers' control i e fallow plot was also left as the fifth treatment in 1988 In 1989 two additional treatments were tested (plowed fallow and improved fallow by growing crotalaria) After harvesting rainy season crops (cowpea and maize) muskwari sorghum was transplanted either in late September or the first week of October During the rainy season the excess runoff water of the experimental area was collected in a pond which was constructed in December 1987 so as to give supplemental irrigation to muskwari if necessary

Results (Table 18) indicate that there was no significant yield difference in maize or cowpea between flat and ridge/furrow system of planting In general, muskwari yield was slightly better after cowpea rather than after maize However, muskwari yield was increased upto 50% when two irrigations were applied as compared to no irrigation

The highest net return under double cropping was obtained by growing cowpea in the rainy season and muskwari in the dry season which was closely followed by a maize (ridge/furrow) and muskwari system It is worth mentioning here that under the cowpea-muskwari system there is always a possibility to maintain or even improve the soil fertility as compared to a maize-muskwari system

5 2.5 IN-SERVICE TRAINING

1) Mr Ndikawa, the Cameroonian counterpart attended the "Striga Training Workshop" at Ouagadougou, Burkina Faso, organized by ICRISAT from 5-10 October, 1987
2) Mr Ndikawa attended a Training Workshop on "Management of Vertisols" at ICRISAT Headquarters, Hyderabad, India from 28 May to 10 June, 1989

3) Mr. Ndikawa attended 2 months English language training course at the American Language Centre, Yaounde from 23rd October to 21st December, 1989.

4) Mr. Ngue (T A) has gone for a long term (8 months) training course on "Management of Field Experiments" at ICRISAT Headquarters, Hyderabad, India (March to November, 1990)

5.2.6 PRIORITIES FOR FUTURE RESEARCH

1 Sorghum based mixed cropping and crop associations in different agro-climatic zones of northern Cameroon need to be studied in greater detail Also the impact of different crop associations on soil properties should be monitored

2. Studies on soil and water conservation practices under different cropping systems and land management practices for major soil groups in northern Cameroon should be carried out

3 Management of soils, especially degraded soils, through improved fallow system, crop covers, alley cropping, tree plantation etc in order to stabilize and sustain crop production needs special attention

4 Studies on Striga control through integrated approaches needs to be continued Efforts should be made to identify an economically viable method of controlling Striga and other non-parasitic weeds

5 The full potential of Vertisols should be exploited through double cropping, proper drainage, use of supplementary irrigation, identification of alternate crops, especially valuable/cash crops which could be substituted for muskwari

6 Use of animals for traction, small tools and implements needs in-depth study

TABLE 1 RESPONSE OF SORGHUM TO TIED RIDGING IN VARIOUS TRIALS CONDUCTED IN NORTH CAMEROON (1985-1989)

YEAR	NO OF TRIALS CONDUCTED	NO OF TRIALS SHOWED SIGNIFICANT RESPONSE	MAGNITUDE OF RESPONSE %	MAGNITUDE OF RESPONSE KG/HA
1985	4	1	19	1040
1986	6	3	28 TO 48	820 TO 1020
1987	6	4	26 TO 80	750 TO 1720
1988	4	0	0 TO 28	0 TO 293
1989	2	0	4 TO 23	54 TO 237

TABLE 2 EFFECT OF LAND TREATMENTS ON MEAN YIELD OF TWO DIFFERENT SORGHUM GENOTYPES SOWN EARLY OR LATE, MOUDA

TREATMENTS	MEAN GRAIN YIELD (KG/HA) (MEAN OF 1987,88 AND 89)				MEAN STOVER YIELD (KG/HA) (MEAN OF 1987 88 AND 89)			
	FLAT	RIDGE	TIED RIDGE	MEAN	FLAT	RIDGE	TIED RIDGE	MEAN
VARIETY S-35								
EARLY	1717	1602	1680	1660	4237	4224	4672	4378
LATE	1311	1044	1121	1159	4108	4575	4836	4506
MEAN	1514	1323	1401	1413	4173	4399	4754	4442
VARIETY WALAGANARI								
EARLY	1649	1605	1616	1623	8843	9043	10487	9458
LATE	1079	1157	1274	1170	5178	6516	6523	6072
MEAN	1364	1381	1445	1397	7011	7780	8505	7765
OVERALL MEAN	1439	1352	1423	-	5592	6090	6629	-

TABLE 3 EFFECT OF GRADED STEPS OF COMPONENT TECHNOLOGIES ON SORGHUM, MOUDA (MEAN YIELD PERFORMANCE OF 1987, 88 AND 89)

LEVELS OF COMPONENT TECHNOLOGIES			GRAIN YIELD (KG/HA)	
FERTILITY	CROP MGT	SOIL MGT	LOCAL (DJIGARI)	S-35
LOCAL	LOCAL	LOCAL	1156	1208
LOCAL	LOCAL	IMPROVED	1210	1131
LOCAL	IMPROVED	IMPROVED	1410	1190
IMPROVED	LOCAL	IMPROVED	2049	2125
IMPROVED	IMPROVED	IMPROVED	2172	2343
MEAN			1599	1599

TABLE 4 EFFECT OF CROPPING SYSTEMS AND FERTILITY LEVELS ON SORGHUM YIELD

Fertility Levels	Mean Sorghum Grain Yield (Kg/ha) Under Different Systems				
N-P2 05 - K20 (Kg/ha)	Continuous Sorghum	Sorghum After Cotton	Sorghum After G'nut	Sorghum + G'nut Associa	LER
0 - 0 - 0	769	1250	1606	990 + 566	1 09
0 -20 -20	1548	1991	1955	1091 + 532	1 13
20-20 -20	1938	2401	2282	1210 + 470	1 15
40-20 -20	2200	1618	1950	1158 + 486	1 13
60-20 -20	1826	1590	1804	1050 + 473	1 05
20- 0 - 0	1088	1639	1509	1045 + 506	1 08
20-20 - 0	1703	2017	2398	1417 + 470	1 37
Mean	1582	1787	1929	1137 + 500	

SE± For System 73, For Fertility = 107, For F x S = 193

Sole Groundnut Yield = 1215 Kg/ha, Sole Sorghum Yield = 1582 Kg/ha

TABLE 5 EFFECT OF SULPOMAG AS SOURCE OF SULPHUR, POTASSIUM AND MAGNESIUM ON SORGHUM (1987 AND 1988)

TREATMENT	GRAIN YIELD (KG/HA)		
N-P2 05-K20-S-Mg (Kg/ha)	1987	1988	Mean
60-30-30-30-25 (Sulpomag)	3020	1395	2208
60-30-30-30-25 (Non-Sulpomag)	2625	1723	2174
60-30- 0-30-25	2835	1706	2271
60-30-30- 0-25	2955	1599	2277
60-30-30-30- 0	2750	1369	2060
60-30- 0- 0- 0	2775	1638	2207
0- 0- 0- 0- 0	1950	770	1360
SE±	410	90	-

TABLE 6 YIELD UNDER SORGHUM BASED ASSOCIATION, MOUDA, 1989

Crops/Crop Association	Grain Yield (Kg/ha)	LER	Stover Yield (Kg/ha)
Short Cycle Sorghum (Pure)	1573	1 00	5281
Long Cycle Sorghum (Pure)	1390	1 00	9615
Short+Long Cycle Sorghum (1 1)	798 + 900	1 15	1875 + 4766
Short Cycle Sorghum + Cowpea (1 1)	1104 + 516	1 14	3031 + 1153
Long Cycle Sorghum + Cowpea (1 1)	1229 + 488	1 29	6069 + 844
Short Cycle Sorghum + Groundnut (1 1)	873 + 688	0 80	2995 + 1281
Long Cycle Sorghum + Groundnut (1 1)	1168 + 547	1 12	5234 + 1177
Short Cycle Sorghum + Millet (1 1)	746 + 431	0 87	1302 + 1537
Long Cycle Sorghum + Millet (1 1)	1163 + 349	1 16	6745 + 1381
Cowpea (Pure)	1185	1 00	1485
Groundnut (Pure)	1979	1 00	2365
Millet (Pure)	1084	1 00	4615
SE+ (Sorghum)	194		1083

TABLE 7 YIELD PERFORMANCE OF SHORT AND LONG CYCLE SORGHUM UNDER SOLE AND MIXED PLANTING

TREATMENT	GRAIN YIELD (KG/HA)			
	MOUDA	GUETALE	TCHATIBALI	MEAN
Short Cycle Damougari (Pure Stand)	1049	3166	1537	1917
Long Cycle Walaganari (Pure Stand)	1519	2386	2230	2045
Short Cycle CS-54 (Pure Stand)	1484	2967	1706	2052
Damougari + Walaganari (1 1 in Rows)	1317	3110	1866	2098
Walaganari + CS-54 (1 1 in Rows)	1765	3028	2226	2340
Damougari+Walaganari+CS-54 (1 1 1 in Rows)	1141	3100	2292	2178
Damougari+Walaganari (Seed Mixed and Planted in Equal Proportion)	1237	3012	1922	2057
Walaganari+CS-54 (Seed Mixed and Planted in Equal Proportion)	1088	2043	1759	1630
Damougari+Walaganari+CS-54 (Seed Mixed in Equal Proportion and Planted)	1245	3343	2317	2302
SE+	253 3	232 7	241 9	-
C V (%)	33	13	21	-
Mean Without Fertilizer	1044	2470	1738	1751
Mean With 40-20-20	1589	3342	2248	2398
SE+	198 5	327 0	206 8	-
C V (%)	26	18	18	-

TABLE 8 YIELD PERFORMANCE OF SHORT AND LONG CYCLE SORGHUM VARIETIES PLANTED IN DIFFERENT RATIOS AND PLANT DENSITIES

TREATMENT	YIELD (KG/HA)			
	MOUDA	GUETALE	TCHATIBALI	MEAN
Walaganari (62500 Pl/ha as Pure Stand)	1422	2436	2039	1966
Walaganari (83333 Pl/ha as Pure Stand)	2038	2187	1967	2064
CS-54 (62500 Pl/ha as Pure Stand)	2735	3296	1702	2578
CS-54 (83333 Pl/ha as Pure Stand)	2251	3564	1983	2599
Walaganari+CS-54 (2 1 with 62500 Pl/ha)	1955	2592	1724	2090
Walaganari+CS-54 (1 2 with 62500 Pl/ha)	2333	2924	2082	2446
Walaganari+CS-54 (2 1 with 83333 Pl/ha)	2086	2717	2404	2402
Walaganari+CS-54 (1 2 with 83333 Pl/ha)	2404	3456	2734	2865
SE±	437	314	262	-
C V (%)	35	18	22	-
Full Application of N,P and K (40 20 20)	1830	2871	2274	2325
Split Application of N (20 20 20) + 20 N	2476	2922	1898	2432
SE±	376	96	236	-
C V (%)	30	6	20	-

TABLE 9 EFFECT OF LAND MANAGEMENT AND PLANTING TIME ON SORGHUM YIELD IN STRIGA INFESTED FIELD AT MAROUA, CAMEROON, 1989

LAND MGT	GRAIN YIELD, KG/HA				1000 GRAINS WT (G)			
	EARLY	NORMAL	LATE	MEAN	EARLY	NORMAL	LATE	MEAN
LOCAL (DAMOUGARI)								
FLAT	2714	2922	1148	2261	25 51	23 06	20 92	23 16
RIDGE-FURROW	2788	3529	1005	2441	24 82	24 03	20 31	23 05
MEAN	2751	3225	1077	2351	25 16	23 55	20 62	23 11
IMPROVED (CS-54)								
FLAT	3578	3104	1280	2654	26 24	24 87	20 36	23 82
RIDGE-FURROW	3882	3634	1741	3081	26 24	26 09	21 06	24 46
MEAN	3730	3369	1510	2870	26 24	25 48	20 71	24 14
SE± PLANTING TIME		148*				0 26**		
VARIETIES		121*				0 22**		

** AND * SIGNIFICANT AT 1 AND 5% OF PROBABILITY RESPECTIVELY

TABLE 10 EFFECT OF PLANT POPULATION AND N LEVELS ON STRIGA COUNT IN SORGHUM

PLANT POPULATION (NO OF PLANT/HA)	STRIGA COUNTS/M^2 1987 NO	N40	N80	MEAN	1989 NO	N40	N80	MEAN
41666	39 6	48 7	34 3	40 9	52 8	19 8	19 3	30 6
62500	35 1	26 2	33 6	31 6	45 8	49 3	27 3	40 8
83333	47 9	36 6	39 6	41 6	34 5	37 5	34 5	35 5
SE±	--	11 81	--		--	9 7	--	
MEAN	40 8	37 2	35 8		44 3	35 5	27 0	
SE±	6 8			6 8		5 6		5 6

TABLE 11 EFFECT OF INTERCROPPING ON SORGHUM YIELD (KG/HA) IN STRIGA INFESTED FIELD, MAROUA, CAMEROON

TREATMENT	1987 (DAMOUGARI)	1988 (DAMOUGARI)	1989 (DAMOUGARI)	1989 S-35	MEAN DAMOUGARI
1 Control (No removal of Striga)	1675	1746	1244	1481	1555
2 Control (Removal of Striga)	1535	1821	1660	1548	1672
3 2,4-D Spray at 7 weeks (2 Kg a i /ha)	2085	1806	1837	2427	1909
4 Spray of Garlon (1 5% at 7 weeks)	2385	1836	2134	2704	2118
5 F A O Approach (Exclud Herb)	825	1261	1901	1747	1329
6 Sorghum/Cowpea (1 1 rows)	1525/250	1323/760	1184/450	1480/350	1344/487
7 Sorghum/Soybean (1 1 rows)	1005/160	1178/343	1150/334	1392/457	1111/279
8 Sorghum/Millet (1 1 rows)	775/845	888/115	1579/531	1232/798	1081/497
9 Sorghum/Cowpea (Same hill)	-	-	2036/364	2658/385	-
10 Sorghum/Cowpea (Same Rows)	-	-	2039/590	2139/476	-
SE± (Treatment Means)	260	70	130		
SE± (Variety Means)	-	-	58		

TABLE 12 EFFECT OF SOME HERBICIDES ON STRIGA CONTROL AND SORGHUM YIELD (KG/HA) AT MAROUA, CAMEROON

TREATMENT OF DJIGARI	1987 (DJIGARI)	1988 DJIGARI)	1989 (DJIGARI)		MEAN S-35
1 Control (Striga not controlled)	195	1772	1934	1735	1300
2 Hand Pulling of Striga	290	1881	2029	2492	1400
3 2,4-D Spray at 6-7 weeks (2 Kg a i /ha)	485	2058	2161	2518	1568
4 Urea Spray (20% solution against Striga at 6-7 weeks)	280	1824	2409	2770	1504
5 Spray of Buctril (2 l/ha at 6-7 weeks)	366	1903	2107	2278	1459
6 Ametryn/Paraquat (1 Kg a i /ha) spray against Striga	525	1917	1754	2246	1399
SE± (Treatment Means)	85	177	125		-
SE± (Variety Means)	-	-	72		-

TABLE 13 YIELD RESPONSE OF PEARL MILLET CULTIVARS TO PLANT POPULATION AND PLANTING DATES (MEAN OF 1988 AND 1989)

PLANTING DATES	PLANTS/HA, IKMV-8201				PLANTS/HA, MOURI		
	16666	25000	41666	MEAN	16666	25000	MEAN
22 July	1646	1834	1674	1718	1391	1434	1413
6 July	1527	1764	1869	1720	1653	1557	1605
21 July	1227	1582	1581	1463	1369	1598	1484
5 August	774	997	1076	949	-	-	-
Mean	1294	1544	1550	1463	1471	1530	1501

SE± For Comparison of any two means 102 5

TABLE 14 EFFECT OF TRANSPLANTING DATE ON THE YIELD (KG/HA) OF MUSKWARI SORGHUM

DATE OF TRANSPLANTING	1986-87		1987-88	MEAN
	SAF-7	BOURG -28	BOURG - 28	
18/20 SEPTEMBER	1036	1490	995	1174
5/6 OCTOBER	1260	1175	1120	1185
19/20 OCTOBER	745	1110	825	893
2/5 NOVEMBER	520	785	685	663
MEAN	890	1140	862	-
SE±	96		75	-

TABLE 15 YIELD (KG/HA) OF MUSKWARI SORGHUM UNDER DIFFERENT PLANT POPULATION

PLANT POPULATION/HA	1986 - 87	1987 - 88	1988 - 89	MEAN
10000	1350	730	1169	1083
20000	1394	780	1426	1200
26667	1575	830	1354	1254
40000	1580	645	1227	1150
50000	1340	580	1286	1068
SE±	100	105	130	-

TABLE 16 EFFECT OF TRANSPLANTING ON FLAT OR DIKED AREA (IN RAINY SEASON) ON MUSKWARI YIELD

TREATMENT	GRAIN YIELD, KG/HA				STOVER YIELD, KG/HA		
	1987-88	1988-89	1989-90	MEAN	1987-88	1989-90	MEAN
FLAT	1025	1091	1186	1101	1765	1823	1794
DIKES	965	853	1185	1001	1565	2140	1853
SE±	60	91	77	-	57	120	-
C V (%)	17	23	18	-	10	17	-

TABLE 17 EFFECT OF SUPPLEMENTAL IRRIGATION AND FERTILIZER APPLICATION ON MUSKWARI SORGHUM

TREATMENT	GRAIN YIELD, KG/HA				STOVER YIELD, KG/HA			
	1987-88	1988-89	1989-90	MEAN	1987-88	1988-89	1989-90	MEAN
CONTROL	1040	1183	1150	1124	2640	3208	2375	2741
30 N + 30 P2 05 (I_0)	935	1327	1211	1158	2850	3833	2243	2975
NO FERT (I_1)	1185	1707	1326	1406	2745	4250	2326	3107
30 N + 30 P2 05 (I_1)	1115	1783	1607	1502	2675	3625	2375	2892
30 N 30 P2 05 (I_2)	1430	2128	1937	1832	2920	4708	2604	3411
SE±	94	277	80	-	240	443	146	-
C V (%)	16	24	11	-	17	16	12	-

I_0, I_1 AND I_2 ARE NO IRRIGATION, ONE IRRIGATION (5 CM AT 1 MONTH AFTER PLANTING) AND TWO IRRIGATIONS (5 CM EACH AT ONE AND TWO MONTHS AFTER TRANSPLANTING) RESPECTIVELY

TABLE 18 MUSKWARI BASED DOUBLE CROPPING ON VERTISOLS, MOUDA (MAROUA), CAMEROON

CROPPING SYSTEM		GRAIN YIELD, KG/HA										
RAINY - DRY		1988-89				1989-90				OVERALL MEAN		NET
SEASON	SEASON	RAINY	DRY SEASON			RAINY	DRY SEASON			RAINY	DRY	RETURN
CROPS	CROP	SEASON	I_0	I_1	I_2	SEASON	I_0	$_1$	I_2	SEASON	SEASON	CFA/HA/ YEAR
MAIZE (F) -	MUSK	1501	1225	1371	1451	3899	1073	1192	1376	2700	1281	211,480
MAIZE (R) -	MUSK	2084	1260	1437	1615	3853	1003	1226	1510	2968	1342	225,160
COWPEA (F)-	MUSK	1344	1428	1863	1917	1190	1050	1265	1463	1267	1498	253,700
COWPEA (R)-	MUSK	1442	1422	1702	1872	1208	1029	1282	1506	1325	1469	205,520
CROTA (G M)-	MUSK	-	-	-	-	-	1053	1329	1492	-	1291	40,280
PLOW FAL -	MUSK	-	-	-	-	-	886	1029	1115	-	1010	27,800
NATU FAL -	MUSK	-	492	728	1485	-	683	693	783	-	811	11,880
MEAN		-	1165	1420	1668	-	968	1145	1321	-	-	-
SE± (MUSKWARI) CROPPING SYSTEM				113		-		31				
IRRIGATION				87		-		13				
CROPPING X IRRIG				NS		-		33				
C V (%)				19		-		4				

GM-GREEN MANURING, N S NON SIGNIFICANT, I_0-NO IRRIGATION I_1-ONE IRRIGATION (5CM), I_2-TWO IRRIGATIONS (5CM EACH), F-FLAT, R-RIDGE

6 TESTING AND LIAISON UNIT

6.1 BAMBUI TLU

6.1 1 INTRODUCTION

The TLU-Bambui is the original Testing and Liaison Unit Established in 1981, it is based at the IRA station in the village of Bambui (1500 m a s l) in the North West Province and is responsible for maize and rice-based farming systems research in the western highland zone of Cameroon (i e , North West and West Provinces) The unit has one expatriate agricultural economist, 4 national counterpart researchers (one in the U S for PhD training) and 3 agricultural technicians Two counterparts were trained to the MSc level (one economist, one agronomist) under the NCRE Phase II participant training program

6 1.2 OBJECTIVES

The TLU was designed 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 farmers' circumstances and problems to station researchers,
- to translate research results into recommendations to be extended to farmers

6.1 3 CONSTRAINTS

The constraints most limiting on the work of the TLU-Bambui during the last 5 years included

- Inadequate vehicle support (i e , too few, and inappropriate vehicles),
- Insufficient cash flow, especially in the last 2 years,
- Delays in departure of national counterparts for MSc training, and then the simultaneous absence of all 3 counterparts in the U S for 2 years,
- Lack of adequate field lab facilities

6.1 4 ACCOMPLISHMENTS

By the end of 1985, four years of extensive TLU on-farm varietal testing had led to the identification of several new maize and rice varieties for recommendation to farmers in large parts of the western highlands A number of these varieties were

already being extended by MIDENO, UNVDA and the Community Development Project Bafut, and being adopted by farmers An initial fertilizer recommendation was also available for maize in two mid-altitude sub-zones

TLU-Bambui on-farm research from 1986 to 1990 encompassed surveys and on-farm trials Surveys were of two types· rapid rural appraisals (diagnostic) and resource monitoring (descriptive). Trials (both maize and rice) were of 3 types exploratory (diagnostic), refinement (site specific and regional trials) and verification (farmer managed) The trial program comprised 3 major themes varietal testing, soil fertility management and cropping patterns.

1986

Maize NxP response Site specific (4 reps) nitrogen and phosphorus response trials were set out on 14 farms in 3 sub zones in the North West Province This was a follow-up of the same trial in 1985 In the Ndop Plain, there was a 73% maize yield response to 75 kg/ha of nitrogen, but a small negative response for the associated groundnuts No responses were observed to phosphorus - In the Eastern highlands, where yields were generally low, maize responded slightly to N (MRR=59%), but not to P - In Bali, a problem soil area, maize yields increased 58% to 75 kg N and 77% to 60 kg P

Maize+groundnuts cropping pattern The effects of varying maize plant density at 2 fertilizer levels on crop yields in a maize+groundnut intercrop were investigated in on-farm trials in Ndop Plain, Bamenda Plain and the Western Province Plateau (**table 1**). The three plant densities used were 26666, 40000 and 53333 plants/ha, and the fertilizer levels, 0 and 400 kg/ha of 20-10-10 compound fertilizer The trial was planted on 21 farms in the 3 zones.

Table 1· The effect of maize plant density at 2 fertilizer levels on maize grain yields (kg ha^{-1})

Maize density	Bamenda -F*	Bamenda +F	Ndop -F	Ndop +F	West Province -F	West Province +F
53,333	1762	5237	2948	5635	1537	5882
40,000	1606	4629	3450	6667	2366	5630
26,666	1742	4137	2636	5576	2133	4508

*** -F = no fertilizer +F = 400 kg/ha 20-10-10**

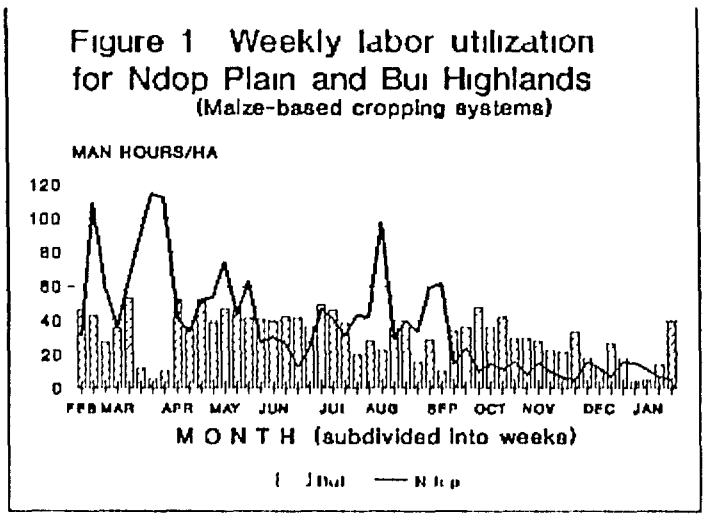
Maize yields responded positively to increasing plant density, especially when fertilized Groundnut yields responded negatively, if at all Optimal densities for unfertilized and fertilized maize were 40,000 and 53,333 plants per hectare, respectively

Rice variety trial in the Mbaw Plain The Mbaw Plain is a remote rice growing area in the north eastern corner of the North West Province Problem of access during the rainy season, prevented the TLU from entering the Plain prior to 1986 following minimal road repairs, the first on-farm rice variety trials were introduced in 1986 Of 5 new varieties and a local variety, CICA 8 and CISADANE had the highest yields (38% and 30% above the local check) and best farmer rating

1987

Survey of maize-based cropping systems in the Ndop Plain, NWP (1150-1300 m a s l) This was the principal research operation in 1987 Twenty-four farmers were visited daily by village-based enumerators, who collected data on labor utilization crop production farm sales and market prices This information was supplemented by field observations including soil and plant tissue sampling for analysis description of planting configuration and measurement of field size The TLU staff also interviewed the farmers about the cropping history and cultural practices on their maize fields

Mean total labor utilization for the maize-based cropping system (which included a 2nd season bean crop on some farms) was 1838 man-hours per hectare (figure 1) Labor requirements were highest for the land preparation/planting and weeding operations Total harvest labor was much less than that for weeding, but, restrictions on the timing of the harvest resulted in a higher labor constraining peak



Wives provided most of the labor (41%), followed by children (31%) and the husband (14%) Farmers used hired labor for only 5% of the total labor input (figure 2)
With mean yields of 1 973 kg/ha for maize, 53 kg for groundnuts, 77 kg for cocoyam and 39 kg for bean the market value of the maize intercrop per hectare was assessed at 141 562 CFA (figure 3) and the net return to farm family labor
amounted to 61 CFA/man-hr Mean total crop sales from the farm equaled 131,227 CFA (figure 4)
Maize+ groundnuts stepwise trial

At this point, the TLU had a preliminary farmer recommendation for the mid-altitude zones that included changing the maize variety, planting density, and fertilizer rate However, when faced with multiple component recommendations, especially those requiring increased cash outlays, farmers will often adopt only part of the package

Figure 2 Distribution of total labor utilization on monitored fields

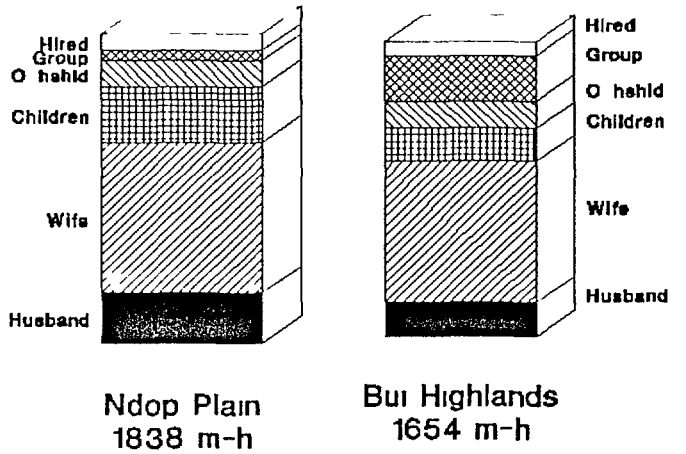
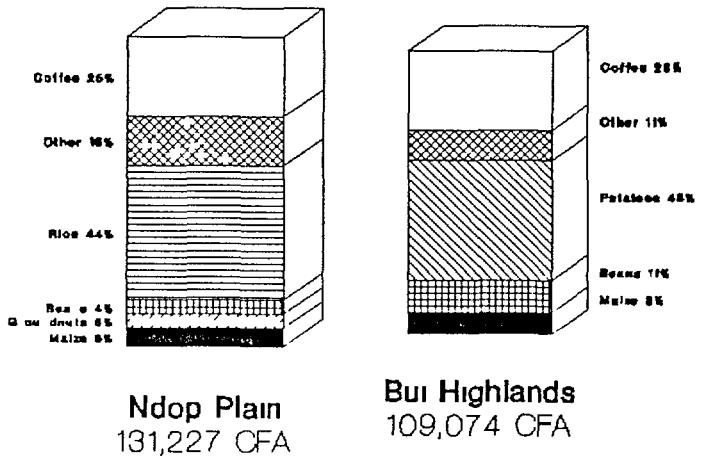


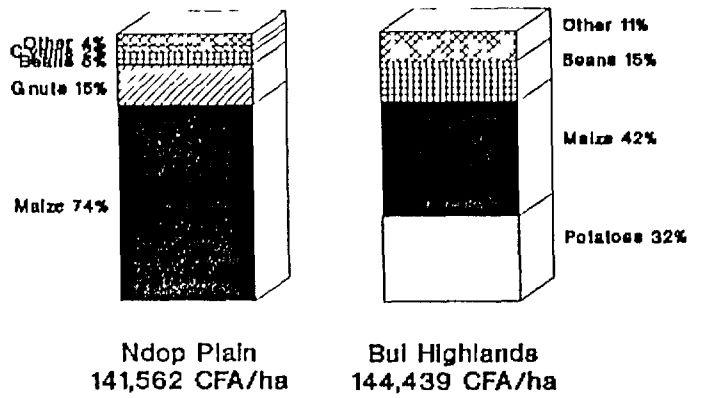
Figure 4 Distribution of crop sales



Ndop 1987 and Bui 1988

A step-wise trial was designed to examine the effects of partial adoption The treat-ments rep-resented the stepwise adoption of an improved maize variety (Kasai I or COCA), 50 kg N, 25 kg P and an increased maize plant density (20,000 to 40,000 plants/ha), with the first treatment representing the farmers practices and the last treatment, the full recommended package

Figure 3 Distribution of total market value of monitored field crops



1987 prices

In the Ndop Plain (21 farms x 2 reps), there were profitable maize yield responses to variety (Kasai), nitrogen and increased maize density In Bamenda, profitable responses were observed for variety (COCA) and nitrogen

Maize-rice cropping system trial Rice farmers in the Menchum Valley (NWP) typically leave their rice paddies in grass fallow during the first half of the rainy season (March-July), before transplanting the rice in August (to be harvested in December/January) Meanwhile, they plant maize on upland fields in March, and harvest it in July

In an attempt to intensify the system, improving the land use efficiency and reducing labor, the TLU designed a trial to examine the potential for planting a maize crop in the rice paddy prior to the rice crop The maize-rice cropping pattern was tested under 4 fertilizer regimes, and compared with the normal grass fallow-rice pattern

This trial was carried out on the same 4 farms for 3 years, to investigate the long term effects on maize and rice production and on disease progression The results are presented in table 2

Table 2 Effect of cropping pattern and fertilizer rate and timing on maize grain yield (kg ha^{-1}), rice grain yield (kg ha^{-1}), and net revenue (CFA ha^{-1}) in the Menchum Valley, 1987-89

Pattern/ Fertilizer	1987 Maize	1987 Rice	1988 Maize	1988 Rice	1989 Maize	1989 Rice	Total Maize	Total Rice	Net Revenue (1)
Maize->Rice/									
200 -> 0	2913	4190	4601	5770	3874	5267	11,388	15,227	1,511,410
0 -> 200	2668	5334	3060	5775	3799	4872	9,527	15,981	1,489,750
100 -> 100	3348	4925	4029	5767	5074	4614	12,451	15,306	1,559,460
200 -> 200	3204	4753	4124	5559	5109	4713	12,437	15,025	1,529,230
Grass->Rice/									
0 -> 200	-	4350	-	5233	-	4793	-	14,376	996,320

(1) Shelled maize and rice paddy prices = 40 and 70 CFA/kg, respectively
Fertilizer cost = 50 CFA/kg

Over a three year period, rice yields were unaffected by replacing the grass fallow with a maize crop, while planting maize increased net revenue from the system by an average 526,142 CFA/ha, a 53% increase over the traditional single-crop system Maize averaged 3 8 t/ha and rice 5.1 t/ha in the Maize -> rice system, compared to a mean of 4 8 t/ha for rice in the grass -> rice system

Rice variety trial (Mbaw Plain) In follow-up variety trials in the Mbaw Plain, ITA 222 proved to be the highest yielder (5 7 t/ha), while being rated first among the six tested varieties by 8 of the 9 participating farmers However, the steadily worsening rice market situation is forcing the majority of farmers to abandon rice production in the Mbaw Plain

1988

Survey of maize-based farming systems in the Bui Highlands, NWP (1400-2300 m a s l) This survey was virtually identical to the yearlong resource monitoring survey of the Ndop plain, only this time it was carried out in a high altitude zone, and involved 20 farm households

Labor utilization in maize-based cropping systems in the Bui highlands was found to be more evenly distributed over the year than in Ndop Plain (figure 1) Land clearing, tilling of the soil and ridge-making are all done during the dry season (November-February) By February, the land is ready for dry-seeding of potatoes, followed by planting of maize and beans in March. The maize matures in late September to November, when the

rainy season is nearing its end There is less urgency in harvesting the maize in a timely manner than at lower elevations, where the harvest period coincides with the height of the rains

Mean total labor utilization was 1654 man-hrs/ha Wives accounted for most of the work (43%), followed by children (20%), farmers' cooperative work groups (14%) and the husband (10%) Very little hired labor was used (4%)(**figure 2**) The most labor intensive operations were harvesting & carrying (32%), weeding (28%) and tilling/ridge-making (21%) Mean yields for maize, potatoes and beans were 1259, 1207 and 161 kg/ha, respectively. Mean total market value of the maize-based crop association was 144,439 CFA (**figure 3**) and net returns to farm family labor was 59 CFA/man-hr Mean earnings from the sale of crops amounted to 109,074 CFA (**figure 4**)

Maize+beans yield constraints (exploratory) trial (Bui Highlands) Exploratory trials on 16 farms in Bui examined the effects of nitrogen (N), phosphorus (P) and maize plant density (D) on the productivity of a maize/beans intercrop An additional 2 treatments permitted a comparison between the maize variety being extended to farmers in Bui (COCA, a variety selected for the mid-altitude zone) and the local variety (derived from the Kitale Synthetic II variety, introduced into the area from East Africa in the 1960's)

There was no difference in yields between COCA and the local variety This confirmed previous years' on-farm variety trials of the TLU Maize yields responded positively to N, P and increased maize density, although only slightly to the latter (**table 3**) Bean yields increased with N, were unaffected by P and diminished in response to the higher maize plant density Total revenue, used as a measure of the intercrop, was increased by N and P, but not by density

1989

Maize+beans nitrogen x phosphorus levels trial (Bui highlands) The exploratory trial in the Bui Highlands (1988) showed nitrogen and phosphorus to be yield limiting factors Accordingly, an on-farm NxP levels experiment was designed and implemented in 1989 to estimate a response curve to N and P, and to determine economically optimal application rates for farmers The experiment took the form of a regional trial in the terminology of Hildebrand and Poey (1985), with 10 treatments (full factorial arrangement plus a zero check treatment) and an RCBD design (2 replications per farm) It was planted on 4 farms in each of 5 villages in Bui Division (20 sites), at altitudes ranging from 1640 to 2200 meters

Table 3. Effects of nitrogen phosphorus and maize plant density on mean maize grain yield (kg ha^{-1}), bean grain yield (kg ha^{-1}) and total revenue (CFA ha^{-1}) (plot size 24 m^2).

	Maize Yield[1]	Bean Yield	Total Revenue
Nitrogen			
0 kg/ha	2120	470	133,000
100	3060	540	174,000
% change	+ 44%	+ 15%	+ 31%
Phosphorus			
0 kg/ha	2270	490	141,000
120	2910	520	166,000
% change	+ 28%	+ 6% (NS)	+ 18%
Maize density			
20,000 plts/ha	2430	530	152,000
40,000	2760	480	155,000
% change	+ 14%	- 10%	+ 2% (NS)
SE	± 76	± 11	± 3,300
CV(%)	33	25	24

1 Mean grain yields for COCA and Local maize varieties were 2550 and 2470 kg ha^{-1}, respectively

Use of diammonium phosphate (DAP) and urea, combined with the cool temperatures and a spot application method led to apparent ammonia toxicity at most locations No responses to N or P were observed However, the explanatory power of several collateral variables (slope, position on slope, erosion score and altitude) was demonstrated The trial was to be repeated in 1990, on the same farms

High altitude maize variety trial (Bui Highlands) The results of TLU on-farm maize variety trials in the Bui Highlands (above 1500 m) from 1984-85 demonstrated that no IRA variety yielded more than the local cultivar Recent trials by the MIDENO adaptive research agronomist on Trial and Demonstration Centers (TDC) at Dzeng (2200 m) and Mbiyeh (2000 m) confirmed these findings

The NCRE/IRA breeder had been screening a highland population for the previous 2 years and provided seed to the TLU for limited on-farm testing in 1989 The justification for putting the new varieties out on-farms at this early stage in their development was the lack of suitable on-station trial sites for the breeder to adequately evaluate genetic stability across environments As it is, the breeder is obliged to use the Mbiyeh MIDENO-TDC as his principal high altitude breeding site

Two new (pre-) varieties (High Altitude Population or HAP/nicknamed "Happy", and Pool 9 Synthetic) were tested against the local variety and COCA in a randomized complete block design

with 4 replications per site The trial was planted on 11 farms and one TDC (Dzeng) Because of a shortage of seed for the new varieties, they were tested separately on 5 farms each, and together on one farm and the TDC Fertilizer was applied at the rate of 100N-120P_2O_5 In all cases, the maize was intercropped with beans

HAP (46% above local variety yields) performed relatively better than Pool 9 (16% above local), although it was planted on poorer sites (23% lower mean site yields) The trial was to be repeated in 1990

Mid-altitude maize variety trial (Bamenda, Ndop, West Province) Four years of on-farm maize variety testing in three mid-altitude zones in the western highlands had established COCA and Kasai I as the outstanding varieties released by IRA/NCRE breeders However, neither variety possessed resistance to maize streak virus (MSV) The NCRE/IRA highland maize breeder released 2 MSV resistant varieties (MSR and Synthetic 1) for on-farm testing in 1989, following 2 years of agronomic trials on-station The unique disease resistance of these varieties justified the resumption of on-farm variety testing in the zone.

The trial consisted of 5 treatments the 2 new entries, COCA, Kasai I and the farmer's local variety, all intercropped with groundnuts, arranged in a RCB design with 4 replications, planted on 24 farms in the Bamenda Plain, Ndop Plain and West Province "Haut Plateau" Fertilizer (300 kg/ha of 20-10-10) was applied as a sidedressing at 1 month after planting (mimicking the farmers' practice that has been proven to be very effective)

The maize yield results are presented in **Table 4.**

COCA ranked first in yield on 9 of the 24 farms and first in the combined analysis for each subzone, as well as, for the overall combined analysis On average it was 1 ton higher yielding than the local variety MSR, Synthetic 1 and Kasai I were not different from each other, but outyielded the local variety by 0 6 tons There was a significant site by variety interaction effect, with the improved varieties showing yield superiority only on farms with a mean yield (environmental index) above 2 tons The ranking of the 4 improved varieties remained much the same across environments

Table 4: Maize grain yields (kg-ha^{-1}) for two new mid-altitude varieties (MSR and Synthetic 1) compared with yields of COCA, Kasai I and the farmers' local variety.

Maize Variety	Z O N E Bamenda	Ndop	West Prov	Mean
COCA	2418 a*	5228 a	4728 a	4551 a
MSR	2153 ab	5174 a	4180 b	4256 b
Synth 1	1956 b	5068 a	4248 b	4207 b
Kasai I	1934 b	5067 a	4212 b	4189 b
Local	1876 b	4143 b	3670 c	3568 c
SE	137	169	156	98
CV (%)	26.5	21 6	23 4	23 2
Prob-level	0.04	0 00	0 00	0.00
Farmer yield	2566	3438	3724	3325

* DMRT (p=0.05)

Farmer managed maize trials (Ndop Plain) The TLU provided Kasai I seed to agricultural extension agents to distribute to farmers About a month after the farmers planted the seed, the TLU went around pegging sample plots (mean size = 73 sq m) and providing 20-10-10 fertilizer to the farmers at the rate of 250 kg/ha to be applied only to the sample plot Aside from maize variety and fertilizer rate, all management decisions were left to the farmer (e g , planting date, maize density, crop association, weeding frequency and timing, timing and method of fertilizer application, etc)

The TLU arranged to harvest the Kasai I plot on each farm, plus a nearby sample plot of the local variety, representing the farmer's traditional technology Kasai I outyielded the local variety on all the farms (n=22), with a mean yield margin of 84% (1855 to 3409 kg/ha)

Irrigated rice variety trial (Menchum Valley) Several improved rice varieties have been released by IRA/NCRE and adopted by large numbers of farmers These include ITA222 and CICA8 They are high yielding and disease resistant, with long, bold grain types However, the major constraint faced by farmers is their inability to market the rice Price is one problem, grain quality is another The imported Thai rice tends to be long and slender, a more attractive rice for urban consumers

In 1989, the NCRE rice breeder provided the TLU with new varieties having better grain qualities (long, slender, translucent) for testing on farm One new variety, TOX 3145-34-2-3, yielded 12% less than ITA222, but was preferred by all 11 farmers having the trial The trial was to be repeated in 1990

Minikit maize trials Since 1983, the directly implemented TLU trials have been supplemented by "maize trial minikits" The minikit is an innovation of the TLU, designed to increase the

number of farmers exposed to new maize varieties , while providing important farmer feedback Basically, it is a trial-in-a-bag, containing seed, fertilizer, measuring string, plot labels, instruction sheet, observation sheet and pre-addressed envelope

The minikits have been distributed to extension agents of MIDENO/PDA (NWP) and UCCAO (WP) at an average rate of 300 per year They are planted by the farmer under the supervision of the extension agent, who records the necessary observations over the season, plus farmer's comments, on the observation form, and mails the form to the TLU

New maize varieties tested in minikits have outyielded the local varieties by 5-25% (figure 5) Farmers expressing preference for the new varieties outnumber those preferring the local variety 3 to 1 (figure 6)

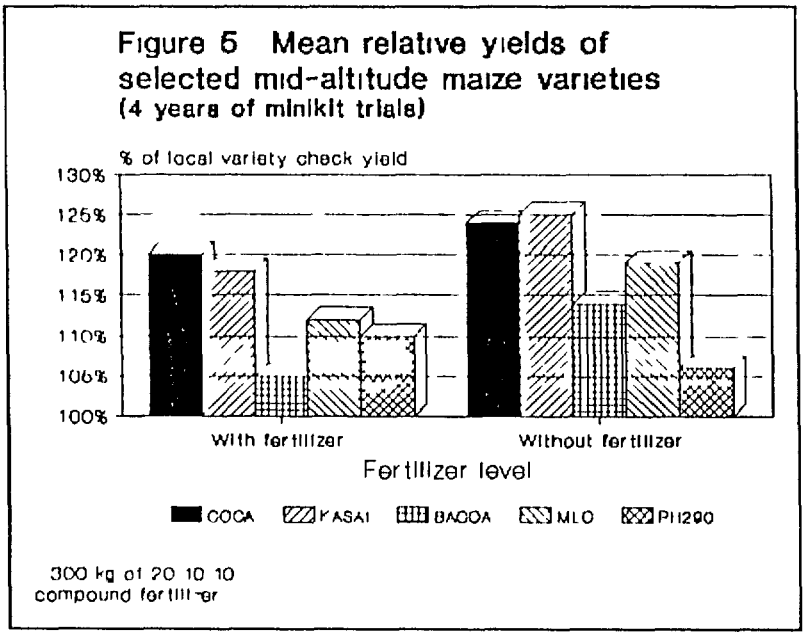


Figure 5 Mean relative yields of selected mid-altitude maize varieties (4 years of minikit trials)

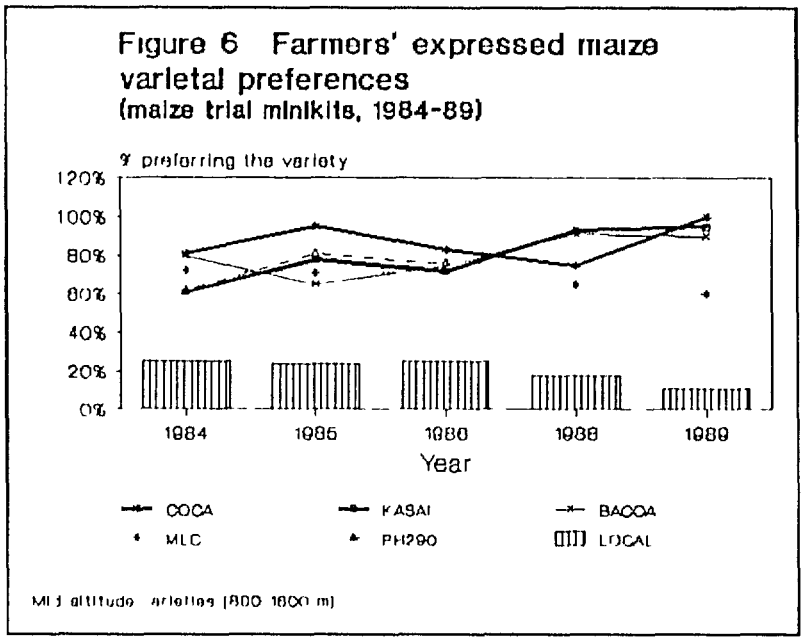


Figure 6 Farmers' expressed maize varietal preferences (maize trial minikits, 1984-89)

1990

Results for 1990 on-farm research are not available at this writing (September 1990)

Farmers maize storage loss survey Both rapid appraisals and formal surveys have consistently shown maize storage losses to be of primary concern to farmers Storability ranks very high among the maize characteristics used by farmers in their assessment of new varieties The new varieties have been demonstrated to behigh yielding, and are well received for their taste and cooking qualities However, farmers regularly complain that the large denty grains do not store as well as the small flinty grained local varieties

The TLU, in collabor-ation with the FAO Food Loss Reduction Project (FLRP), is sampling maize from 60 traditional farmer stores, and assessing losses using gravimetric methods Farmer maize use patterns are also being observed The objectives are to assess real storage losses, to identify and characterize the insect and fungal agents responsible for the losses, and, to estimate the economic loss

Maize+beans nitrogen x phosphorus levels trial (Bui Highlands) A continuation on the same farms of the same trial from 1989

High altitude maize variety trial (Bui Highlands) A continuation of the same trial from 1989

Mid-altitude maize variety trial (Bamenda, Ndop, West Province) A continuation of the same trial from 1989, with 2 added varieties. early white and ATP (acid tolerant population).

Maize+beans exploratory NxPxDensity trial (Ndu & Fundong Highlands) This is identical to the yield constraints trial carried out in 1988 in the Bui Highlands It is being implemented in 2 new high altitude zones in Donga-Mantung and Fundong

Mid-altitude farmer managed trials A continuation of the farmer managed trials initiated in 1988, but extended to new areas including Bali, Bamenda Plain and the West Province High Plateau

Irrigated rice variety trial (Menchum Valley) A continuation of the varietal trials in 1989, with the same varieties

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
Meppe Francois (agronomist)	Maize production course	IITA
Ngwa Thaddeus (technician)	"	"
Samatana Marc (economist)	On-farm research training workshop	UCD

Every year for the past 5 years, agricultural schools in the area have sent students to work with the various units at IRA-Bambui (including the TLU), as a part of their practical training The participating schools include University Centre Dschang, ITA-Dschang, the Regional College of Agriculture (RCA-Bambili) and the Technical School of Agriculture (TSA-Bambili) The students range from terminal year junior technician to 4th year "ingenieur agronome" The TLU received between 1 and 3 students each year The students work with the TLU from 1 to 3 months, and prepare comprehensive written reports of their activities as a part of their academic requirements

6 1.6 PRIORITIES FOR FUTURE RESEARCH

The number one priority for the next 5 years is to rapidly turn over greater research responsibilities to the national counterparts This includes responsibility for research planning, design, implementation, analysis and interpretation

The TLU-Bambui will be seeking more cost-efficient methods of testing new varieties and agronomic practices This is especially critical, if IRA is to sustain its on-farm research program after USAID funding is terminated One promising avenue involves a modified minikit trial approach

Soil degradation through over-cropping and soil erosion is a major constraint in large parts of the western highlands, where land is becoming ever scarcer and farmers crop land with slopes of up to 50% Increasing fertilizer costs and lack of cash will force farmers to depend more than ever on so-called "organic" soil fertility management practices The TLU will concentrate on several such practices, including

- Alley-cropping establishing erosion controlling hedgerows on the contours, and,
- Improved fallows a planted fallow using soil improving leguminous species

The TLU will continue to test new maize and rice varieties on farms, as long they represent enhanced productivity or have specific improved characteristics that are desired by farmers Examples of the latter for maize are flinty grain type, yellow as well as white grain color, short plant height, disease resistance, good ear husk tip cover, tolerance to acid soils and earliness For rice long, slender, translucent grains to better compete with the imported rice in the marketplace.

Adoption and impact studies will also be an important element of the research program for the next 5 years

6 2 EKONA TLU

6 2.1 INTRODUCTION

The Testing & Liaison Unit (TLU) was established at Ekona in mid-1986, and is responsible for the Coastal Humid Forest Region of Cameroon The TLU functions as an interface between IRA and the extension service of the Ministry of Agriculture, channeling information and resources in both directions Within its own research program, it has developed baseline food-crop data, tested the new NCRE maize varieties and IRA cassava varieties under diverse farmers' conditions, done diagnostic studies of soil management, weeding and storage problems, and collaborated with NCRE researchers based at Nkolbisson and Dschang to carry out necessary on-station research in maize selection, storage, food-crop agronomy and sustainable soil-management techniques

6.2 2 OBJECTIVES

The TLU works to improve food crop production of smallholders in South West Province through diagnosis of agricultural constraints and opportunities, testing of improved varieties and agronomic cultural practices, and informational liaison between the extension service and IRA Research in 1986-90 focussed on (1) provision of baseline data on smallholder agriculture to guide IRA research in food crops and soils, (2) on-farm testing of NCRE maize and IRA/IITA cassava varieties, (3) diagnosis and costing of farmers' land and labor management practices, (3) soil and weed management trials on-station, and (4) 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 localized research groups (focus villages)

6.2.3 CONSTRAINTS

The NCRE Project came to Ekona just before the national economic crisis made it impossible for IRA to undertake new hiring or physical infrastructure creation Thus many facilities available elsewhere in the Project (office, lab, storage and drying space, furnishings, support staff) have been lacking or provided directly by the Project at extra cost IRA Centre Ekona has done all it could to remedy these deficiencies. Ekona, which is ecologically very different from Yaounde, is the only NCRE site without a Cereals agronomist on-station. Ekona is also unusual in that the second agricultural season is nearly as important to farmers as the first, as a result, the Ekona TLU works a double year and has difficulty finding time for complete data analysis or staff leave On the other hand, this provides an advantage in doubled information

Other difficulties have included (1) inadequate up-to-date technical information to develop sustainable agriculture and storage programs, (2) lack of timely and sufficient improved planting materials of maize seeds and cassava cuttings for farmers, (3) bad roads, communications and fragmented administrative centers, affecting liaison with farmers and extension, (4) difficulty of forming farmers' groups to facilitate field work and information dissemination, and (5) harvest of on-farm trials by farmers prior to a set date of harvesting

6 2.4 ACCOMPLISHMENTS

6 2.4 1 Farming Systems Surveys of South-West Province

This series of surveys, undertaken from 1986-88, was designed to overcome a complete absence of information on the agricultural systems and research needs of the province The surveys included compilation of secondary data, interviews and joint survey with the extension service, preliminary zoning by ecological criteria, formal questionnaires to random samples of a total of 393 farm households in 72 villages representative of the zones, and in-farm interviews, soil sampling and field descriptions for one to two food-crop farmers per village. The results have been published in four divisional reports which have been provided to 140 local, regional, and national agricultural and planning offices, IRA researchers in all food-crop programs, and requesting international researchers and planners (USAID, IITA, IBRD, ODI, universities) Within IRA, they are known to have influenced the research orientation of the Root & Tuber, Plantain, and of course Cereals Programs

South West Province, which accounts for the majority of smallholder production in the Coastal Region, is extremely varied, annual rainfall from 1 800 to 9 800mm, three primary soils types (volcanic, sandy sedimentary and granitic), eighteen indigenous ethnic groups and immigrant groups totalling 30% of the population, cultivated land at altitudes from 0 to 2500m asl, virgin forest and permanently cultivated areas 23 agro-eco-zones were identified, of which 17 were surveyed, the others being a day's walk or more from roads and of no commercial importance for the foreseeable future[1] Zones were differentiated according to soils, rainfall, major crops and cropping system, and land preparation methods.

Six conglomerate zones were identified as of major importance in terms of present production and population These are the high-density cocoa zone of Kumba Corridor (KC), the commercial-smallholder Lower Volcanic (LV) zone, the granitic, productive but little commercialized zones surrounding Mamfe Town (Mamfe), the sandy sedimentary cassava-egusi zones (Sands); the densely populated Manyu Highlands, and the Mountain Forest zones Together, these account for 84% of the economic value of food

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[1] Only one, Upper Mbo, has demographic importance

crops, 82% of caloric value and 75% of farming households in the province. The TLU has focussed on the four lowland zones, which include 64% of economic value, 66% of caloric value, and 58% of farmers, represent the four major soils types of the province, and vary greatly in cropping systems

KC farmers plant dense beds of mixed maize, taro, cocoyam, and groundnuts inside their cocoa trees LV farmers plant maize, taro, cocoyams or vegetables in monocrop or intercropped with each other and some other crop, usually on the flat Mamfe farmers on the heavier soils of the south plant dense mounds of taro intercropped with maize, cocoyams, water yams, groundnuts and egusi, northern ones center mounds on a cocoyam or yam and cassava on the side, intercropped with maize and egusi In the Sands, the lower-rainfall south plants cassava/yams with maize and egusi/groundnuts, usually on mounds, while the high-rainfall Sands II plants egusi mixed with maize, cocoyams or yams on the flat, usually planting cassava later

The two excluded conglomerate zones have highland systems The Manyu Highlands' is similar to Dschang's, and its farmers look to that city for markets and inputs They are characterized by dense mixed cropping of aroids, maize and beans, usually on steep, often denuded slopes The Mountain Forest zones grow little but cocoyams and plantains, for which there is little appropriate IRA technology yet These zones plant mostly under forest shade, leaving the natural cover to protect the slopes

Among food crops, plantains are both the highest contributor to monetary value (29%) and the principal source of sales earnings (34%), across divisions They are followed, and in some zones superseded, by cocoyams (Xanthosoma, 19% and 16%) These are also the crops that farmers across the province perceive as having the greatest field losses, 40% for cocoyams (mostly to root rot) and 20% for plantains (to borer weevils and nematodes, before the black sigatoka epidemic began in 1988) Plantains and cocoyams are trucked from all over the southern half of the province to Douala and outside the country.

Maize, taro, cassava and yams follow these two in economic value; cassava and maize outrank them in caloric value, cassava providing 34% and maize 18% of total calories

Maize is important in all the super-zones except the Sands and Mountain Forest, but is usually commercialized fresh, due to storage and drying problems It is sold primarily to Douala traders in the LV and local markets elsewhere Stem borers and streak virus are major field problems, and weevils cause large storage losses (37% by 4-5 months)

Cassava is most important in the Sands and Mamfe, both with strong garri-making industries that provide extra female employment. From the Sands, it is exported in large quantities to Douala and other countries Aside from generalized low levels of mosaic virus, bacterial blight and anthracnose, there are localized problems with mealy bug (Akwaya, and by 1988, Sands) and tuber rot (Bangem and parts of Kumba Corridor)

Taro is found primarily in the LV and Mamfe, the longer-growing forest types were preferred to the new Ibo type beyond Fako but increasingly are losing ground In Manyu and Ndian, both types of taro were seen or reported to have root rot, though much less so than for cocoyam

Yams are very important to a minority of farmers in most lowland zones, others plant few or none because of the hard work involved, as well as seed problems D rotundata is more common in the south, and D alata in the north

The primary companion crops are egusi melon (Citrullus lanatus), which is an excellent cover crop and of commercial importance in the Sands and Mamfe, and groundnuts, important primarily as a relish and soil-enhancer Cowpeas are not important in the lowlands, and true beans are rare Egusi production is reduced by at least a third by post-germination beetle attacks which may be controllable by seed treatment

Soil management problems are rapidly developing in the more densely populated areas, with the exception of the recent volcanic soils, and constrain population increases elsewhere In the LV, Sands(I) and KC, fallows have dropped to 0-2 years, with average fallow-to-cultivation ratios of 0 9, 1 2 and 0 5 respectively The LV soils remain productive, but many overused KC fields have texture, pest/disease and fertility problems

Most farmers own their own land, through traditional right or purchase and inheritance The land situation is tightest in the KC, LV and Sands I, where the majority of farmers are immigrants and there are large plantations It is unclear whether this limitation of access is greater than that related to labor Cash payments for manual clearing represent about 80% of cash inputs to agriculture, and the clearing months are the peak for family labor Most of the province is too rocky, hilly or forested for tractor use, and animal traction is ruled out by tsetse fly

Forty-nine percent of food crops by economic value are sold, and 88% of farmers sell at least some food crops However, in Manyu and other remote zones, most of the produce is sold to consumers within the village itself Amounts sold and numbers selling are closely related to the size of attainable markets The state of the roads are a major constraint to increasing production in Mamfe, the Manyu Highlands, most of the Mountain Forest zones and many minor zones Most farmers have cocoa and coffee, but food crops were more important cash sources except in KC even before the suspension of cocoa payments.

Cash inputs to agriculture are almost entirely limited to labor payments The money is saved in local ethnic- or kin-based tontines, which are convenient, safe and comprehensible to the farmers These are sometimes merged with labor exchange groups, and are usually gender-specific Commercial improved seed is non-existent Fertilizer supplies in local cooperatives before the crisis were limited but seldom exhausted due to extremely low demand Chemicals were used in the small amounts distributed by

extension for cash crops, and sometimes were applied to food, seldom with the necessary safety precautions About 9% have ever used fertilizer on any food crop, 12% manure, and 9% an insecticide, herbicide or pesticide Maize and plantains are the primary recipients of each Manure is often applied to home garden crops to scare off animals, not to fertilize, and even the cash crops rarely receive fertilizer

Women are the principal managers and workers in food crops (other than plantains) in the north and west of the province, but men share some of the work in the commercialized south, and usually manage the food farms in Nigerian immigrant families Men work with tree crops, plantains, and yams, usually in one- or two-crop systems Extension workers deal mostly with men, although this is changing somewhat as IRA provides useful food crop technology for them to extend

The survey series led the Ekona TLU to expand its maize/cassava variety and fertilizer testing program to include research work on improved biological soil management techniques, labor requirements for land clearing and preparation, post-harvest drying and storage problems of maize, food markets, and extension to food-crop farmers, particularly women All these themes are represented below

6.2.4.2 Variety Assessment

On-farm testing of improved varieties of maize and cassava has gone on since first season 1987 to evaluate their adaptability potential to the diversified environments of South West Province and assess their acceptance by consumers Eighty researcher-managed, farmer/researcher implemented and 340 farmer-managed (minikit) trials have been carried to completion from first season 1987 to first season 1990 and second season 1989 respectively. The improved maize varieties CMS 8501, CMS 8503, Suwan 1 SR Y, DMR ESR Y, and Ndock 8701 showed their superiority over the local in yield, resistance to maize streak virus, sweetness when consumed green and good texture in corn fufu Their main shortcomings were susceptibility to bird damage, due to their poor ear cover aspect, and weevils, relative to the local yellow variety Three other varieties (CMS 8507, CMS 8611 and CMS 8602) were dropped after trial

Similarly the improved IRA cassava varieties (8017, 8034, and 8061) outyielded local cassava by 2 to 2 5 times, tested across all zones, had better tolerance to cassava mosaic virus, were harvested earlier, and made excellent waterfufu and good garri. Their shortcomings were rotting if harvested later than 1 year after planting in some zones, poor cookability in the snack-food form, and too much branching, creating problems of harvesting and shading other companion food crops

Maize varieties

Table 1. The effect of N-P-K application on maize yield (kg ha^{-1}) from on-farm trials, Ekona (1988 - 1990)

Treatment	1988		1989		1990	
	1	2	1	2	1	Mean
CMS 8501 F0	2558	2664	2996	2138	3816	2834
CMS 8501 F1	3562	3350	3430	3351	3972	3533
CMS 8503 F0	2408	2676	-	2506	-	2530
CMS 8503 F1	3372	2925	-	3097	-	3131
Suwan1SRY F0	-	2490	-	2196	3258	2648
Suwan1SRY F1	-	3856	-	3725	4600	4060
Ndock 8701F0	-	2697	2918	-	-	2808
Ndock 8701F1	-	3680	3806	-	-	3743
DMR ESR Y F0	-	-	2798	1752	2734	2428
DMR ESR Y F1	-	-	3211	2227	4072	3192
Local F0	1833	2154	2270	2009	2631	2179
Local F1	2333	3052	2506	3032	4171	3019
Mean	2678	2954	3000	2603	3657	

Fo = 0-0-0 kg ha^{-1} of N-P-K
F1 = 80-40-40 kg ha^{-1} of N-P-K in 1988 and 1989 but 60-30-30 kg ha^{-1} in 1990

CMS 8501 - a late, sweet variety with white flint kernels, has a wide spectrum of adaptation and can give maize yield advantages of up to 40% over local without fertilizer It is the best variety in LV in first season but not in second season due to the shorter rain period It is sensitive to acidic soils as exemplified by its poor performance on our on-farm trials at Mamfe It makes an excellent fufu The variety most tested in minikit form, farmers of all zones report higher yields and good acceptability, but failure (lower yields than local) has occurred in a fifth of cases in most zones under farmer management 8501 is ready for multiplication and distribution to farmers.

CMS 8503 - an intermediate variety with white dent kernels, it does better than CMS 8501 under poorer environments, but worse in others It makes good fufu

Suwan 1 SR Y - a late variety with yellow flint kernels, sweet and preferred for green consumption It has a high yield potential but has not been tested for as many seasons as CMS 8501. It is anticipated to flood the green maize markets of Douala due to its high yields, sweetness and good appearance However, it has shown yield variability under researcher management and failed to perform as well as local in over 15% of minikit returns from granitic and sandy soils

Ndock 8701 - a late variety, sweet with white flint kernels, it is high yielding, highly rated in fufu making, and was second to Suwan 1 SR Y in green maize evaluation It could be an excellent substitute for CMS 8501 but due to seed unavailability has not yet been adequately tested to determine its yield stability and acceptability. Minikit returns from the sole season of distribution gave contradictions that need to be resolved

DMR ESR Y - an early/intermediate variety with yellow flint kernels. In 1990 first season DMR ESR Y was the first green maize available in Kumba market due to its earliness in maturity, giving excellent profits to the farmers In Mamfe zone in 1990, it gave the highest mean yield of 3192 kg ha^{-1} compared to 1740 kg ha^{-1} for local, and a similar yield trend was observed in 1989 Thus, DMR ESR Y may have better tolerance to acid soil and be a potential variety for Mamfe zone

Highland varieties - the only important maize-growing highland zones in South West Province are remote from Ekona The TLU has thus restricted itself to sending out minikits of varieties released by IRA-Bambui Kasai, MSR 85, Coca and Bacoa Kasai and MSR 85 averaged 60-70% higher perceived yields, but with considerable risk Palatability ratings were low for all varieties, with the taste of Kasai being preferred, and both MSR 85 and Kasai were judged to be worth more than the local in the market

In summary, in the first season, since maize is grown predominantly for green consumption, Suwan 1 SR and DMR ESR Y are recommendable varieties because both have yellow colored kernels which are attractive to consumers Additionally, Suwan 1 SR has good sized cobs with sweet kernels, whereas DMR ESR Y due to its earliness in maturity captures the high prices at the beginning of the season. In the second season, drying is not a problem, and more dry maize is produced for fufu making The recommendable varieties for this season are CMS 8501, Ndock 8701, CMS 8503, and possibly DMR ESR W, which we have not yet been able to test. These varieties are preferred because of their yields, white color and soft endosperm Since second season is a short growing season the intermediate/late maturing varieties (CMS 8501 and Ndock 8701) should be treated cautiously

Cassava varieties

Cassava yields in South West Cameroon are low due to a combination of low soil fertility and use of disease susceptible and low yielding local cassava varieties Therefore adaptive research on cassava varieties x fertilizer x cropping system was carried out on farmers' fields during the 1987 through 1990 crop seasons across the 4 key zones of South West Cameroon

The 1987-88 results showed that the improved cassava varieties 8017, 8034 and 8061 outyielded the local variety by 2 to 2 5 times (Table 2). This was further confirmed by the results obtained in 1988-89 where 8034 yielded 68% higher than the local at Yoke station Additionally, the 1989-90 on-farm trials showed that the improved varieties outyielded local when grown as mono

and/or intercropped with maize across all zones Maize intercropping did not affect cassava yield significantly

In 1989-90 additional adaptive research was carried out on the improved cassava x fertilizer x cropping system The results showed that 8017 outyielded 8034 by 9% averaged across all zones The modified yield stability analysis revealed that 8034 was superior to 8017 in the poor cassava environments (Sands), whereas 8017 was superior to 8034 in better cassava environments (LV and KC)

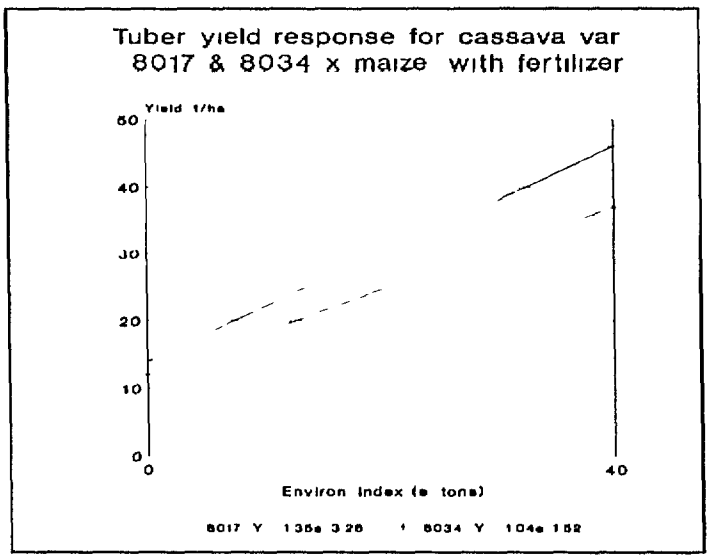


Figure 1

In the LV zone N-P-K (80-40-40 kg ha^{-1}) did not affect either maize or cassava yields significantly whereas, in Mamfe the maize yield was increased significantly by N-P-K application while cassava yield was depressed In all zones cassava yield was higher when intercropped with maize + fertilizer than the yields of mono cassava + fertilizer (Table 3) Furthermore, 8017 showed constant superiority over 8034 when both varieties were grown in association with maize + fertilizer (Fig 1)

Table 2 Cassava variety intercropped with maize yield of cassava by zone 1987/88.

Variety	Zones			Mean
	LV (2)	Sands (3)	KC (3)	
8017	22 8	21 0	21 9	21 9
8034	19 5	18 0	17 6	16 5
8061	13 0	18 7	17 9	18 3
Local	16 4	6 8	6 8	10 0
Mean	17 9	16 1	16 0	

LSD 05 = 6 1
CV (%) = 21%

Table 3 1989/90 - Summary of maize & cassava yield (t/ha)

TREATMENTS	Lower Volcanic			Kumba Corridor			Sands			Mamfe			Overall		
	MZ	CS	*	MZ	CS		MZ	CS		MZ	CS		MZ	CS	
8034 F_0		20 3	BC*		23 1	B		24 1	A		25 7	ABC		23 8	B-23 3
8017 F_0		19 2	BC		24 1	AB		24 6	A		33 7	A		26 1	B
8034 F_1		22 2	BC		25 2	AB		25 5	A		23 5	C		24 6	B
8017 F_1		24 6	AB		31 9	AB		26 3	A		25 6	ABC		26 5	B
8034+Mz F_0	2 5	21 5	BC	2 3	24 1	AB	1 8	30 5	A	1 5	26 8	ABC	2 1	25 5	B
8017+Mz F_0	2 6	25 2	AB	2 1	23 1	B	1 4	24 8	A	1 3	32 6	AB	1 9	23 7	B
8034+Mz F_1	3 2	16 6	C	2 6	28 7	AB	2 1	29 5	A	1 8	24 9	BC	2 4	25 4	B
8017+Mz F_1	2 6	30 5	A	2 6	34 0	A	1 6	30 5	A	2 6	30 4	ABC	2 4	31 7	A
Mean	2 7	22 5		2 4	26 8		1 7	27 0		1 8	27 9				
CV(%)	16	16		31	26		23	25		20	15			26	

*Durcan multiple range test (P=0 05)

6 2.4.3 Soil Amendment

6 2.4 3.1 Fertilizer Trials and Marginal Returns

Low soil fertility, due to impoverished basement materials, burning of residues during land clearing, and/or shortened fallow periods, is one of the major constraints to food crop production in South West Province Soil analysis results from the 4 key zones (1987-1990) show that of the key zones, the Lower Volcanic is rich in N, P, and K, Kumba Corridor is low in P, the Sands are deficient in N, P, and K, while in Mamfe, soil in mounds and ridges is generally satisfactory in N, P, and K, but flat surfaces are low in all these, as observed from the soil profile pits and Farming Systems Surveys In some Mamfe sites we had high acidity and aluminum toxicity which led to total failure of the on-farm maize trials

This situation has led us to focus on soil fertility amendment options. Work on chemical amendments (fertilizer) has been on-going since 1987, and both biological results and socio-economic evaluation point to the desirability of including other options Some work on legume rotation began in 1986, alley cropping in 1988, and legume intercrops, improved fallows and mulches in 1989

In the on-farm trials, the response of maize to N-P-K application varied from season to season across the 4 key zones In first season 1987 N-P-K application significantly increased maize yields, especially for CMS 8501, in the Sands zone but not

the LV In second season, the improved maize varieties CMS 8611 and CMS 8602 were badly damaged by stem borer, cutting grass and domestic animals and therefore, N-P-K application did not affect maize yields significantly

In 1988 first season the yield differences due to fertilizer application were in general non-significant, due to theft, animal damage, and shading by big trees It was not worthwhile to apply N-P-K even in the Sands where the plots were overwhelmed by weeds and snail damage However, in the second season N-P-K application increased maize yield significantly The highest mean yields of over 3600 kg ha^{-1} were obtained from Suwanl SR and Ndock 8701 with fertilizer

In 1989 N-P-K application increased maize yield significantly in Mamfe and the Sands but not in the LV and KC In the second season results showed significant yield increase due to fertilizer application even in Lower Volcanic and Kumba Corridor In 1990 first season the response to N-P-K application was significant in all 4 key zones The 1990 maize yield results were atypical of the previous years' results in the different zones because (a) the rains started late thus planting was delayed, (b) some farmers unlike in the past used mixed IRA maize varieties in lieu of local, (c) we had unusually heavy rainfall in July and August, causing heavy ear rotting These results lead us to conclude that N-P-K application is needed across all zones in the second season in order to optimize the biologic yield of maize, whereas in the first season N-P-K application should be limited to Mamfe and the Sands

In 1987 second season, at Yoke Station (Sands), maize yield increased significantly due to N single application but not due to P or NxP interaction, the yield advantage due to nitrogen over the check was 82% In 1990 first season on-farm trials single applications of N and P did not affect maize yield in KC due to the highly heterogenous nature of the environments (CV = 36%) In the Sands nitrogen increased maize yield significantly but phosphorus had no effect Complete analyses will be done after the 1990 second season crop harvest

The N-P-K time and rate of application trials at Yoke (1987-1989) demonstrated that maize biologic yield was significantly increased with increase of N-P-K rate of application from 40-20-20 to 160-80-80 kg ha^{-1} However, the marginal rates of return were 7 2, 8 6, and 5 6% for the 40-20-20, 80-40-40, and 160-80-80 kg ha^{-1} of N-P-K, respectively Therefore 40-20-20 kg ha^{-1} of N-P-K was the optimum level and preferred because the differences in marginal rate of return from 40-20-20 to 80-40-40 kg ha^{-1} was only 1 4 and even went down to -3 0 when the rate was increased to 160-80-80 kg ha^{-1} Considering the limited capital of the farmers they should apply N-P-K at 40-20-20 kg ha^{-1} in the sedimentary sandy soils The time of N-P-K application results demonstrated that N-P-K should be applied at 4 weeks after planting which coincides with the first weeding period

Farmers in SWP seldom use fertilizer, even on commercial crops. In the baseline surveys (1986-88), 10% of farmers had ever used fertilizer on a food crop In the impact survey (1990), 15% had used it, but only 5% were still doing so Most objected to spending money on it Such expenditure, while much lower than for labour for land preparation, comes immediately after the latter in the agricultural calendar, when cash resources are at their lowest point

In order to evaluate the economic efficiency and risk of fertilizer use in the province, the TLU carried out economic analysis of the 80 on-farm maize variety and fertilizer trials harvested since 1987 Fertilizer rates were 0-0-0 (F_0) and 80-40-40 (F^1) N-P-K ha^{-1} in 1987-89, and 0-0-0 and 60-30-30 N-P-K ha^{-1} in 1990 Effects on the local variety and on the only IRA variety constant across all trials (CMS 8501) were analyzed

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

These advantages varied by zone and season (Table 4) In KC, in first season, the improved variety and fertilizer gave rates of return of 58% and 28% respectively, but only 26% and 8% in the second season In the LV zone, the improved variety and fertilizer gave 16% and 33% advantage, respectively, in first season, and 23% and 9% in second season

Due to the small number of trials per season (<20) in the KC, Mamfe and Sands zones, only an elementary form of risk assessment (% of trial replications in which net benefits were negative) was used to evaluate the technologies within recommendation domains For example, in KC the risk associated with applying fertilizer was 58% on the local and 50% on CMS 8501 in first season, but in second season, the risks were only 30% and 10%. The risks associated with using CMS 8501 instead of the local variety, without fertilizer, were 8% first and 30% second seasons, respectively, while the risks of variety switch with both varieties fertilized were 25% and 40% (Table 5).

Table 4: Advantages (ratios of net benefits) of variety and fertilizer by zone and season 1987-1990

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

Table 5· Risks of using CMS 8501 and Fertilizer in 1987-90 on-farm trials by zone and season.

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

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

1 Farmers in the LV zone should plant CMS 8501 without fertilizer, and if they have to plant the local maize they should consider applying fertilizer

2 The same recommendation as in 1, applies to farmers in the four key zones combined CMS 8501 without fertilizer has a higher average net benefit than local without fertilizer. The average of the lowest net benefits for local with fertilizer is higher than the average of the lowest net benefits for local without fertilizer Overall, the averages of the lowest net benefits for the technologies recommended above are higher than the averages of the lowest net benefits for the farmers' practices

6.2.4.3.2 Farmers' Soil Management Practices and Biological Soil Amendment

Since 1989, the unit has focussed attention on diagnostic studies of farmers' soil management methods in order to suggest and evaluate locally acceptable biological techniques for sustaining fertility These have included rapid appraisals and monitoring of land preparation and weeding activities, weed/fallow appraisals, soils analysis and farmers' yield studies, some of which are still going on The results are as follows

The general pattern is to slash, uproot, and burn residues at least a month before planting during the main first-season land preparation KC farmers incorporate weed residues and burn crop residues and sticks Few others incorporate There are variations in every zone in extent of burning, usually due to residue quantity and woodiness whether a full burning is done across the field, or the weeds are heaped in a few places and burned In the second season due to wet plant residues and continuous rainfall the residues are mulched to suppress weeds by shading in the LV, and incorporated inside beds/mounds in KC and Mamfe

The most common weed is Sorghum arundinaceum followed by Chromolaena odorata, the former in the more fertile, less acidic soils and the latter, in the more acidic ones Farmers weed late The first weeding occurs from 6-10 weeks after planting, and a second weeding for long cycle crops comes at 5-6 months Weed growth is usually too slow in the sandy soils, including most of Mamfe, to interfere with the early maturing crops, and late or no weeding at all in these zones is logical In the volcanic soils (LV and KC), weed growth is extremely rapid, despite burning, and even at four weeks after planting the weeds compete strongly with maize Cover crops (egusi melon and groundnut) are the most efficient non-chemical means of control, egusi growing better in first season and groundnut, in most zones, in second season

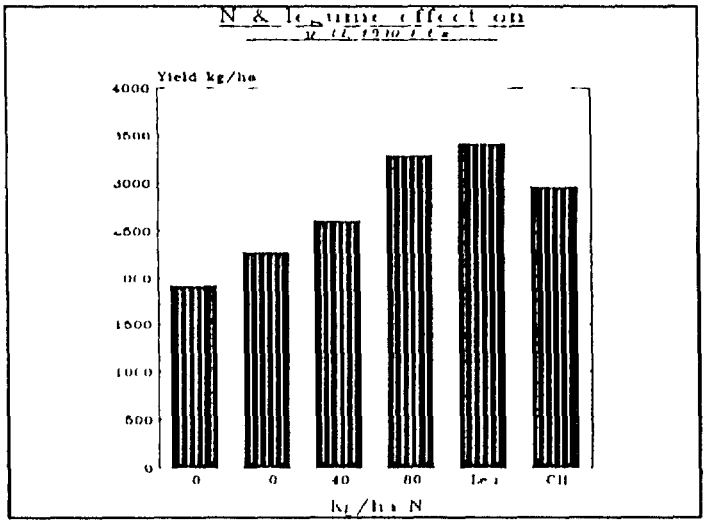
The incorporation of residues and preparation of mounds or beds apparently reduce weed growth Mounds and beds provide significantly better fertility and texture for plant establishment and growth than flat planting in most zones. Those and the large numbers of stumps and saplings extant in the fields make major field modifications such as those necessary for alley cropping or row planting expensive

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

Women, men, paid labour, njanggi (labor exchange) and even children all do land preparation There is no distinct gender specific activity, but the extent of labour input to each activity varies with gender On the whole women provided about 35%, the men 32%, njanggi 24%, paid labour 23% and children 12% The LV and KC zones used more family labour, 59% and 73% respectively, than the other zones, while the Sands and Mamfe zones used more non-family labour, 61% and 58%

The need of soil amendment through properly designed crop association and rotation, residue management, mulching/green manuring and/or alley cropping can not be over-emphasized To this effect, the Unit has established legume adaptability screening trials (14 species), maize groundnut rotation, and alley cropping using Leucaena leucocephela and Gliricidia sp in the sedimentary sands of Yoke Station The objective was to determine the N-input potential of the legumes and to identify promising species for introduction to farmers' fields in forms that will fit their cropping systems and labor constraints Additionally, collaborative research with the Nkolbisson Lowlands Cereals Agronomist has been conducted since 1989 on short fallow management using Sesbania Sesban in lieu of natural fallow (grassy), in-situ green manure production using Cassia spectabilis, and cassava + maize + groundnut association and rotation (see his section of the report)

In the maize-groundnut rotation trial, groundnut reduced the nitrogen requirement for maize by 50% The alley cropping results showed significant maize yield increase due to nitrogen application and mulching with leucaena and gliricidia Leucaena mulched plots gave the highest maize yield (3 4 t/ha) followed by 80 kg ha^{-1} N fertilized plots (Fig 2) Currently leucaena and cassia spectabilis are being tested on some farmers' fields



The legume species selected from the screening trial were pigeon pea (local), Desmodium distortum, Teophrosia vogelii, and Crotolasia anagyroides Local pigeon pea had the highest dry biomass (10 2 t/ha) and the highest nodule formation (9 ml/plant) Crotolaria anagyroides in spite of its high nodule formation and vigorous seedling establishment was badly attacked by Fusarium wilt The maize seedling vigor from the plots mulched with pigeon pea, desmodium, teophrosia, and crotolaria are highly rated Final analysis will be given at the end of the season

In 1990 first season a weed control trial on maize was carried out at Yoke The treatments included roundup, arlan, almazine, 2,4-D, hand weeding 5 WAP, 3+6 WAP, 4+7 WAP, and unweeded check Since the field was properly plowed and disc harrowed the weed population was initially low Therefore, the treatments did not have any significant effect on maize yield However the fresh weed weights at harvest varied significantly due to the control measures used The highest fresh weed weight (30 4 t/ha) was obtained from the unweeded check plot compared to 5 5 t/ha from the 3+6 WAP weeded plot Since this result is only from 1 season we suggest further trials be carried out in the upcoming seasons in order to get recommendable weed control measures for the small holders since weed control is tedious and conflicts with farmers' other labor requirements

6.2.4.4 Post-Harvest

6.2.4.4.1 Maize Storage and Drying

In cooperation with the Dschang Cereals Entomologist, the TLU-Ekona has carried out a series of surveys and trials to identify and solve the critical storage/drying constraint to South West maize production A 1987 rapid assessment in the south of the province verified and supplemented data from the Farming Systems Surveys, and generated a hermetic storage trial and an economics thesis on the costs and benefits of farmers' storage and drying practices An on-going storeability trial assesses the relative losses in storage of the improved varieties under test in the National Variety Trials

In first season, South West maize must be harvested wet to avoid rotting in the heavy rainfall, and drying facilities are inadequate for large harvests In second season maize is harvested dry from the field or dried in front of the house in the sun, but second-season production is lower due to stem borer attack and low photosynthesis in the first month after planting Also, later field harvest seems to increase the weevil damage.

The storage loss estimates from farmers in two different surveys and from pre-planting assessment by the entomologist are internally consistent and indicate losses of about 43% by 6 months, most from weevils, and starting to be apparent at 2-3 months after harvest Eighty-five% of farmers store maize for more than a month, some store only for seed, usually tying cobs on a line over the fire and experiencing great and erratic losses, while others store for food and intermittent sales to satisfy small cash needs from one harvest to the next. These latter use "bandas", wide shelves or false ceilings above the kitchen fire with an average capacity of 1 9m^3 A calculation from use patterns, seasonal price changes and loss rates indicates that it is extremely disadvantageous for the farmer to try to store beyond six months (It is also more economical to sell the fresh maize as it is harvested from the field)

A few farmers have been found using hermetic containers to store shelled grain, principally the maize farmers of one Metta village in KC who store in oil drums This method gives very good results, but each oil drum contains as much maize as most farmers store in a season, and they must be used up within a month of opening This was the rationale for the TLU hermetic storage trial, which tested the efficacy and efficiency of small containers that would fit better into most farmers' needs

Results, reported elsewhere in this volume by the Cereals Entomologist, showed that 6-month sealed storage destroyed about half the embryos, making the grain unusable for seed, but that the cans were both effective and economically efficient for food storage They gave profit margins 2 7-4 times greater than for banda storage, the best of the traditional methods The storage consultant just brought believes that the germination problem can be traced to inadequate drying of the seed before storage, and that a further trial should be put Both the 1989-90 trial and the cost/benefit analysis of farmers' methods indicate substantial economies of scale in maize storage

Drying is limited more by available storage space over the fire than by firewood However, a single fire can only dry 1 $0m^3$ safely, so that most bandas are kept only partially full during drying. Cement cocoa dryers are good maize dryers, but must be very carefully used to avoid burning, and they are expensive and rare, most farmers do not use them, and a few that do estimated 10% loss in drying and subsequent shelling The more common zinc cocoa ovens never seem to be used for this purpose and may be hotter Since most farmers dry and store simultaneously, they do not notice specific drying losses Drying costs are minimal, the extra wood added to the cook-fire, however, farmers living in urban areas with little storage space or forest access have difficulty accumulating enough wood for the rainy season harvest

6.2 4.4.2 Food Markets

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

Food crop markets in South West Province are of three categories local village markets, markets receiving wholesale buyers, and urban markets Some are permanent, while others, even the largest, are weekly Crop prices vary by season and location, and the most expensive market for some foods may be the least for others There was a general decrease in prices in the second year of the study (1989/90) at both the provincial and divisional levels This decrease could be due to (1) reduction in money supply (cash flow) caused by the economic crisis, (2) a shift from cash crops (cocoa and coffee) production to food

crops as the world market prices for cash crops decrease annually and (3) the diffusion of new technological packages from IRA

Crops showing price increases were dry maize (Manyu Division only) and white yams (D rotundata, except in Fako Division) Manyu experienced poor maize harvests due to drought, and yam increases may be due to an increase in demand, Fako being the principal yam zone maintaining a slight decrease Generally banana was the cheapest food crop per kilogram while unshelled egusi melon was the most expensive across the four divisions and in the province Manyu Division had the cheapest markets while Fako had the most expensive, as reflected by their market baskets This is explained by the greater weight of demand over supply in the provincial situation, because of the poor state of roads linking Manyu most of their food stuffs are sold within, while Fako Division has a large influx of buyers from other provinces, particularly Littoral, and countries such as Gabon

Table 6· Mean Prices in South-West Province Markets, by crop and division, 1988-90

Crop	Mean Price (FCFA/kg)									
	South West		Fako		Meme		Manyu		Ndian	
	yr 1*	yr 2*	yr 1	yr 2	yr 1	yr 2	yr 1	yr 2	yr 1	yr 2
Maize green cob	88	88	103	113	66	60	80	101	87	87
Maize dry grain	120	150	90	73	55	62	145	234	160	151
Cassava gari	156	159	194	169	190	138	106	112	164	105
Cocoyam	101	95	117	116	67	69	85	88	113	88
Taro - Ibo	56	54	57	56	41	42	50	51	63	57
Taro - Mami	52	43	51	46	38	36	70	61	52	36
Plantain	80	76	85	77	52	45	81	87	77	71
Banana	39	36	44	43	17	16	40	34	40	39
White Yam	134	151	148	146	105	159	118	132	123	126
Sweet Potato	73	67	76	75	39	44	64	55	85	70
G'nut unshelled	198	164	239	164	241	174	151	148	225	187
Egusi unshelled	381	354	441	445	602	382	300	249	281	334
Basket	146	140	165	152	161	130	121	122	140	130

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

6 2 4 5 Liaison and Impact

6 2 4 5 1 Liaison with the Extension Service and Farmers

Agricultural extension in South West Province is provided solely by the Ministry of Agriculture (MINAGRI), with no special projects other than limited training and transport assistance from a now-defunct cocoa project There are an estimated 120 extension agents active at farmer level in the province, or about 1 agent for 600 farm families

The Ekona TLU has incorporated this extension service in its research and training activities since 1986, to increase our outreach both to the farmer and back to the researcher This cooperation includes 5 workshops which have trained about 40 different farmer-level agents as well as their supervisors, minikits, or farmer-managed trials, that have been sent to almost all extension agents for their supervision, researcher-managed trials that have been carried out with the active collaboration of 40 different agents, and surveys and monitoring studies which have involved about 20 agents intensively These activities have drawn the agents closer to their food-crop farmers, provided them maize, sweet potato and cassava planting material, and increased their technical knowledge of food crops and interviewing methods, as well as provided the TLU with broader information than could be gained if we were dependent only on our own resources for farm trial and farmer interview

Our liaison strategy includes a central, interactive group of researchers, extension agents and farmers, that are involved in all on-farm researcher/farmer-managed trials and most surveys In 1990, this group was shrunk to eight "focus" villages, two per key zone, in order to increase our contact with the farmers and reduce coordination and travel costs The remainder of the extension service participates through the minikit program, and within the annual workshop, to which agents from outside the key zones and agent supervisors are invited together with the core group In 1990, the workshop was structured to allow the participants to review and recommend changes in two key areas of our research, the variety selection program and the new soil improvement program

The focus village strategy was adopted in 1990 in order to strengthen interaction with the farmers so as to increase their input of opinions, information and labor into the trial program Two open meetings were held in each village, one in September 1989 in which we solicited the experiences and views of the villagers on every type of "modern" agricultural technology, and declared our intent to work closely with them, and one near planting to describe the trials we planned and solicit volunteers The first set of meetings led us to add trials in pest control and cassava rotting/cookability to our workplan for 1990 We tried to set the trials up as group efforts, as the Nkolbisson TLU has done, and convinced the farmers to try it by comparison with the local work-exchange groups However, the local groups have organizational rules that conflict badly with our require-

ments, and this was dropped for second season, the only way to avoid the conflict would be to reduce the trials to two treatments The focus village method requires further refinement to work well, but it has already increased farmer feedback and representativeness, as seen in the percentage of women participants, 44% just before we changed strategy and 69% in 1990

6.2 4.5 2 Impact on Farmers

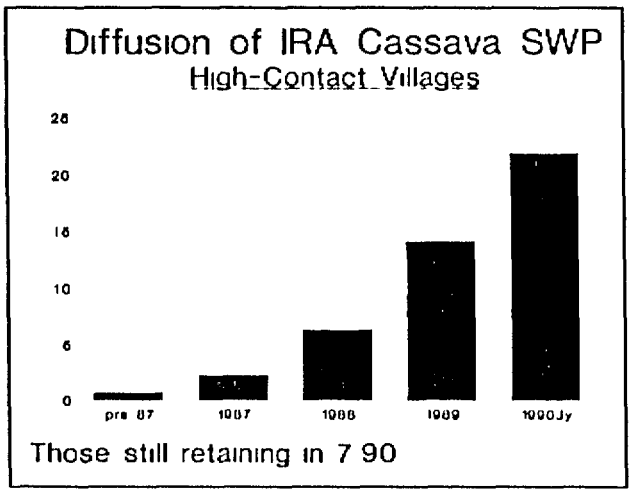
TLU impact on farmers to date is mostly limited to changing varieties in maize and cassava, since work on soil improvement, pest control and storage are not yet ready for diffusion Further impact should be felt through the better training and interest of extension agents in food crops, but the evidence in this area indicates that this too has been limited to variety work. An adoption survey carried out by TLU researchers and technicians in June-July 1990, using random samples of 16 villages in the four key zones, half in which we had worked extensively (high-contact, or HC) and half not (low-contact, or LC), provides most of the data for this discussion

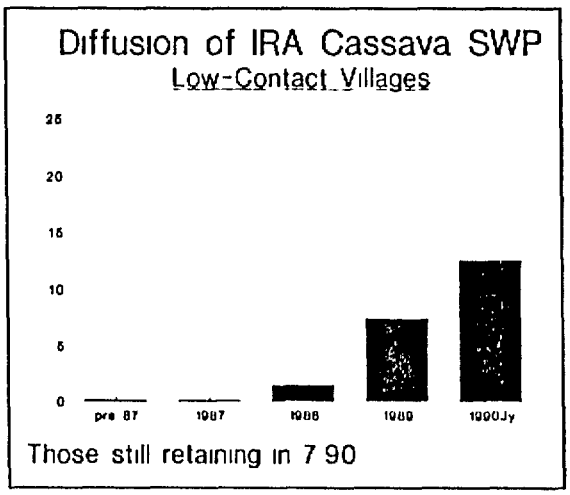
Interest in the IRA maize and cassava varieties is high. 72% of farmers (and 63% in the more representative LC villages) had heard of IRA maize, and 82% (80% LC) of IRA cassava For both crops, two-thirds of those who had heard (62% LC) had tried to obtain planting materials Half the farmers had learned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

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

A fifth of the farmers already had the IRA cassava by mid-1990, including 16% of low-contact farmers, and it is possible to project an adoption ceiling of 94% of farmers by 1996 from current trends However, the loss of the Gatsby Project financing for IRA multiplication will curtail future direct distributions, which account for 46% of the increase to date Most recipients have multiplied for themselves for one to two years and then let others take cuttings, those who have completed their own multiplication are planting on average 55% of their cassava fields to the IRA varieties, keeping their local for snack food and to have cassava during the months when the IRA

cassava, which has shorter durability, has been harvested The IRA cassava is highly valued at home and in the market for its white, tasty water fufu and good garri, high yields, and early maturity Although it is very bushy for some cropping systems, farmers have adjusted by later planting or wider spacing





Diffusion of improved maize is more complicated to achieve and to evaluate With two parents, even composite maize rapidly degenerates by admixture with locals in the field, and improved seed must be replaced regularly from a pure source IRA has no facilities for large-scale seed multiplication, and the Ministry of Agriculture has done no seed multiplication in the coastal lowlands The sole source of CMS maize in the South West is the TLU-Ekona, and it has been given out only for trial, in 200-300g minikits or 1kg on-farm trials, each time to be planted next to a local maize for comparison, guaranteeing contamination Two thousand minikits and 174 researcher/farmer-managed trials have gone out since 1987, or, per season, 1 minikit for every 230 farmers in the province and 1 trial for every 1500 farmers in the key zones The majority of recipients have been women, who are the principal maize farmers Maize is also easy to lose edible, so people and weevils eat it up, and less resistant to most insects and drought than cassava The loss rates of 54% (69% in LC villages where farmers who lost it were not resupplied) should be no surprise

What is surprising is that 18% of LC farmers receiving maize in 1988, and 43% of those in 1989, still had it to plant in 1990 The record for farmer seed preservation in the survey is 7 seasons for Ekona Yellow (an old IRA variety), 6 seasons for CMS 8501 and 5 for CMS 8602, both sent out first in 1987 18% of HC farmers and 4% of LC farmers currently had CMS seed in mid-1990[2].

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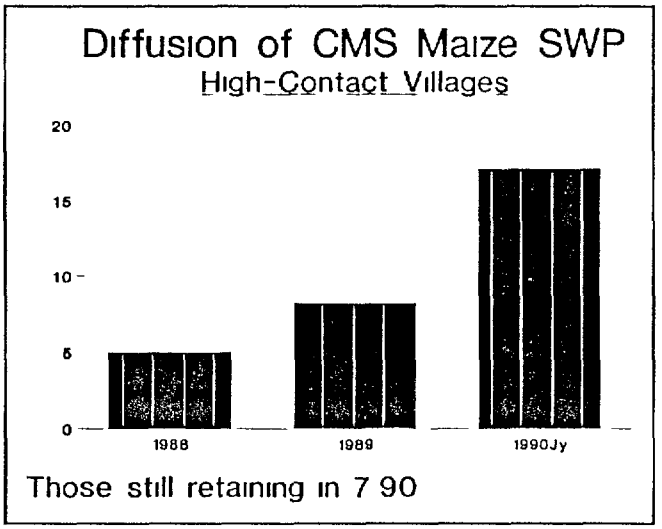
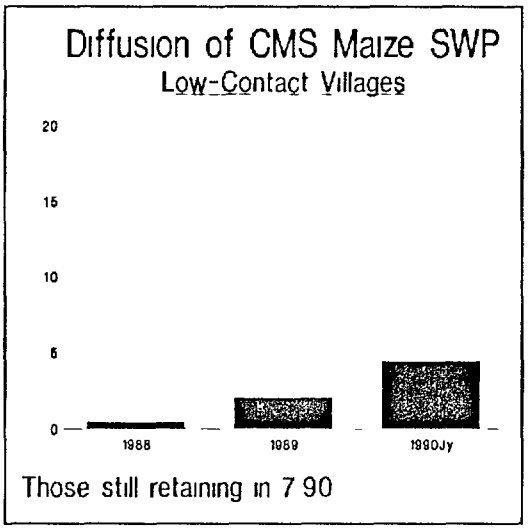
[2] The numbers are probably higher, we have several cases of maize identified by the farmer as local which was recognizably CMS, and usually we could not inspect the maize she was using

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





The National Extension and Training Program of the Ministry of Agriculture plans to multiply CMS 8501, and the other varieties as released, for general distribution across the province, and to improve the extension agents' training of farmers If this is done, adoption rates should rise steadily, but it is difficult to predict now to what level In the high-contact villages, about 70% of the farmers who heard of the maize tried to get it, and 30% of those who got it ate it up rather than keep it to plant again (some because of disapproval and some sure that weevils would eat it if they didn't) Farmers who have had the maize more than a season now put 67% of their maize field into IRA maize It seems probable that the IRA maize will ultimately reach a smaller proportion of the farmers than the cassava, but be used on a much larger part of their fields However, final ceilings and rate of adoption will depend more on the success of regional seed multiplication than on levels of farmer interest

6 2 5 IN-SERVICE TRAINING

6.2 5 1 Local Training

Inside the TLU, training in on-station and on-farm agronomic research methods, scientific and popular presentations, formal, informal and group interviewing, and data analysis have been continuous for research- and technical-level staff Training in computer management, MSTAT, SYSTAT, graphics and word processing have been undertaken at researcher and secretarial levels, and been extended throughout IRA-Ekona

For the Ministry of Agriculture, the TLU has held 5 Food Crop (or Farming Systems) Training and Planning Workshops, one to three days long, and one five-day IITA-financed Root & Tuber Training Course The first Workshop, in 1986, was attended by 27 agents from Fako Division only, and the latest, in 1990, was attended by 52 participants (including 9 farmers) and covered by radio and newspaper accounts Six divisional-level extension staff have also had in-service survey training, and 20 and 30 local-level staff training in rapid assessment and on-farm trial methods respectively

The TLU at Ekona has also supervised six students on apprenticeships, two non-thesis I T A agronomy students from the University Centre Dschang, two thesis I T A economics students from U C Dschang, one Nkambe Technical School student doing economics thesis work, and one I A economics thesis from U.C Dschang

6 2.5.2 International Training

One TLU staff member, Dr Manfred Besong, completed his PhD in Agricultural Economics at the University of Nsukka, Nigeria, under the NCRE in 1990, a course which included short-term training at IITA, the University of Florida and George Mason University Three others have benefitted from international training courses Mr Mboussi A Messia, 1989, IITA/Ibadan course on sustainable agriculture, Mrs Christine Poubom nee Ngundam, 1990, Wageningen (Netherlands) International Agricultural Centre International Course for Rural Extension, and Mrs Comfort Ateh nee Amba, 1990, IITA course on maize research and production

6 2 6 PRIORITIES FOR FUTURE RESEARCH

Priorities are listed in two areas, socio-economic and agronomic These two will continue to be developed through joint planning and evaluation as before Most of these are continuations or extensions of on-going research at Ekona

Priorities for socio-economic research are (1) analysis of resource productivity in typical farming systems of SWP (including building of whole farm budgets from individual elements), (2) market studies (price recording, specific studies on market access and market elasticities, gender effects), (3)

follow-up impact studies (effects of changing distribution methods, economic impact of changed techniques once adoption is more advanced), and (4) partial budget analyses, risk and stability analyses of agronomic trials

Priorities for agronomic trials are (1) on-farm variety testing (maize varieties, the new cooking cassava, and in the future, cocoyams and sigatoka-tolerant plantains), (2) on-farm trials on soil management and weed control practices (improved fallow and alley cropping with species identified in 1990 legume selection trial, biological control of Chromolaena odorata, spear grass and Sorghum arundinaceum, fertilizer trials with emphasis on N in the Sands and P in KC), (3) on-farm trials on insect pest control for maize and egusi, and (4) storeability and field damage susceptibility of promising maize varieties

6 3 MAROUA TLU

6 3.1 INTRODUCTION

On-farm testing has been conducted at IRA Maroua since the early 1980's, beginning under the SAFGRAD Accelerated Crop Production Officer Program

In September 1986 the on-farm testing component of IRA Maroua became a Testing and Liaison Unit within NCRE In June of 1988, the TLU in Maroua was fully integrated into the NCRE Project with the recruitment of an IITA extension agronomist

Although on-farm tests have been conducted in the mountainous areas (Mokolo) and in the very far north near Lake Tchad, by far the majority of on-farm tests have been conducted in the Centre Nord, i e the cotton-growing areas of this zone of action, in collaboration with SODECOTON This geographical area, plus the mountains and plateaux of Mayo Sava and Mayo Tsanga Department,will remain the research domain of the TLU

The principal food crops of this zone are sorghum, pearl millet, cowpea, and peanuts The major cash crop is cotton, although peanuts and--to a lesser extend, in the Mayo Louti department of North Province--maize are important sources of cash

Systematic diagnostic studies of the farming systems of the Extreme North and economical analysis of the results of on-farm tests from 1984-1988 began in 1989 with the addition of an IITA agricultural economist to the TLU team

6 3.2 OBJECTIVES

To increase knowledge of the farming systems of North Cameroon and contribute to the generation, evaluation and dissemination of technologies proven under farmers' conditions to increase food crop yields, improve yield stability, maintain soil fertility, and increase small farmers' incomes

6.3 3 CONSTRAINTS

Logistical problems in running trials and survey have been compounded by long distance to be covered in the TLU mandate area and generally poor road conditions during the cropping season Access to mountain villages have been at times extremely difficult As result, most of the vehicles need to be replaced within 2-3 years

TLU has lost experienced technicians when IRA reopened several antennas, this is complicating follow-up of on-farm tests and surveys

Collaboration with the National Extension and Training Project agents had a slow start as they are still confronted with logistical problems

6.3.4 ACCOMPLISHMENTS

SORGHUM

6.3.4 1 1986 Sorghum Variety Test

Planned for 46 sites, successful results from 38

Variety	Mean Grain Yield (kg/ha)
CS 54	2201
CS 61	2168
S 35	2164
Locals	2128 ns

From 1984-1986 data, S35 seems more stable and higher yielding over locations than local varieties, and is recommended by SODECOTON for its short-cycle sorghum package A partial budget analysis of the 1984 data revealed that S#% had a marginal rate of return of 423% over the local variety

6.3.4 2 1987 Survey of Adoption of Sorghum Variety S35 by Farmers Having Tested IRA Varieties From 1984 to 1986

211 farmers responded (72 5% of farmers having conducted tests during the previous three years) Each interview took 10 to 20 minutes, in Foufoulde or Moundang, directly with the farmer

	%of farmers who came to interview	%of farmers growing S35 in 1987	%of sorghum area planted with S35	difference S35 & local (kg/ha)
All tests	72.5	31 7	30 3	300
1984	73 9	23 1	27 9	612
1985	67.9	29 0	29 2	100
1986	75 8	48 0	32 7	25

Weaknesses of S35 cited were susceptibility to bird damage and grain mold if planted early Some felt S35 required more weeding care and was susceptible to Striga. S35 was adopted for late planting in 1987 by about 1/3 of the farmers who had tested it The typical adopter planted 2/3 of his land to the local variety early, presumably without plowing, and then planted the remaining third to S35 in pure stands later, after plowing. More farmers who had tested the variety recently were planting in 1987 than farmers who had tested it two or three years previously.

6 3.4 3 1987 Sorghum Variety Trial

Planned for 46 sites, successful results from 38.

17 VILLAGES IN MORA MOKOLO AND MAYO LOUTI		18 VILLAGES IN KAELE, DIAMARE AND MAYO DANAY	
Mean grain yield (kg/ha)		Mean grain yield (kg/ha)	
CS54	2041 a	CS54	1986
CS61	2041 ab	CS61	1891
S35	1833 b	S35	1941
Local	1535 c	Local	2100 ns
LSD (0 05) = 206		LSD (0 05) = 156	

Significant differences in varietal yield in the 2 western SODECOTON regions but no differences in the 3 eastern regions, led to the belief that 2 separate recommendation domains exist for sorghum varieties Overall, regression of yield of CS54 on S35 across all locations indicated that CS54 may be stable in yield Results of partial budget analysis of improved short cycle varieties during the rainy years of 1985-1987 indicate very low marginal rates of return (29 to 83 %) over local varieties

6 3.4.4 1988 On-Farm Trial Of Varietal Adaption

Planned for 69 sites, placed on 67, results from 61 Design RCBD with 3 blocks per site Treatments = 4 varieties

Objective· to confirm existence of recommendation domains for sorghum varieties in the Extreme North by analyzing the location-by-variety interactions of a wide range of sorghum genotypes across a broad range of representative on-farm environments and to examine in detail the effect of a range of agroclimatic variables on sorghum yield On the basis of apparent lack of interaction between varieties and geographical regions, the recommendation domains' postulated from 1987 results do not hold true for this year The local Gueling, little known in previous collections, had the highest yields in almost all locations, was much liked by farmers, and was recommended to the sorghum breeding section, where it is proving one of the most promising of the local types

6 3.4.5 1986 Sorghum Agronomy Test Land Preparation

Planned for 23 sites, successful results from 22

Treatments	Mean grain yields (kg/ha)
Tied ridges	1475
Plowing	1439
Dry scarification	1395
Direct seeding	1330 ns

There was no significant effect of land preparation There was a significant region by treatment interaction due primarily to the poor response to tied ridges in Mayo Danay while tied ridges was the best treatment in the four other regions.

6 3.4.6 1988 On-Farm Test of Sorghum Seed Treatments

Planned for 23 sites, successful results from 21 Main plot factor variety (S35 or farmer-selected local). Subplot factor seed treatment 1) none, 2) Thioral, 3) Marshal

No significant effects of seed treatment, variety, or variety-by-treatment interaction on yield Overall grain yield was 1498 kg/ha. S35 had significantly higher plant stands than the locals, both Marshal and Thoiral gave batter early plant stand than no treatment In terms of numbers of pockets reseeded, Marshal was significantly better than Thioral, which was significantly better than no treatment

6.3 4.7 1989 On-Farm Test of Sorghum Seed Treatments

Objectives: To determine if a reduced dose of Marshal (0 05%) was as effective as the full dose (1%) and as Thioral (the current recommendation, with one replication (block) per site

Treatment	Grain yield (kg/ha)	Density 15 d a s (plts/ha)	Density 30 d a s (plts/ha)	Harvest Density (plts/ha)	Panicle Density (pan /ha)	Farmers' Choice for Good Yld
Marshal 1 0 %	1937 a	49 627 a	54 147 a	50,497 a	48,996 a	10
Marshal 0 5 %	1910 a	47,970 a	53,981 a	49,938 a	47,693 a	7
Thioral	1899 a	46,250 a	49,717 b	47,763 a	47,020 a	3
S E	68 7	1 323 4	1 267 6	931 3	1,054 6	
LSD (0 05)	197	3,881	3,643	2,671	3,019	
C V	16 %	10 %	10 %	8 %	10 %	

Apparent lack of effect of treatments on stand 15 d a s is due to the fact that at that time most of the sites had been or were being reseeded Farmers were given the choice of reseeding and/or transplanting, most did one or both Given the importance of good stand establishment, the benefit for average farmers of improved stands from Marshal could be great, although in this test those benefits were not translated into yield increases, due to the conscientiousness of the collaborating farmers. Reduced rate of Marshal recommended to extension services

6.3.4 8 1989 On-Farm Trial of Sorghum/Sorghum Intercrops

Objective: requested by extension, to determine which of three proportions of S35 to the common local variety Djigari might be superior in terms stability of production over varied

environments, grain and stover yield, tolerance to striga, and yield loss to birds One site in each of 10 SODECOTON sectors Results indicate that this type of association may be more stable across sites (figure ') Another year of regional tests, with a simpler design and more sites is being done in 1990

6 3 4 9 1989 Test of Sorghum/Cowpea Intercrops for Striga Control

The objective was to confirm under farmers' conditions evidence that intercropping cowpea with sorghum may help suppress striga and to increase overall food crop productivity in fields heavily infested with striga The test was planned for 10 on-farm sites, one in each of SODECOTON sectors

Cropping Pattern	Sorghum Grain Yld (kg/ha)	Cowpea Grain Yld (kg/ha)	LER	Striga Density (plts/ha)
Djigari pure	950 a	-	1 00	124,563 a
Djigari/Vya	870 ab	110 b	1 13	122 167 ab
Djigari/BR1	532 bc	169 b	0 88	128 344 a
S35/Vya	583 abc	187 b	0 97	113 365 b
S35/BR1	448 c	204 b	0 86	124 594 a
Vya pure	-	522 a	1 00	-
S E	131 2	89 9		3,068 2
LSD (0 05)	383	247		9,051
C V	51 %	96 %		6 %

Yield results indicate that Djigari/Vya may be the best intercrop option, not only in that it gives highest LER, but more importantly that it provided some cowpea yield with little or no decrease in sorghum yields A partial budget analysis indicated marginal rates of return of 8932% for the choice between Djigari pure and Djigari/Vya, 6232% between Djigari pure and S35/Vya, 4492% between Djigari pure and S35/BR, and 1498% between Djigari pure and Djigari/BR1 Moving from one sorghum/cowpea association to another involved dominated options and was therefore not considered

6 3.4 10 1989 On-Farm Test of Urea for Sorghum in Striga-Infested Fields

The objectives were to confirm under farmer conditions evidence that N fertilization could improve sorghum yields under heavy striga infestation and to confirm farmer observations that urea itself may also serve to suppress striga The test was planned on 16 on-farm sites No significant effect was shown

Treatment	Grain Yield (kg/ha)	1st Striga Count (plts/ha)	2nd Striga Count (plts/ha)
0	1658	93,291	94,440
25	1742	63,935	74,726
50	1639 ns	73,312 ns	77,919 ns
S E	86 7	26,901 7	21192 6
LSD (0 05)	254	79,929	62,966
C V	18%	111%	81%

PEANUT

6.3 4.11 1986 Peanut Variety Test

Planned for 30 sites, successful results from 28, in Mayo Danay, Mayo Louti, and Mora-Mokolo regions

Variety	Mean Pod Yields (kg/ha)	Mean Grain Yields (kg/ha)
IB 66	1775 a	1212 a
28-206	1694 a	1126 b
Spancross	1581 b	1098 b

Pod yields and oil quality equal to 28-206, plus superior grain yield due to higher shelling percentage let to recommendation of IB 66 by SODECOTON in the Extreme North in 1988

6 3.4.12 1987 On-Farm Peanut Agronomy Trial

Planned for 24 sites, successful results from 21
Treatments 1) no ridges/40 cm rows 2) no ridges/50 cm rows
3) ridges/40 cm rows 4) ridges/50 cm rows

Mean Pod Yields (kg/ha) for Row Width

40 cm	2000 a	
50 cm	1818 b	LSD (0 05) = 70 C V. = 11 2%

There was no significant effect of ridging, nor of ridging-by-row width interaction 40 cm row widths are being maintained as the recommended by SODECOTON

6.3.4.13 1988 Test of Single Super Phosphate on IB66

Planned for 28 sites, successful results from 23 Treatments. Rates of s s phosphate 0, 50, 100, 150 kg/ha

Means for pod yield (kg/ha)

150 kg ssp	1476 a	
100 kg ssp	1433 a	
50 kg ssp	1414 a	
0 kg ssp	1333 b	LSD (0 05) = 74 C V = 12.5%

Response only to first 50 kg/ha At 7000 FCFA per sack of fertilizer and a price of unshelled peanuts of 75 FCA, this rate seems to just break even, not considering labor needed to spread fertilizer Farmers thought phosphate improved haulm yield and quality, but this was not measured SODECOTON added recommendation of 100 kg/ha SSP as an option on its Fiche Technique as of 1989

COWPEA

6 3 4 14 1986 Cowpea Variety and Tied Ridges Tests

Planned for 23 sites, successful results from 18

Variety	Mean pod yield (kg/ha)
TVX 3236	1728 a
VIYA	1675 a
BR1	1589 a

Treatments	Mean pod yields (kg/ha)
with tied ridges	1709 a
no tied ridges	1619 a

BR1 recommended as an improved variety by SODECOTON based on its yields equal to TVX3236 and its superior grain quality (large, white), and its bruchid resistance, manifested by delayed attack

6 3 4 15 1987 On-Farm Cowpea Minimum Insecticide Trial

Planned for 18 sites, successful results from 14 Treatments no spraying, one spraying (40 days after seeding), two sprayings (40 days and 55 d a s), three sprayings (30, 40 & 55 d a s)

Mean Pod Yields (kg/ha)

3 sprays	1073 a	
2 sprays	1035 a	
1 sprays	867 b	
0 sprays	712 b	LSD (0 05) = 166 C V = 20 2%

Overall, two sprays are as effective as three, and this reduced schedule has been adopted by SODECOTON for recommendation to farmers, reducing their costs of production

6 3 4.16 1989 On-Farm Test of Cowpea Varieties

Objective to test four new varieties from the IRA Maroua Cowpea Section, in comparison with the currently recommended variety BR1 Criteria of interest were grain yield, hay yield, stand establishment, and farmers' appreciation of grain quality, cycle, and tendency to shatter Tests were conducted in 10 farmers' fields, one in each of 10 SODECOTON sectors

Variety	Grain Yield (kg/ha)	Hay Yield (kg/ha)	Density 15 d.a s (plts/ha)	No. Farmers Citing as Preferred Var.
BR1	953 a	833 b	45,495 a	8
IT82D-699	819 b	656 bc	43,724 ab	0
IT82D-952	788 b	673 bc	44,421 a	2
TVX-3236	749 bc	607 c	41,452 bc	0
IT81D-897	691 c	1263 a	39,160 c	4
S E	32 0	63 2	812 3	
LSD (0 05)	92	191	2,322	
C V	18%	35%	8%	

The results confirmed the high productive potential of BR1 (a variety identified originally by the IRA Maroua Cowpea Section as resistant to bruchids and to virus) and its acceptability to farmers. TVX-3236 was least favored by farmers due to its tendency to shatter IT81D-897 was liked by farmers for its good hay yield and grain characteristics, and its longer cycle, which allowed farmers to transplant their dry season sorghum fields while the cowpea matured, whereas short cycle varieties created a labor conflict BR1 should continue to be recommended (the only problem seems to be availability of seed), and consideration should be given also to extending 897 as an alternative variety

MILLET

6.3.4.17 1986 Millet Variety and Density Test

Planned for 13 sites, placed on 11, successful results from 5

Variety	Mean grain yields (kg/ha)
Local	1068 a
INMV	569 b

Seed set of INMV was very poor, the most likely explanation of which was possible pollen washing due to coincidence of flowering with heaviest rains Higher densities (40,000 plts/ha) gave significantly better yields than low ones (10,000 plts/ha)

6 3 4 18 1988 Test of Pearl Millet Variety and Date of Seeding

Planned on 15 sites in millet-growing zone, 13 seeded, 10 gave adequate results Design RCBD with one block per site Treatments 1) Local Variety seeded 1 july, 2) IKMV seeded 1 july, 3) IKMV seeded 15 July, 4) IKMV seeded 31 July

Mean Grain Yield (kg/ha)

Local 1 July	746 a	
IKMV 15 July	510 ab	
IKMV 1 July	407 b	
IKMV 31 July	293 b	C V = 55 7% LSD (0 05) = 263

The 15 July date gave yields not significantly different from that of local varieties, likely due to the high degree of experimental error Differences in on-farm and on-station millet results in 1986 and 1988 let to feedback to the millet breeder that varieties be tested in multi-location trials in the millet-growing zone before being proposed for on-farm testing This procedure was incorporated in the millet breeding program beginning 1989-90

MAIZE

6 3.4 19 1989 Testing of Green Maize

Each of 50 farmers collaborating in TLU tests with SODECOTON plus a number of farmers receiving extension advice from MINAGRI's National Extension and Agricultural training project planted either CMS-8704 or DMR-ESR-Y, or both These early-maturing varieties, intended to be eaten green as a source of nourishment during the "hungry period" just before the harvest of other crops, were very highly appreciated by farmers (figure 2)

SOCIO-ECONOMIC STUDIES

Until the end of 1988, TLU had concentrated exclusively on on-farm testing of varieties and agronomic practices developed on station Since 1989 the scope of TLU activities has broadened to include diagnosis of existing farming systems, farm level studies on resource use, storage practices and the evolution of agricultural studies

6 3.4 20 Rapid Rural Appraisal Surveys in 1989

Three resource (Mora-Mokolo Plains, Mandara Mountains and south-western Plateau) were identified during the February-March rapid rural appraisal (RRAS) The second RRAS to cover the rest of E N province into 8 farming systems zones (including the 3 zones in the Mayo-Sava and Mayo-Tsanaga Departments) See map in TLU Working Paper No 2, 1990

In addition to common environmental constraints (rainfall shortages and erratic distribution), major problems cited by farmers for cereals and grain legumes include

1) Striga infestation in sorghum ranked number one constraint),
2) Insect pests and diseases (grain mold, leaf diseases, spodoptera spp , and head bugs) in sorghum causing varying degrees of damage according to location
3) Losses due to bird damage on early maturing varieties (S-35) 4) Thrips and storage losses due to bruchids in cowpea cultivation;
5) Millipedes, rosette, rust and leaf spots in peanut found to reduce yields in many locations
6) Lack of credit for animal traction and to purchase fertilizer and inefficient market infrastructures (outside the cotton growing zone)
7) Lack of feeds during the long dry season
8) Labor constraints at peak demand season for land preparation, weeding and at time of transplanting dry season sorghum

6.3 4.21 Multiple Visit Agricultural Practice Surveys

The studies were initiated in 1989 in 6 villages (Guinglay, Kourgui, Djinlyia, Kolora, Tcherfeke and Djougui) selected to represent major agro-ecological zones of TLU mandate area In 1990 the sites were relocated (5 were dropped and 3 more selected) to begin setting up permanent research villages in the E N and Mayo-Louti Department of North Province

In 1989, 1118 crop fields were monitored, covering 634 ha of 263 farms The average farm size was 2 45 ha More than 80% of these plots were planted to pure crops, sorghum and millet represent 67% of the total More than half the plots (55%) were under continuous cultivation in the SODECOTON zones for over 25 years. Judged by the percentages of plots rented out (15%) the overall land constraint in the region appears less binding

For all rainy season food crops combined, the sample data indicate that 46% of the plots were sown after the first usable rains without land plowing which occurs 2 to 4 weeks later at the time of first weeding in order to improve water retention and guard the plants against lodging Flat flowing is the norm Only 20% of the plots received some form of fertilization (animal manure, mineral fertilizer, crop residues etc)

With regard to improved practices for sorghum, the sample data indicate that 45% of plots were under sorghum-cotton-sorghum rotation (SODECOTON recommendation), 12% oxen plowed on flat, 55% row seeded and 25% sown with treated seeds Average on-farm yields are 930kg/ha in pure stand 773 kg/ha in association For peanut, the proportions are 50% of plots in peanut-cotton-sorghum; 9% oxen plowed on flat and only 9 3% sown with treated peanut seeds Average on-farm yields are 911 kg/ha in pure and 890 kg/ha in association Cowpea has the least proportion of plots (11%) under recommended rotation (cereal-cowpea), but 56%

of plots were row-seeded, 20% with seed treated and 2% weeded twice Average yields are respectively 350 kg/ha in pure and 129 kg/ha under association

6 3.4 22 Labor Use In Agricultural Activities

Was monitored on a sub-sample of 63 farms to identify peak demand periods and the relative importance of each farm operation and hired labor The results are presented in figures 4 and 5

By order of magnitude, weeding (37%), harvesting (33%) and land preparation (21%) are the most demanding operation,. Farmers in the E N province hire outside labor for nearly all field operations The overall demand amounts to 13% of total labor required with the following break down by operation. land preparation (27 2%), seeding (13%), weeding (19 3), fertilization (0%), insecticide application (18 6%) and harvesting (45 5%) There are two peak periods July-August (land preparation and weeding)and November due to high labor demand in muskwari transplanting and harvesting of rainy season crops

6 3 4 23 On-farm crop production costs

In evaluating on-farm input-output ratios, costs of production per hectare and the costs price of producing one kilo of each major crop were estimated as shown below

	Sorghum Tradit	Sorghum Improved	Millet	Peanut	Cowpea
Total Cost (CFA/ha)	72,050	85,300	56,400	90,000	77,100
Cost Price (CFA/kg)	64 6	56 8	84 2	99 9	220

These costs were calculated using average on-farm yields, opportunity costs of family labor, average costs of hired labor and non-labor inputs

6.3.4.24 Agricultural Price Survey

Since 1989 TLU is monitoring commodity prices on a monthly basis in a least 7 sites (including Maroua) across the E N Province The objective is to obtain reliable data on seasonal variations of commodity prices for use in budget analyses Figure 3 pictures the evolution of sorghum, groundnut, millet and cowpea prices in Maroua These prices are normally the highest during the hungry season (June-August) and the lowest in November following harvests Shelled groundnuts secure the highest grain price at any period

6 3.4 25 Adoption Survey of Improved Technologies In The e N.

A survey is being completed in 36 villages in the SODECOTON zones of E N and Mayo-Louti, to assess the extent of adoption of food crop varieties and improved practices developed by IRA/NCRE over the least 5-10 years Sampling with probability proportionate to size (number of farmers) was used in selecting

the villages. The results of this study (expected by December 1990) will also provide information on the characteristics of adopters and non-adopters and on constraints to adoption in TLU mandate area

6.3 4.26 Adoption by Sodecoton Farmers of TLU-Promoted Technologies

The greatest success that the collaboration between TLU/IRA has had is in the promotion of improvements in the sorghum agronomic production package (figure 6) Although components of this package which require cash outlay are lagging somewhat (use of urea, for example), though which require little expenditure of capital (seed treatments or achieving high densities by seeding in rows) are being well received

Adoption of improved sorghum varieties (e g S35) is somewhat hampered by the fact that these varieties call for particular cultural conditions (late seeding, for example), nevertheless, the SODECOTON estimates of adoption (figure 7) almost certainly underestimate true adoption, in that its statistics only reflect adoption by farmers receiving seed from SODECOTON, while many farmers are growing S35 from seed they have saved from the previous year. This is confirmed by the chief of one sector who estimates that the total surface of S35 in his sector this year is more that 1000 hectares, SODECOTON itself admits that availability of seed is the major constraint to wider adoption of its intensive S35 package

Similarly, the major constraint to adoption of BR1 cowpea, which was grown on 63 hectares by SODECOTON farmers in 1989, is availability of seed and of insecticide for intensive production

6.3.5 IN-SERVICE TRAINING

- 1 counterpart received his Ms degree in 1986 (Alabama A&M Univ); trained through on-the-job training and gained more than 5 years of experience in on-farm testing

- 1 counterpart completed a 6 month training at ICRISAT

- 1 counterpart agricultural economist has completed a 6 week training course (USDA) on survey methodology and statistics (September-October 1990)

- Both counterparts participated in 1-week statistics workshop (8-12, January 1990 at Yaounde) and attended the January-February 1990 FSR workshop at the University of Dschang

- 19 to 23 SODECOTON Sector chiefs and 5 region chiefs trained annually during 1-day presentation of on-farm research results (1984-1990)

- SODECOTON extension agents trained during 1-day session and through season-long follow-up of on-farm tests

1986	-	139
1987	-	69
1988	-	88
1989	-	50
1990	-	40

- 4 SODECOTON regional trainers, 2 regions chiefs and 1 Deputy Director for rural Development, as well as MINAGRI technical specialists and chefs de service departementaux trained at 1 day visit of IRA research sites

- Subject matter specialists (National Extension and Training Project) have received monthly 1-day training at IRA center on various subjects

- 46 MINAGRI extension agents trained during 3 one-day sessions in on-farm test design, implementation and interpretation (1989)

- 9 MINAGRI extension personnel (techniciens and chefs de service) trained in 1-day session on successful harvest and storage of foods crops

- 7 enumerators trained to conduct farm-level surveys (1-week long session in 1989) plus continuing on-the-job training, including 4 field assistants posted in TLU permanent villages for the conduct of on-farm tests in 1990

6 3.6 PRIORITIES FOR FUTURE RESEARCH

- Need for 1 to 2 more years of surveys on agricultural practices to identify farmers' solutions and strategies with regard to the chief agro-ecological constraints a short growing season and erratic rains

- Increase on-farm research tests with emphasis on adaptation of stable, drought tolerant varieties of sorghum, millet, peanut and cowpea

- Emphasis on on-farm research to devise sustainable production systems (maintenance of soil fertility, crop associations, low input use etc) by incorporating farmers' own solutions

- Current research on cowpea storage losses needs to extend to cereals to estimate the extent of the problem and to propose practicable solutions

- Emphasis on the economics of improved technologies being proposed to farmers in the E N Province

Fig 4 Demand for Hired Labor by Activity

Average Farm in E N

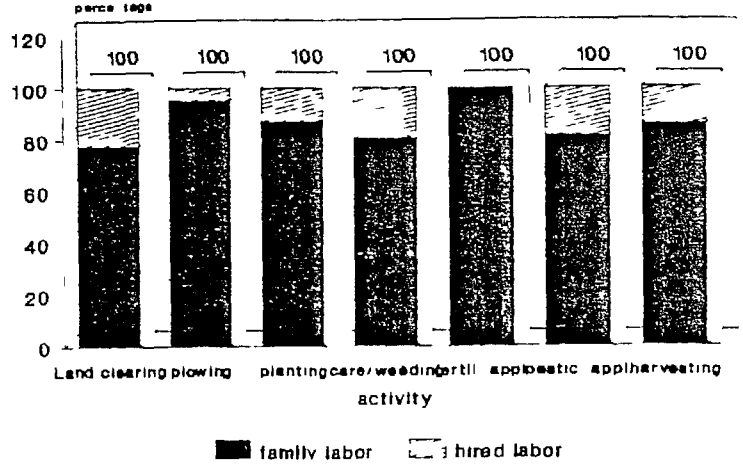


FIG 5 Labor Use Profile for an Av Farm in Extreme North Province

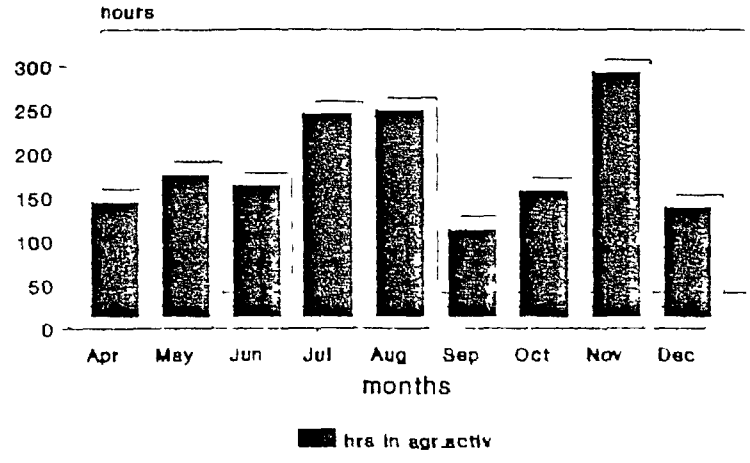


FIG 6 ADOPTION OF SORGHUM AGRON IMPROVEMENTS PROMOTED BY TLU

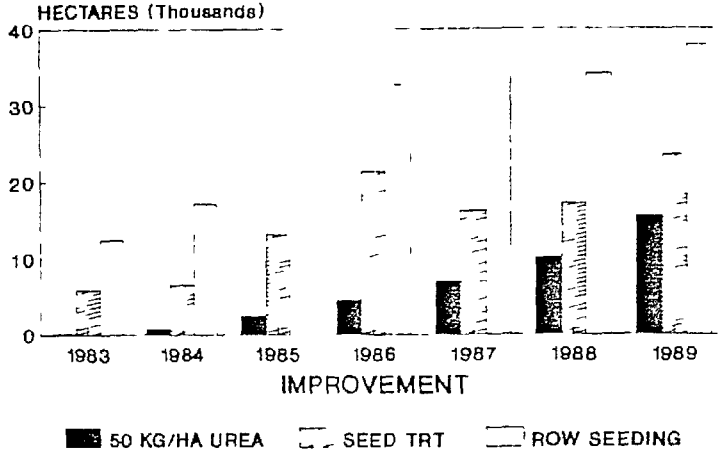


FIG 7 ADOPTION OF S35 SORGHUM

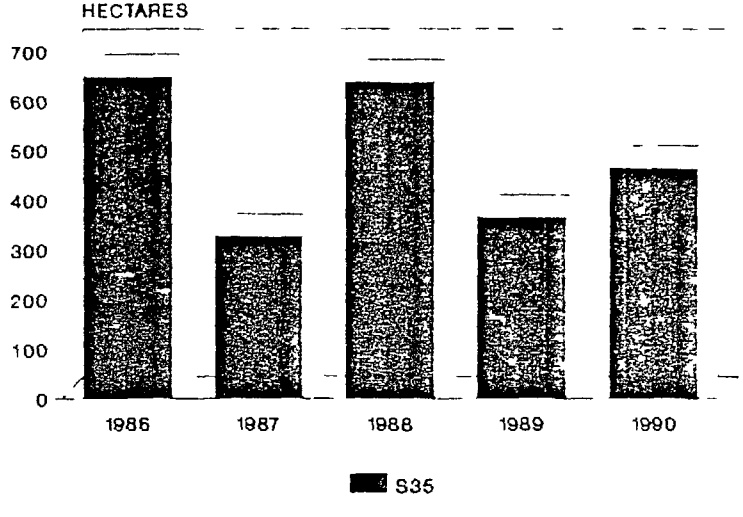
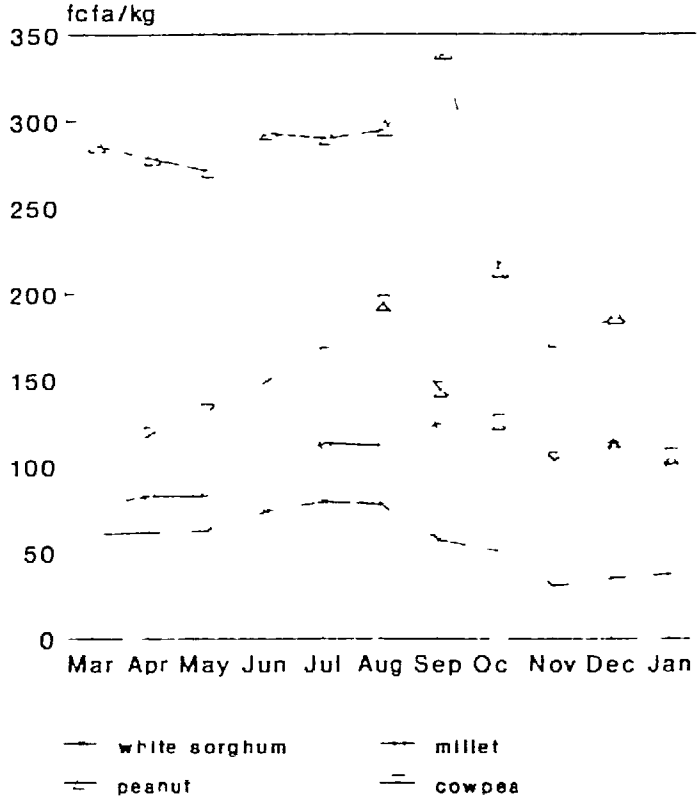


Fig 3 Seasonal Variation of Agr Prices
Cereals and Grain Legumes 1989-90



Maroua Market

FIG 1 DJIGARI/S35 INTERCROPS
MOD STABILITY ANALYSIS 8 SITES 1989

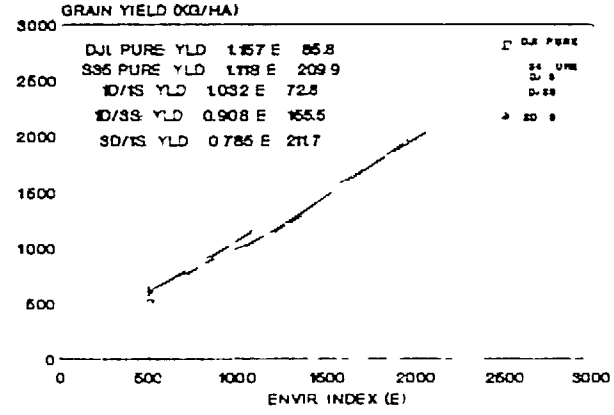
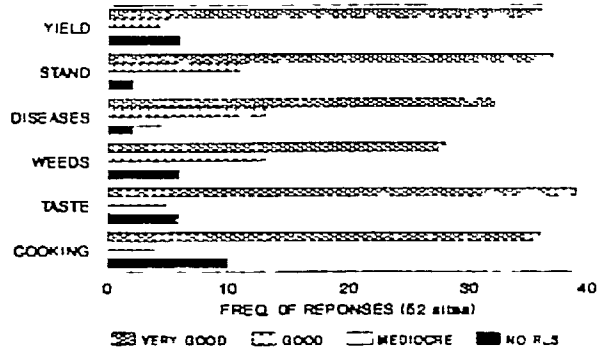


FIG 2 COMPOUND MAIZE 1989
FARMERS EVALUATIONS CMS 8704



6 4 NKOLBISSON TLU

6.4.1 INTRODUCTION

Nkolbisson TLU is responsible for farming systems diagnosis, on-farm testing, and extension liaison in the Centre and South provinces Since its creation in 1986, the TLU has concentrated on the Centre Province TLU activities in the Centre Province focus on two distinct research domains--the semi-humid forest zone and the forest-savanna transition zone Cropping systems, practices, problems and utilization patterns differ between the research zones

Most TLU activities have been carried out in a small number of representative villages [1] From late-1986 through 1987, the TLU worked in Ossombe and Biatsota II, in Ntui Sub-Division of Mbam Division These villages offered a wide variation of systems embracing semi-humid forest and forest-savanna transition zone features Since 1988, Nkol-Fep and Nkometou II have been representative villages for the semi-humid forest Kiki was added as a transition zone representative village in 1989

Between 1986 and 1988, farming systems diagnosis was limited to field observations and two single-visit surveys In 1989 and 1990, several additional diagnostic activities were initiated as part of an overall expansion of the TLU program, including rapid appraisal surveys, field monitoring, farmer assessment surveys, and informal market price monitoring [2]

The TLU testing program has included both components and cropping systems trials Components research has addressed varietal assessment, planting practices, fertilization and weed control. Systems trials have been used to generate information on the viability and acceptability of various cropping and agroforestry systems Since 1987, all TLU trials have been carried out on-farm in conjunction with farmers The primary

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[1] Research is concentrated in representative villages in order to reduce research costs, create focal points for technology diffusion, and enable development of researcher-farmer relationships Diagnostic findings and testing results are validated through regional testing and surveys, carried out in collaboration with extension field agents.

[2] Rapid appraisal surveys are used to determine priorities for any planned expansion of the TLU programme into new areas Field monitoring is carried out on trial plots in order to help with trials analysis, and also on farmers' fields in order to generate data on current practices and cropping outcomes Farmer assessment surveys are used for feedback on specific technologies and to obtain information on farmer circumstances

testing format has been joint researcher-farmer trials [3] Farmer managed and implemented (FMI) trials have been used to assess new varieties and practices which do not differ greatly from existing practices

Extension liaison activities since 1987 have included annual training courses held for extension agents and collaboration on several single-visit surveys In 1988, a regional testing program was initiated in collaboration with SODECAO The regional tests are farmer managed, and are complemented with farmer assessment surveys

6.4 2 OBJECTIVES

Diagnostic, testing and liaison activities of the Nkolbisson TLU are directed at enhancing rural income and food security in the Center and South provinces through more productive and sustainable crop production systems

The specific objectives of system diagnosis have been to:

a) determine farmers' problems, preferences, and priorities
b) identify relationships between cropping patterns, practices, pests and outcomes
c) assess the compatibility of IRA technologies with farmer circumstances
d) feedback information on farmers' circumstances and practices to other IRA research programs

The TLU's testing program has addressed three primary constraints identified in the NCRE Project Five Year Work Plan, namely lack of improved cultivars adapted to farmers' conditions, soils with low nutrients, and high levels of weed infestation All three constraints relate to underlying problems of declining fallow and increased forest exploitation due to growing human population density To address these constraints, the testing objectives of the TLU have been to identify and assess

a) improved and well-adapted varieties
b) improved weed control methods
c) appropriate, low risk maize fertilization rates
d) acceptable and more productive cropping patterns
e) biological technologies that improve and sustain soil fertility

The TLU has not tried to develop a single best cropping system or a single best technology Rather, the TLU has tried to assess a range of appropriate, economically profitable and acceptable technologies for three major crops--cassava, groundnut and maize.

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[3] In this format, farmers and researchers jointly implement experimental treatments, while farmers are responsible for managing and implementing all non-experimental operations.

The TLU's objectives with respect to extension liaison activities have been to

a) increase farmer and extension agent knowledge of improved food production materials and methods
b) increase IRA-extension interaction and feedback about farming systems constraints and development opportunities
c) validate TLU identified technologies through regional testing

IITA technical assistants on the TLU have supplemental responsibilities as Head of IRA's Farming System Program and TLU Coordinator The primary objectives with respect to these roles have been to

a) increase interaction and feedback among the TLUs and other IRA researchers
b) improve TLU research and extension liaison methods
c) improve TLU human resources

6.4.3 CONSTRAINTS

The size and scope of the TLU's program was constrained during most of the 1986-1990 period by lack of personnel Until September 1988, the team comprised only one IITA technical assistant and two national counterparts The team was not expanded to its full size until February 1989 [4] The TLU now has an adequate number of researchers, but only one technician--resulting in a 1 8 technician-researcher ratio Only one national counterpart has received graduate training in (agricultural economics)

Insufficient development of technologies by IRA's commodity programs has forced the TLU to concentrate on a relatively narrow range of technology options For example, no improved materials are available for major crops such as groundnut, plantain or cocoyam

Another on-going constraint is lack of planting material No cassava cuttings are available at Nkolbisson Agroforestry planting materials have been in short supply, so a species with known establishment problems had to be used for alley cropping. Not enough Cajanus cajan, Crotalaria caricea, or Desmodium distortum has been available to initiate widespread testing of managed fallow. The lowland maize program has produced several promising varieties but not enough seed of some promising varieties has been provided for village and regional testing.

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[4] Members of Nkolbisson TLU (with affiliation and starting date) are John POKU (IITA, 1986), Georges DIMITHE (IRA, 1986), L A ENYONG (IRA, 1987, on study leave), Doyle BAKER (IITA, 1988), Regine MANKOLO (IRA, 1989), Michel NDOUMBE (IRA, 1989), Pierre BOUMTJE (IRA, 1989), M Remy ASSOUMOU (IRA, 1989), Jupiter NDJEUNGA (IRA, 1989, on study leave), and Rose NDEMAH (IRA, 1990)

The representative village testing program has been disrupted on several occasions due to circumstances beyond TLU control Following 1987, it was necessary to abandon villages in Mbam Division due to logistical problems in reaching Ntui Efforts in 1988 to work in Abondo, a forest zone village, were halted because of disagreements among collaborating farmers and farmers' expectations for remuneration This year it has been necessary to curtail work in Nkometou II due to loss of the TLU's farmer representative to alternative employment

Extension liaison activities have been constrained by a lack of financial and logistical support for extension field agents Field agents for both MINAGRI and SODECAO have not had funds for travel or field activities Perhaps an insurmountable setback occurred during 1990 with the closure of SODECAO until a restructuring plan is developed

The TLU has continually struggled with inadequate logistical support Until June 1989, members of the TLU were spread across several offices and the TLU was entirely dependent on the Project's administrative unit for computer access and photocopying During 1989, the TLU obtained two computers and a photocopier, and an abandoned IRZ building was converted to a TLU office But in 1990, the TLU's photocopier was destroyed in a fire and its printer has been broken for most of the year The TLU's two computers provide insufficient access for eight researchers and one secretary More than a year after moving into the new office, the TLU is still waiting for bookshelves, filing cabinets and other basic office furniture Nkolbisson continues to be the only project site lacking a backup vehicle, the last one being wrecked beyond repair in early 1989

Another major constraint has been competing demands on the IITA technical assistants A substantial amount of time has been required for office visitors, including several USAID consultants and individuals seeking information about, or collaboration with, the TLU program Until arrival of the NCRE Deputy Chief of Party, a lot of time was required for non-TLU NCRE Project and IRA activities

Farmers in the Centre Province face innumerable constraints which limit potential TLU impact Adoption of food crops technologies is constrained by inadequate access to improved inputs (seed, fertilizer and pesticides), low market prices, and high transport costs Even if input access could be improved, cash is not available to purchase inputs Other technological options require labor instead of cash, but farmers do not have surplus time due to competing demands of food and export crops. Progress in policy reform, and institutional and infrastructural development will greatly influence the pace and spread of technological change

6.4.4 ACCOMPLISHMENTS

Since 1986, the TLU has made substantial progress in developing a cost-effective, sustainable research approach for IRA's Sub-Humid Research Center [5] Expenditures per researcher have been kept to a small fraction of those by other project units. Improvements have been made each year in research design, questionnaire formats and trial implementation procedures To further improve TLU effectiveness, collaborative relationships have been established with SODECAO, ICRAF and several of IRA's commodity programs

Farming Systems Diagnosis

Diagnostic research has been carried out, with a minimal investment of research funds, through several single-visit surveys administered by collaborating extension field agents and TLU village staff A rapid appraisal survey was carried out in Ntem Division, site characteristics data sheets were developed for collecting collateral data from trial sites, and a standardized format was established for farmer assessment surveys.

On the basis of a 1987 production practices and practices survey, administered in Ntui, Soa and Obala Sub-Divisions, the TLU confirmed that there are significant differences in cropping patterns and practices between Ntui Sub-Division (forest-savanna transition zone) and Soa and Obala Sub-Divisions (forest zone), necessitating separate research domains The survey also confirmed that research on improved varieties, soil maintenance options and weed control methods is needed in both areas. Crop specific constraints were identified

Through a 1988 maize and groundnut storage and utilization survey, administrated in all divisions of the Centre Province, the TLU showed that there are substantial differences in storage and utilization patterns between the forest and transition zones, and identified priorities for future storage research

Through a household characteristics survey, administered in 1989 by collaborating SODECAO field agents throughout the Centre Province, the TLU analyzed differences across the province in (a) household size and age-gender composition, (b) age and gender roles in food and cocoa production, (c) farmer ratings of resource constraints, (d) frequencies and farmer ratings for non-agricultural revenue, (e) frequencies and farmer ratings for sales and purchases of crop products, and (f) marketing patterns for cassava, groundnut and maize

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[5] The approach is based on a minimal investment in formal diagnostic surveys, reliance on farmer managed and implemented trials in representative villages, utilization of low-cost village staff, and collaborative regional research with SODECAO.

Through a SODECAO administered field characteristic survey and trial sites monitoring, the TLU generated information about main food crop associations, fallowing and land preparation practices, and pest and other agronomic problems--for priority setting and feedback to on-station researchers

On the basis of a SODECAO field agent survey, the TLU characterized extension activities, assessed differences between food crop and cocoa extension by SODECAO, elicited feedback on farmers' problems and research priorities, and obtained feedback from SODECAO field agents on the TLU's regional test and future research priorities

Through six farmer assessment surveys, each administered following a farmer managed or regional test, the TLU elicited farmer ratings of IRA versus local material (maize and cassava) for production and taste characteristics, rankings of production problems, descriptions of utilization patterns and marketing practices, and intentions for seed retention and future use

A 1989 rapid appraisal survey in Ntem Division (South Province) generated information on crop enterprises, practices and problems, farmers' perceptions and marketing patterns, and helped the TLU develop contacts with PNVFA personnel The survey was used to define and characterize a deep forest research domain.

Through on-going informal market price monitoring (initiated in 1989), the TLU has been generating prices for use in economic analysis of TLU tests

Technology Testing

Maize varieties The TLU has evaluated eleven improved maize varieties in various on-farm trial formats CMS 8704, CMS 8501, CMS 8806, CMS 8503, CMS 8507, CMS 8602, CMS 8611, Ndock 8701, DMR ESR-W, BSR-Sinc 1, TZEE-Y, CMS 8602 and CMS 8611. These varieties are distinguishable by color and growing time, such that some are competing varieties while others fill complementary niches

CMS 8704 and CMS 8501 have been the most extensively tested The TLU has developed support for release and extension of both varieties CMS 8704 is particularly promising since it has consistently out-yielded other IRA varieties as well as local varieties, and is top ranked by farmers with respect to growing and taste characteristics The main drawback to CMS 8501 is its white color, but this should not interfere with adoption in the transition zone. CMS 8507 and CMS 8503 are similar to CMS 8501, and the TLU has shown that both significantly out-yield local varieties Either could substitute for CMS 8501 in a seed multiplication and extension program

The TLU has identified CMS 8806 as an early maturing yellow variety of particular value for the short second growing season TLU tests have shown that farmers appreciate its short growing

cycle, while expressing some concern about taste characteristics Overall, the TLU has developed sufficient support to justify regional testing of CMS 8806 as a final step prior to approval for release In 1990, the TLU started testing TZEE-Y as a potential substitute for CMS 8806 Testing also started on two early maturing white varieties DMR ESR-W, which is a white version of CMS 8806, and BSR Sinc-1, a popular soft endosperm variety in East Province with streak resistance incorporated At least one more season of testing is needed before these can be forwarded to regional testing

Work has stopped on three varieties In 1989, the TLU tested Ndock 8701 as a possible substitute for CMS 8501, but it did not do well in farmer managed tests or farmer assessment survey. CMS 8602 and CMS 8611 significantly out-yielded the standard local variety in 1987 but were dropped in 1988 in favor of CMS 8704 and CMS 8503 due to farmer reaction about plant characteristics.

<u>Cassava varieties</u> The TLU has evaluated three improved cassava varieties 8017, 8034 and 8061. TLU tests have shown that all three varieties out-yield local varieties due to greater average tuber weight, whether grown sole or in crop mixtures Although all three have a spreading plant architecture, a 1989 trial showed that there was no significant adverse effect on inter-cropped groundnut. The main problem with the varieties is a relatively poor farmer taste rating for roasted tubers. Nevertheless, the TLU has generated enough support to justify regional testing and taste assessment in anticipation of release for use as transformation varieties

Cassava planting methods were examined in conjunction with cassava variety testing in 1989 The TLU showed that there is no significant yield advantage in planting cassava as recommended by IRA's Roots and Tubers Program, ie one cutting planted on an angle, instead of farmers' standard practice of two cuttings planted flat Delinking variety and planting method recommendations should speed varietal acceptance

<u>Maize fertilization</u>. The TLU carried out a series of fertilizer level trials in 1987 and 1988, first focusing on 20-10-10 (NPK) and then on various combinations of N and P [6] In the NPK trials, the TLU showed there was a significant yield response to 20-10-10 for both local and improved varieties, but the response beyond 300 kg/ha was too little to justify high application rates The N and P trials showed there is a substantial, profitable response to N, while response to P is erratic and often not statistically significant The profit maximizing rate for N was 102 kg/ha

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[6] Another 1987 test focused on micro nutrients SUL-PO-MAG (15 S, 40 K, 20 Mg) and various combinations of the same nutrients delivered through straight carriers There was a small response to sulphur in Ntui, but no response to magnesium--so no further work was done on micro nutrients

Following the above tests, the TLU regionally tested a tentative recommendation of 60 kg/ha N in both seasons of 1989 [7] The average yield response first season was 795 kg/ha, resulting in a net gain of nearly 70,000 FCFA/ha During second season, there was a substantial yield difference (although not significant due to a large number of complete site failures) In post-test evaluation surveys, a large majority of farmers said that 60 kg/ha had a large effect on ear size and total production Nearly 80 percent of the collaborating SODECAO agents said that 60 kg/ha N should be an extension recommendation The TLU has concluded the same and is now working on whether 30 or 60 kg/ha P might be a warranted supplement in the transition zone [8]

<u>Weed control</u> Work is continuing toward formulation of weed control recommendations for groundnut-based mixed cropping patterns and sole maize, with 1990 or 1991 expected to be the final year for research village testing

In 1987, one versus two hand weedings were compared for sole maize planted at three densities (40, 60, 80 '000/ha) Maize yield from double weeded plots was almost twice that from single weeded plots, but this line of investigation was dropped after determining that most farmers would not consider shifting to double weeding Work on herbicide weed control started in 1988 Five combinations of glyphosate and 2,4-D were tested against hand weeding at four weeks after planting The net benefit for three herbicide treatments exceeded that for hand weeding and a low herbicide application rate had the highest net benefit

In 1989, a low application rate of pre-emergence herbicide was tested versus hand weeding and hand weeding plus herbicide for the traditional groundnut-based mixed cropping system and for sole maize [9] The groundnut mixture trial showed yield and financial benefits from pre-emergence herbicide compared to farmers' practice, but not relative to non-weeding In the sole maize test, Alachlor GD gave a significant yield benefit relative to either hand weeding or Alachlor GD plus hand weeding Since this treatment also had a minimal labor time requirement, it had a

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[7] This rate had the highest marginal rate of return in earlier tests and represented a lower risk to farmers than would a 100 kg/ha recommendation

[8] The TLU has also tried to determine if the profitability of 60 kg/ha N could be linked to fallow cycle or other field characteristics, but no significant relationship could be identified

[9] Alachlor GD (alachlor plus atrazine) was used for sole maize, but only alachlor was used for groundnut mixtures since groundnut is sensitive to atrazine The groundnut mixture trial also included a non-weeding treatment, to assess yield losses due to weeds when groundnut is randomly planted at around 280,000 plant/ha

significantly higher partial benefit than either of the other treatments

Weed control for both groundnut mixtures and sole maize were again assessed in 1990 Yield differences between treatments were not significant Herbicide application, in the end, might not out-perform hand weeding but will likely be formulated as an option for farmers facing labor shortages

Cropping patterns. In cropping patterns tests, the TLU has generated information about maize-cassava intercropping and other alternative mixed cropping patterns for groundnut-cassava-maize

A 1987 maize-cassava intercrop trial showed that simultaneous establishment of both crops resulted in an increase in cassava root yields relative to planting cassava four weeks after sowing maize (a common farmer practice) The same trial showed that pruning cassava in the second season reduced tuber yields to about the level obtained with delayed cassava planting

In 1988, the TLU compared various sole and intercrop patterns for CMS 8503 and CMS 8704 maize, and 8017, 8034, 8061, and local cassava The trials generally showed that neither maize nor cassava root yield was significantly affected by intercropping For all maize-cassava variety combinations, land equivalent ratios were substantially above one

A cropping systems trial involving various combinations and patterns of groundnut, cassava and maize was planted in 1989 and has been repeated in 1990 The first year of the trial showed the gross benefit and composition of product (in value terms) from each system, and that each system giving a higher expected return also had more variable returns The TLU determined that benefits from modified planting patterns primarily depend on whether farmers replant in second season, and on expectations about the market price of maize

Agroforestry The TLU has made the least progress in identifying and assessing agroforestry strategies During 1988, alley cropping (hedgerows) was introduced in farmers' fields in collaboration with the ICRAF project The alley cropping work initiated in 1988 was put on hold until 1990 due to poor establishment. During 1990, hedgerows were planted at six forest zone sites, border hedges (living fence) were planted at several transition zone sites, and repeated attempts were made to introduce managed fallow It is too soon to tell whether acceptable agroforestry options will be identified

Extension Liaison

In 1988, more than 30 MINAGRI agents were provided with information about food crops production practices and IRA research activities Several participants later served as enumerators for various TLU surveys In 1989, comparable courses were provided to SODECAO field agents At each course, participants were given seed, fertilizer, and instructions for

implementing on-farm tests and demonstration plots, and administering surveys

In 1990, SODECAO field agent training was carried out in each division of the Centre Province Agents were provided with seed, instructions and questionnaires for regional tests More than 200 additional agents were provided with instructions and seed for adoption plots In mid-1990, the TLU developed agreement with MINAGRI to begin regional testing in 1991 The TLU is also organizing a MINAGRI training course on food crops anddemonstration methods, to be attended by senior level staff from all three southern provinces

TLU Coordination

The most tangible accomplishments of TLU coordination have been as follows

a preparation of two review papers on TLU activities[10] and several briefing documents
b organization of three TLU staff meetings and one methodological workshop
c explanation and justification of the TLUs to Project and IRA evaluators and visitors

Through the above activities, there has been a noticeable convergence in TLU methodologies, thereby laying the groundwork for IRA institutionalization of the TLU program Inter-team discussion and review of TLU methods has increased and methodological guidelines have been developed covering 20 topics [11] TLU staff recommendations have been prepared on TLU priorities, methods, publication channels, circulation procedures, etc The value of the TLUs has been well established both within IRA and among national and foreign institutions collaborating with IRA

Other Activities

In addition to testing and liaison activities, the TLU has held two to three village meetings each year, sponsored a village field day attended by more than 100 farmers, implemented several maize variety demonstrations, helped organized two research workshops, and spent time preparing for the NCRE Project and IITA EPR evaluations Supervision was provided for memoirs by Dschang University Centre students TLU staff participated in program planning meetings in 1987, 1989 and 1990 IITA technical assistants (TA) on the TLU often provided assistance to IRA and NCRE Project management Dr Poku on several occasions served as Acting Chief of Party or Acting Deputy Chief

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[10] These are "Incoming Review" in 1988 and "The NCRE/TLU Experience" in 1989

[11] A research methodology handbook, based on proceedings from the 1990 TLU workshop, is nearing completion

6 4.5 IN-SERVICE TRAINING

On-going in-service training has been provided to eight national counterparts All counterparts, regardless of discipline, have been trained in trial implementation and analysis procedures As a result of this training, the counterparts have taken responsibility for most aspects of the TLU's testing program Specialized training was provided in use of Dbase and Systat software

Formal in-service training was provided through the TLU Methodology Workshop held in January 1990 For that workshop, handouts were prepared on rapid appraisal surveys, research domains, decision analysis, farmer groups, yield measurement, collateral data, regional testing, contrasts/mean separation, analysis of covariance, partial budgeting, and research benefit/cost analysis

Prior to the workshop, in 1989, a training case study was prepared on the basis of Maroua TLU circumstances Methodological notes were circulated on general linear tests in regression analysis, and data transfer from Dbase and Lotus to Systat

Three national counterparts attended an NCRE Project biometrics workshop, two attended an FSR short course at CUDS, and five attended an NCRE Project M-Stat workshop.

6.4.6 PRIORITIES FOR FUTURE RESEARCH

The TLU has developed a cost-effective methodology which it will continue to use in 1991-94 Adaptive trials and surveys will be concentrated in representative villages and an attempt will be made to increase the number of villages to two per zone To the extent possible, most trials will be farmer managed. Technology validation through collaborative regional testing will become an increasingly important component of the TLU program

At least through the end of 1991, technology development will continue to focus on improved materials and practices for cassava, groundnut and maize By the end of 1991, the TLU expects to have tentative recommendations for maize and cassava varieties , maize fertilization, and weed control methods for sole maize and groundnut-based cropping patterns. Regional verification and demonstration will be necessary during 1991-1994. The search for biological means of improving and maintaining soil fertility is expected to be an important TLU theme during the rest of the NCRE II Project While the TLU will emphasize getting closure on current initiatives, efforts will be made to establish future technology development research priorities

Linkages established with SODECAO, PNVFA and MINAGRI will be maintained and hopefully expanded Starting in 1991, the focus of extension training will shift to the subject matter specialist level. A concerted effort will be given to development of

technical and "practical advise" extension bulletins The TLU also expects to produce an average of two to three papers or reports each year, summarizing findings for researchers and planners, recommending research priorities, and characterizing research methodology

Institutional development will continue through in-service training of IRA scientists and technicians Both TLU technical assistants will continue to play leading roles in IRA's Farming Systems Program Several TLU coordination activities are planned, subject to authorization of the new Chief of Party

7 CEREALS PATHOLOGY

7 1 MAIZE PATHOLOGY

7.1 1 INTRODUCTION

The Cereal Pathology Unit of the NCRE Project has, like the other component of crop protection (Entomology), no expatriate counterpart As such, less support has been given to the unit's problems and work plan, during the last five years The unit worked in collaboration with other units in order to receive some support from the project for its research activities

The mandate of the unit within the project is to handle all pathological problems of cereals (maize, sorghum and millets), in order to set priorities for the breeding programs in breeding for disease resistance, and developing cultural practices to control diseases

7 1.2 OBJECTIVES

During the first phase of the project (1981-1985), emphasis was laid on identification of diseases, their geographical distribution and severity This resulted into a cartography of major maize, sorghum and millets diseases, ranked by order of importance in each agro-ecological zone

Activities during this second phase (1986-1990) were geared towards

- Population improvement and development of varieties resistant or highly tolerant to major diseases, in very close collaboration with the highland and lowland maize breeding units,
- Monitoring new diseases and studying their etiology and epidemiology with the aim of developing control measures (cultural, genetical),
- Understanding population dynamics of pathogens such as **Excerohilum turcicum** which are found in the highlands and lowlands of Cameroon

7.1 3 CONSTRAINTS

This unit has been allocated inadequate funds for the past five years

There has been much less backstopping from IITA and/or ICRISAT as the first phase

There has been poor as compared to communication between the NCRE head quarters and the pathology unit, and also between this unit and other units of the project besides breeding units This is a consequence of the fact that there is no expatriate to represenyt the unit at the IITA/NCRE staff meetings

7 1.4 ACCOMPLISHMENTS

About 60% of the work program initiated during the five years have been completed Activities have focussed on

- development of varieties resistant to Maize Streak Virus (MSV),
- population improvement for high tolerance to Blights (**Turcicum** and **Maydis** Blights), to Rusts (**Sorgi** and **Polysora** Rusts) and other foliar diseases,
- development of cultural practices to control **Rhizoctonia solani** on maize,
- characterization of **Excerohilum turcicum** isolate from highland and lowland maize growing areas

7 1.4. Ear and Stalk rots

The incidence and severity of stalk rots vary from year to year and usually they have a local importance During 1989 growing season, we recorded 50 to 75% seedling and stalk rots in the breeding trials at Santa Estate (1750m), and 67% stalk rot in susceptible entries of the IPTT at Babungo (1170m) This was similar to what we observed in breeding trials at Mbiyeh (2000m) in 1988 The stalk rotting fungi commonly encountered are Fusarium moniliforme found everywhere maize is grown, Botryodiplodia theobromae in the humid lowlands, Rhizoctonia solani in hot and very wet environment, and Diplodia maydis in cool environment

In the highlands (and mid-altitude), maize is harvested in August-September, when the rains are heavy This results in high incidence of ear rots (Table 1) A preliminary work on the inventory of seed mycoflora showed that fungi responsible for kernel rots were Fusarium spp Diplodia maydis, Rhizopus spp , Botryodiplodia theobromae When moisture content of stored grain is around 15-17%, Penicellium spp and Aspergillus spp develop and together with weevils, can cause up to 15% postharvest losses

7.1.4 2 Maize Streak Virus

Transmitted by a leafhopper **Cicadulina mbila**, MSV is found in all the agroecological zones, but with differing incidence and severity It is widespread and endemic in Zones II and III (Table 2) where it can cause complete crop failure under epiphytotic conditions The disease is sporadic in the highlands and intermediate zones where it can become important if a second maize crop is grown under irrigation MSV is the main problem in the second season maize crop in the lowlands In the South West Province, 16% of losses in the first season maize crop is attributed to MSV

Table 1 Results of three years of selection to identify sources of resistance to ear rots in maize, Cameroon, 1987-1989

Trials	Nber of lines in different disease reaction categories					Total
	1	2	3	4	5	
1987 season						
Introduction screening	0	1	8	3	0	12
Hybrids	5	14	8	0	0	27
Kasai testcross	1	11	4	0	0	16
34 testcross	0	4	12	0	0	16
1988 season						
Subtropical EVT (CIMMYT mat)	0	5	7	2	0	14
Hybrids sets 1,2,3	10	34	27	1	0	72
34 testcross	0	18	27	3	0	48
1989 season						
Hybrids sets 1,2,3,4	7	82	74	16	3	176
HAP1	0	100	61	8	0	169
HAP2	2	99	43	0	0	144
TCA1	0	20	36	5	3	64
TCB1	0	29	31	4	0	64
TCA2	1	37	24	0	0	62
TCA3	2	30	14	1	0	48
TCB3	3	24	18	4	0	49
34 testcross	0	9	17	8	0	34
ATP	16	153	56	0	0	225
IPTT(IITA)	12	15	78	122	29	256

[a]disease scale 1=traces, 5=heavy infection

7.1.4.3 Screening techniques

Due to its importance, MSV is the first disease for which a selection programme was launched since 1985, in collaboration with IITA of Ibadan, Nigeria

Maize Streak Resistant (MSR) lines are introduced from IITA and used either to develop new varieties following progeny testing scheme or as a donor of resistance genes to adapted varieties through back-crossing, each cycle being screened at IITA under heavy infestation by the vector Table 2 presents MSR varieties developed or converted under the NCRE Project

7.1.4.4 Leaf Blights and Rusts

These are the most important leaf diseases of maize in Cameroon **P sorghi** is specific to highlands, while **P polysora** is widespread and endemic in the lowlands, but is also found in the intermediate zones (Foumbot and Dschang areas)

Leaf blights are known to be altitude specific, but we have observed maydis leaf blight in Foumbot (1100m), and turcicum leaf blight in Nkolbisson (600m), despite their being referred to as lowland and highland leaf blight respectively This overlapping makes it necessary to have varieties, resistant to both highland and lowland blights

7 1.4 5 Screening techniques

Although the principal targets are the two blights, this technique also focuses on any disease that overseasons as mycelium in infected leaves

Infected leaves are harvested before complete senescence, sun dried, ground into powder, and stored in well sealed plastic bags which are kept in cool dry environment

Artificial inoculation is performed when plants are at the knee-high stage A pinch of inoculum is put in the leaf whorl of each plant in the nursery plot This is to secure an even distribution of inoculum, avoid disease escape and identify and select materials resistant to blights

Inoculation by rust propagules is from natural sources. After 50% silking, diseases are rated using a 1-5 scale (1=traces, 5=heavy infection) Selection among and within rows are performed based on the scores, plots or plants scoring 3 and above are discarded Other diseases selected for include Curvularia Leaf Spot, Physoderma Brown Spot, Leopard Spot, etc

In the ear-to-row selection used to improve varieties such as EKONA WHITE, EKONA YELLOW for lowlands, COCA, BACOA, BACOB, and MLC for highlands, only plants scoring less than 3 in the 1-5 scale for blights and/or rusts are selected

Natural inoculation is used as infection source in every population advancement and variety improvement, very susceptible materials are now identified and used as spreaders in future replicated trials

7.1.4 6 Diseases with uncertain etiology

Many diseases with uncertain etiology have been reported in Cameroon The most interesting ones are those that have spread heavily the past two years

- "Leaf Blight", so called because of the type of necrotic lesions it causes on leaves In a situation of severe infection, 70-90% of the leaf surface area can be destroyed, causing premature death of leaves and stunting Lesions are round in shape, with well defined margins, not exceeding 0 50cm in diameter This disease is becoming endemic in the highlands where most of the existing genotypes and the High Altitude population seemed to be susceptible The pathogen responsible for the disease is of a Phaeosphaeria sp

Table 2 Maize streak resistant varieties developed by IRA/NCRE (1985-1989)

Variety	Target zone	Type	Stage
CMS8501	II,III,V	medium,white,OP	released
CMS8503	III,V	-"-	-"-
CMS8507	II,III	-"-	-"-
CMS8602	V	early,yellow,OP	-"-
CMS8704	III,V	medium,yellow,OP	-"-
DMR-ESR-Y	III(Center)	early,yellow,OP	-"-
BSR-81	III(East)	white,OP	-"-
TZSR-W	III(East)	white,OP	-"-
CMS8710	V	late,white,OP	TBR
NDOCK8701	III(Center)	-"-	TBR
KASAI-MSR	I	short,white,OP	TBR
Fbt(3)-MSR-85	I		in process
Fbt(4)-MSR-85	I		-"-
Fbt(5)-MSR-85	I		-"-
Fbt(3)-MSR-87	I	medium,white,OP	-"-
Fbt(5)-MSR-87	I	late,white,OP	-"-
Fbt(4)-MSR-87	I	late,white,OP	-"-
COCA-MSR	I	late,white,OP	-"-
BACOA-MSR	I	medium,yellow,OP	-"-
SHABA-MSR	IV	late,white,OP	-"-

OP = open pollinated
TBR = to be released

- "Unknown Leaf Spot" It was first observed in 1987 and has been monitored throughout the maize growing zones It is present in all the agroecological zones, except zone V It develops on leaves brown, elongated lesions with a yellow halo around the margins, and a well defined centre Lesion elongate concentrically and when fully expanded, is tan in color and can be easily confused with **Turcicum** leaf blight Mature lesions present chains of spores extruding from ostioles of perithecia Spores are dark and two celled, fusoid, with one end shorter than the other end This pathogen has been identified as a **Diplodia** sp

Most of the CMS series, the Acid Tolerant population, BACOA, SHABA, COCA and its liguless version show some susceptibility to the disease

7 1.5 IN SERVICE TRAINING

One national, Mr NANKAM Claude was trained to M Sc. in plant pathology from July 1984 to December 1986 Mr NGOKO, a second national is being trained at Texas A & M University for a M Sc in plant pathology since 1987, and is expected to be back in December 1990

In collaboration with lecturers at the University Center of Dschang, we have directed research works and stages for students in the Ingenieur Cycle (Ingenieur Agronome (I A) and Ingenieur des Travaux Agricoles (ITA) and Techniciens d'Agriculture (I A)

1987	1 I A
1988	1 T A , 2 I T A and 1 I A
1989	1 I A
1990	2 I T A

7 1.6 PRIORITIES FOR FUTURE RESEARCH:

Future work on maize diseases will include

Ear and stalk rots

1- Importance of ear and stalk rots and their study in relation to etiology, interaction with insects and with plant nutrient and element status
2- Identification of conducive site and/or suitable inoculation method for screening purposes
3- Screening genotypes for resistance to these diseases

Head smut

Study of the ecology of the pathogen and the epidemiology of the disease, to know why it is locally important? where and in what proportions off-season pathogen survival occur (soil, seed)? the effect of N on its incidence, the relative susceptibilities of the varieties and hybrids breeders are selecting

Leaf diseases

1- Characterization of isolates of Turcicum and Maydis leaf blights, to determine races existing in Cameroon
2- Pathogen ecology and disease epidemiology for the two organisms and diseases in relation to the key climatic parameters (temperature, relative humidity)

Diseases with uncertain etiology

1- Identify pathogens responsible for the diseases
2- Study their epidemiology
3- Identification of control measures (cultural, genetic)

7 2 RICE PATHOLOGY

7 2.1 INTRODUCTION

During the agricultural campaigns of 1986-1990, the unit of rice pathology has oriented its activities around the three following themes

Theme 1 · chemical control of Pyricularia

The operations conducted during this period are a continuation of studies initiated in previous years These studies had as a goal
a) the scientific investigation of the better products for chemical control of pyricularia, b) the determination of best periods of application and the verification of results already acquired This research started in 1985

Theme 2 Study of influence of cultural practices on the incidence of the pyricularia of rice in the Mbo Plain

These studies started in 1989 They consist of the study of the influence of cultural practices on the incidence of pyricularia on promising varieties (ITA 212, ITA 222 NANG GH HIEP 75-5 CISADANE and CICA8) in the Mbo Plain

Theme 3 : Surveys on rice diseases for the various rice zones of the high plateaus of the west

They are composed of studies of indeterminate duration

7 2.2 - OBJECTIVES

- Identification of the principal diseases of rice for the various rice zones of the high plateaus of the west and north-west
- Study of the sensitivity of rice varieties to the vector agents of these diseases
- Study the methods of control for the principal diseases identified

7 2.3 CONSTRAINTS

- Insufficient budget granted to research This forced the program to limit its activities to the Mbo Plain.

- Insufficient vehicle availability The only vehicle available is used by four researchers

- Delay of SODERIM in the preparation of the experimental plots
- Delay of SODERIM in supplying water to the experimental plots

7 2.4 ACCOMPLISHMENTS

Identification of the principal diseases

- Three the most important fungal diseases of rice have been Identified They are Pyricularia, Rhynchosporium, Acrocylyndrium

Their frequencies of attacks and the variability of these attacks have been established (Table 1)

Table 1 Observations of diseases on rice in September, October and November 1988

			Period							
			5-11 Sept			3-10 Oct			30/10-3/11	
PLACES	TYPES	VARIETIES	JAS	ATT	SPORE	JAS	ATT	SPORE	JAS	SPORE
BAIGOM	IRRI	CICA 8	31	14	P	60	18	P+R	99	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
SANTCHOU	IRRI	CICA 8	-	18	-	-	20	P+R	-	Pf+Pc +R+C
ENVRION	PLUV	IND	20	-	-	-	22	P+R	-	Pf+Pc +R+Has
NDOP	IRRI	CICA 8	55	0	R	100	4	P+R	R0	R+Pf+ Pc+Has
MENCHUM VALLEY	IRRI	CICA 8		0	R	-	4	P+R	-	R+Pf+ Pc+H+Has
PLUV	ABOUT	IND	-	3	-	-	6	P+H+R	-	R+Pf+ Pc+H
TONGA	PLUV	IND	50	3		100	7	P+H+R	120	R+Pf+ Pc+H
BADOUNGA	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
H = Helminthosporium
A = Acrocylindrium
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 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 attacks of 20, 16, 18% respectively

In October, the attacks of 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 the casiers poorly conducted in Baigom, on late transplanted rice in Tonga, in rainfed rice fields in the Menchum valley On the whole the indices of attacks decreased 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 ten 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 activity needs to be pursued for at least 2 years before arriving at definitive conclusions

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 rainfed 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 some varieties of rice in three different sites

Varieties	Locations		
	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

Chemical Control of Rice diseases
Time of application of fungicide

This trial showed the need to treat rice in the vegetative stage

This trial also showed that all treatments were different (figure 1)

Seed treatment followed by a treatment at 50 and 70 days after seeding was the best program of application for the fungicide tested (table 3)

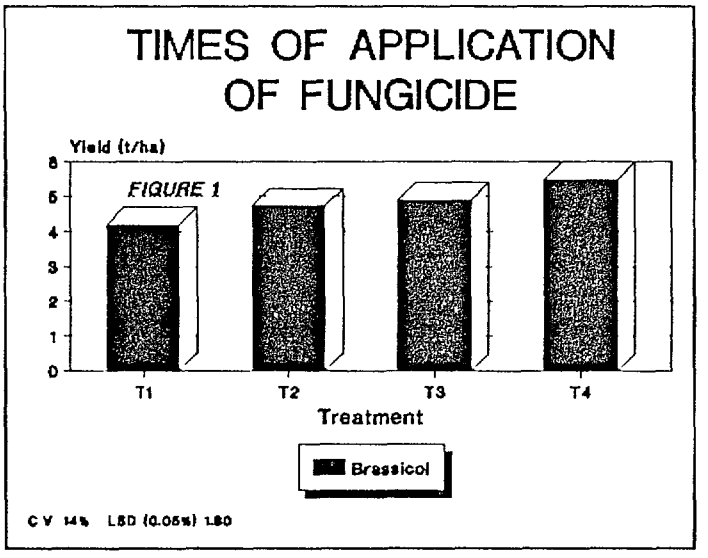

Table 3 Times of application of fungicide, Yield t/ha

Treatments	Yield (t/ha)	% Gain over Check T1	T2
1 Check non treated	4 192		
2 Check + Brassicol	4 739	+13	
3 Treated Seed + 1 treatment at 50 JAS	4 896	+16	0 3
4 Treated Seed + treatment at 50 and 70 JAS	5 500	+31	16
Significance		S**	
CV%	14		
LSD (0 05)	1 60		

Time of application of Pelt 44

This study had the objective of determining the number and the best times of applications of Pelt 44 to stop the attack of in the field at Santchou (Mbo Plain) It appeared that 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 (figure 2, table 4)

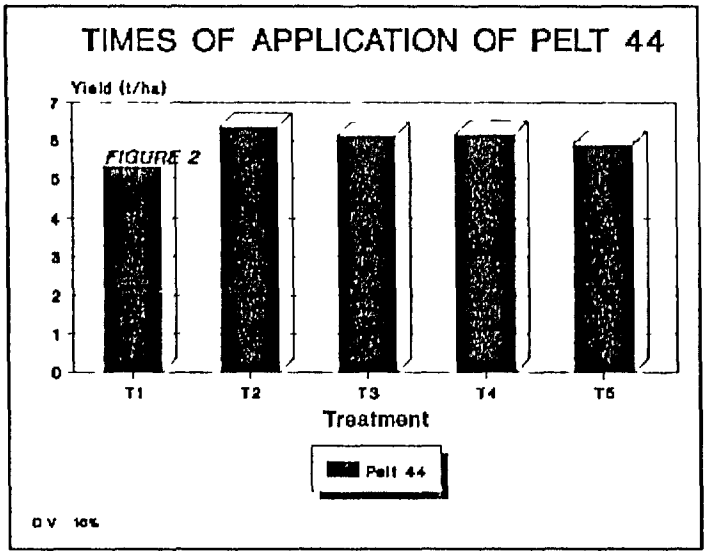

Table 4: Study of best application time of Pelt 44 on rice

Treatment	Yield t/ha	% Gain
Check	5 324	
Treated with Brassicol + 1 treatment at tillering	6 355	+ 19
Treated at tillering	6 128	15
Treated + 1 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**
CV %	16	
LSD (0.05)		

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 conducted 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 (figure 3, table 5)

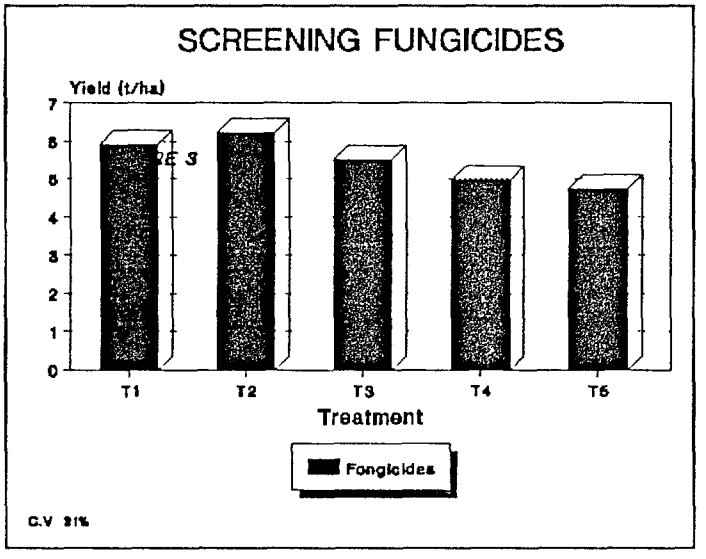

Table 5 Performance of the fungicides

Treatments	Yield t/ha	% Gain
Pelt 44	5 916	+ 25
Grex T	6 218	29
Kitazine	5 520	16
Brestan 60	4 985	5
Untreated Check	4 726	
Statistical significance		S**
CV %	21	
LSD (0.05)		3 75

Soil Treatment with Fungicides

Comparisons 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 organisms and microorganisms

In previous studies we have observed symptoms attributed to Ditylenchus angustu, 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

Effect of Nitrogen nutrition on the incidence of the pyricularia

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

The results 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 (Cisdane) appears to be the most resistant while V5 (CICA 8) is the most susceptible to foliar pyricularia (table 6)

Table 6 Effect Nitrogen application on pyricularia infection

Varieties	Mean return of the 4 replications (t/ha)					
	N0	N20	N40	N60	N80	N100
V1	4 559	4 150	4 451	4 081	5 019	5 007
V2	4 246	4 993	4 621	4 475	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	4 361	4 610
V5	4 774	4 679	4 733	4 766	4 958	5 014

The results obtained for the attack of stems (table 7) are not analogous to those of the leaves (table 8). The influence of the different rates of nitrogen on infection are not clearly demonstrated on the stems

This makes us believe that there is not only a difference of sensitivity among varieties but also, a variability of the virulence of the Pyricularia 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

Table 7: Effect of Nitrogen application on incidence of stem pyricularia

Varieties	Scores Pyricularia on Stem • Mean of 3 observations					
	N0	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 81	6 63	5 01	5 47	4 60
V4	3 54	3 43	5 24	2 94	2 96	4 30
V5	6 17	6 03	4 20	4 92	4.84	3 70

Table 8• Effect of Nitrogen Fertilization on incidence of foliar pyricularia

Varieties	Scores Pyricularia on leaves Mean of 3 observations					
	N0	N20	N40	N60	N80	N100
V1	2 5	3 25	4	3 75	3 5	4 25
V2	2 5	3	3 25	4	4	4
V3	2 75	3	2 75	3 75	3 5	4
V4	2 5	2.25	2 75	3 25	3	3.75
V5	3.2	3 50	4	4 75	4.7	4 75

Effect of Planting date on incidence of Pyricularia

Four planting dates were tested with best selected varieties

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 definitive conclusions This trial should be continued

Effect of Method of Soil Preparation on Incidence of Pyricularia

Three types of soil preparation were tested (table 9) 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 pyricularia attack.

Table 9 Effect of soil preparation method on incidence of pyricularia

Characteristics	Soil Preparation Method		
	M1	M2	M3
Incidence of Disease	absent until flowering Light attacks of Phynochorium at tillering	presence Pyricularia, Rhynchosporium after tillering	string infection after transplanting Pyricularia Rhynchosporium on every variety
Toxicity	none	slight toxicity in iron	toxicity in iron very pronounced
Insect Damage	insignificant	average, CICA 8 attached more	very pronounced
Development	Very good vegetative, vigorous plants	average	heterogenous
Tillering Plant	Strong CICA 8 was better than ITA 222	average CICA 8 and ITA 222 identical	weak 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

Research on disease resistant varieties and new introductions in comparative trials

From 1981 to the present about 10 000 varieties or lines have been introduced to Cameroon They have been tested for their adaptability to local rice growing conditions

The varieties or lines having good resistance to disease (Pyricularia, Rhynchosporium, sheath rot, etc), cold tolerance and 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 a total of 345 lines These materials have been tested at Santchou (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 pyricularium (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

ARLRESS 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 pyricularia

7.2 5 TRAINING

An ITA student is planned for the current year. The research theme remains to be defined

7.2 6 PRIORITIES

We would like to further pursue the following themes

a) Effect of nitrogen, planting dates and land preparation methods on the incidence of pyriculariosis on five rice varieties in the Mbo plain

b) Identification of rice varieties which are resistant or tolerant to the main diseases Pyriculariosis caused by Pyricularia oryzea, Rhynchosporiosis caused by Rhyncosporium oryzea, grain rotting caused by Acrocylindrium oryzea, etc, etc

c) Study of Pyricularia oryzea disease variability

d) Survey and observations on rice diseases in the rice planting area in the west and north-west high plateaux

8 CEREAL ENTOMOLOGY RESEARCH UNIT

8 1 HIGHLAND CEREAL ENTOMOLOGY

8 1.1 INTRODUCTION

Cereal entomology research unit in Dschang is mainly concerned with post harvest handling and storage problems of all the major cereals in Cameroon including maize, rice, sorghum and millet The research program is supposed to cover all the ten provinces of the country

8 1 2 OBJECTIVES

- To acquire and equip a Laboratory suitable for maintaining stored grain insect cultures for experimental use and for grain post production systems work

- To survey and document the traditional storage methods of each type of grain and the various stored grain insect pest species associated with each in the various ecological zones

- To evaluate the efficacy of some traditional and introduced grain storage methods as regards to insect attack and grain quality

- To investigate suitable methods (chemical and non-chemical) for controlling the grain storage pests

- To screen grain varieties for natural resistance/tolerance to storage pests

- To evaluate the efficacy of the available stored grain pest control chemicals

8 1 3 CONSTRAINTS

Due to the fact that no expatriate scientist is posted to the unit, the only national entomologist had very limited means to execute the program

Because of the lack of support staff and financial means, activities were concentrated only in the western highlands and some collaborative work with the NCRE researchers at Ekona in South West Province

8 1.4 ACCOMPLISHMENTS

2.6.4.1 MAIZE POST HARVEST ENTOMOLOGY

This has been the main area of work because maize has the greatest post harvest problems in the South West Province and Western Highlands component to rice and beans grown in the area and because Sorghum/Millet growing areas are for remote from where the research is based

2 6.4.1.1 Surveys of Peasant Maize Farmers' Post Harvest Handling, Storage and Marketing Problems

The operation was achieved in Fako and Meme Divisions of South West Province through collaboration with the NCRE/TLU team of Ekona and in Bui Division and Ndop Sub-Division of N W Province through collaboration with the NCRE/TLU team of Bambui

In both Provinces, drying and storage were the two major problems expressed by the farmers interviewed Farmers expressed the willingness to use improved high yielding varieties to grow more maize if the two problems are solved More than 80% of the farmers in Bui store maize from one harvesting season to the other and even longer (i e above 12 months) while less than 20% of S W Province farmers store above 9 months

All those who store maize in both areas do withdraw in bits for house consumption and for sale rather than disposing all at once It was interesting to note that about 85% of the maize farmers interviewed in S W Province were of West and N W Province origin.

Other major points revealed by the survey in the two areas are summarized in the table that follows

Farmers Responses	% of those interviewed Fako & Meme S W Province	Bui N W Province
Method of Drying After Harvest		
i Smoked dried in Banda	86	60
ii Sundries on roofs or platforms	48	40
iii Hung in veranda	5	-
iv Not dried before storage	5	-
Method of Storage		
i Tied and Hung in the house	33	53
ii Tied and Hung in veranda	10	13
iii Stored in Bamboo Boxes (Dschang)	-	50
iv Spread in Banda with husk	76	27
Estimate Quantity Stored		
<100kg	29	-
100 - 500kg	38	27
800 - 1000kg	19	27
>1000kg	14	46
Use of Protection Measures		
i Uses chemicals	14	60
ii Knows the name of chemical	5	60
iii Uses natural plant material	-	13
Storage Problem by Order of Seriousness		
Weevils (insect Destruction) 1st	62	27
2nd	33	47
Rats 1st	33	53
2nd	57	7
Moulds (Rots) 2nd	5	13
3rd	29	Nil

2 6.4.1 2 Evaluation of The Resistance/Tolerance of Maize Varieties to Natural Infestation and Damage by Stored Grain Insect Pests at Various Ecological Zones

Results have been erratic due to many irregularities in storage management in the various sites when the researcher was unable to grow the varieties himself and control the stores This is now possible on three sites- Dschang, Foumbot, and Santchou using 20 varieties

The differences in storability of nine varieties grown and stored in three sites in Wum Sub-Division of Menchum Division (Wum Central, Ngoh and Xemugeh) was done in 1987 Of the nine varieties composite 290 was the worst damaged (50%) followed by MCC and COCA (45 and 43% resp) while the locals and Ekona yellow were the least damaged (13 and 22% resp) Evaluation was done twice at 3 months and 9 months of storage respectively.

The major stored grain insect pests identified during the storability evaluations in order of abundance include the Maize Weevil (Sitophilus zeamais), the Red Flour Beetle (Fribolium castaneum), the Sawtoothed Grain Beetle (Oryzaephilus surinamensis), the Angoumois Grain Moth (Sitotroga cerealella) and the Flat Grain Beetle (Cryptolestes pusillus)

8 1 4.1.3 An Evaluation of the Efficacy of Some Popular Stored Grain Insecticides for the Control of the Maize Weevil

It was noticed during the surveys of peasant maize farmers post harvest problems that there is no organized supply of stored grain pest control chemicals but farmers treated food maize with chemicals bought from the open market without name labels A few stored grain insecticides are available with some chemical firms in Douala including Actellic 2%, Permethrin (1%, 1 5%, and 2%), Pereal M dust (composed of 1 5 Permethrin and 2% Malathion) and Sumithion/Sumithrin pp 1 8 Recently Sumicombi and Sufagrain have been advertized by Shell Cameroon and Group Roussel UCLAF Companies respectively These two are being tested for the control of maize weevil under three different storage methods Meanwhile three of the chemicals including Sumithion/Sumithrin, Actellic and Permethrin were tested in 1989 for the control of maize weevil in heavily artificially infested maize stored in plastic buckets with lids Five closes were tested including the manufacturer's recommended dose, 2 dosed above and 2 larver. The results revealed that all doses of Sumithion/Sumithrin and Actellic were effective in controlling the maize weevil for up to the 12 months of storage while Permethrin was only effective for up to 6 months

8.1 4.1 4 Pit Storage of Maize in Dschang

It has been shown that even in high rainfall areas such as Dschang, maize could be stored in plastic plus straw lined pits for up to four months Two forms of maize (husked and dehusked cobs) were stored above ground by hanging in house veranda and in 80cm diameter pits dug 80cm deep

Results under six evaluation criteria are shown below

Treatment		No of line Weevils/kg	% Grain Insect	Damage Mould	% MC	% Germination
Conditions at Start		1 67	0 00	0 00	13 3	91 00
Above Ground	Husted	66 43	10 07	6 05	13 7	73 75
	dehusted	28 97	1 91	2 19	13 4	89 25
Pit	Husked	61 45	8 08	1 89	13 4	84 75
	Dehusted	5 88	2 77	6 52	15 9	67 75

If moisture migration into the grain is prevented by providing a good lining, storage of dehusked cobs in pits can be worthwhile

8.1 4 2 RICE ENTOMOLOGY

8.1.4 2.1 Survey and Documentation of Rice Field Insect Population Dynamics and their Effect on Rice Plants

This operation was carried out for two years (1988 and 1989) in Ndop and Santchou

Sweep ret collections were made during the day and hurricane light traps were used for collection of noctruids (night plying insects) Over 40 different species have been collected but only 20 of the most abundant or common ones have been identified and their oclatine intensities calculated for each site Even though most of the species are common in both sites (Santchou and Ndop), their relative intensities are different and this was found to affect the type and severity of damage caused by pest species on rice plants A typical example was seen from the relative intensities of the stalk-eyed borer (Diopsis macropthalma), a very important rice stem borer and the Long and Short Honed Grasshoppers Diopsis population is always higher in Ndop than in Santchou, particularly towards the milking stage of the rice growth thus causing the incidence of white heads which are hardly found in Santchou Their populations are kept quite low in Santchou towards heading by the relatively high populations of the grasshoppers which are known to be predaceous on rice bugs and stem borer eggs

8 1 4.2.2 The Fourteenth International Rice Stem Borers Nursery (IRSBN 1989) and National Rice Stem Borer Nurseries The 4th IRSBN 1989 designed by IRRI was planted in 1989 and screen for resistance to stem borers carried out as per protocol from IRRI

Eight Cameroon National Selections were also screening in the same year using the same IRRI methodology. Tainan V ranked highest in resistance followed by ITA 222 and SISADAN while ITA212 was the least resistant variety

8.1.4.3 Sorghum Entomology

8.1.4.3.1 Scoring of Sorghum and Millet lines for Insect Pest Damage in Maroua

The Sorghum/Millet breeder's lines in Maroua were scored for insect pest damage in Sept 1987 and Sept 1988 Four Sorghum trials were scored in 1987 and 1988 four sorghum trials and one Pearl Millet were scored

The important insects found in the fields included the sugar cane Aphid Melanaphis sacchari, the Green Bug (Schizaphis graminum) in 1987 while in 1988 the important species included Pentatomids or stink Bugs, Earwigs (Labiduridae), a stem borer Heliothis sp and Lady Bird Beetles (Coccinellidae) Generally there was very low level of panicle damage except for same few entries in 1988 The one scoring towards maturity was considered inadequate for screening varieties

8.1.4.4 Maintenance of Insect Cultures

The rearing of maize weevils for experimental use was started in 1986 and has continued to be maintained Sugar jass adapted for the purpose by replacing the glass caps with cross sticked cloth material and wire mesh are quite satisfactory Well designed insect culture jass could be bought (ordered) in future

Cultures of the Bean Weevil (Acanthoscelides obtectus) and the cowpea weevil (Callosobruchus maculatus) are also being established.

8 1.5 IN-SERVICE TRAINING

Only the researcher (entomologist) attended a Grain Storage and Marketing Short course at Kansas State University, U S A from 5 June to 21 July 1989

8.1 6 PRIORITIES FOR FUTURE RESEARCH

- Laboratory Screening of New Cereal Varieties for susceptibility to Storage Insect Attack This will require equipping a laboratory for post harvest grain systems research

- Surveys of Post Harvest Practices This will involve systematic surveys to assess losses associated with various handling and storage methods and documentation of pest species spread It will require a strong 4-Wheel Driven vehicle permanently attached to the unit.

- Survey, Documentation and Test of the Efficacy of Natural Plant Materials used for storage Pest Control It is a proposed thesis research topic

- Test and Evaluation of Grain Loss Reduction Methods This will be done in Collaboration with the Engineering Dept of Dschang University Center

- Screening of Stored Grain Insecticides for control of storage pests in various storage methods.

8.2 MAIZE ENTOMOLOGY

8.2.1 INTRODUCTION

The entomology section of NCRE is the newest section of the project. At first it was composed of only one researcher. Currently it is composed of researchers in several locations. The Nkolbisson research is oriented towards the protection of maize in the field.

8.2.2 OBJECTIVES

- Field identification of the principal maize pests in order to better combat them
- Study of methods of control of pests so identified
- Study of the economic impact of the different methods of of control

8.2.3 CONSTRAINTS

- Lack of transportation: the field trips for follow up of tests are limited
- Lack of personnel: the unit has been without a technician for at least three years
- Lack of collaborator: to obtain assistance or critical advice it is necessary to call upon IITA researchers who are already overburdened
- Lack of appropriate literature reference materials

8.2.4 RESULTS

The first few years were dedicated to an inventory of the insect pests of field maize in the zone of low altitude and high rainfall. The results have shown that only the Lepidoptera stem borers cause the greatest damage in the field. The principal species present are Busseola fusca, Sesamia calamestis, and Eldana saccharina.

The studies were then oriented towards the study of the behavior of the borer species. This has permitted us to determine that only the larvae of Busseola fusca and Sesamia calamestis appear at the beginning of the cycle and attach themselves directly to the young plants. The larvae of Eldana saccharina appear around flowering time and cause injury to the tassels (Table 1).

Table 1 Distribution of B fusca, S calamestis and E saccharina of Minkomeyos, Yaounde (September 1985 - January 1986)

Stage of Plant development	Month	Total insects collected	Number of insects of each specie(*) B fusca	S calamestis	E saccharina
Emergence	September	115	21(18 3)	79(81 7)	0
Pre-flowering	October	612	457(74 3)	137(22 4)	18(2 9)
Post-flowering-maturity	November December	656	239(36 4)	61(9 3)	356(54 3)
Post-harvest	January	130	26(20)	14(11)	90(69)
Total		1513	743(49 1)	291(19 2)	464(30 7)

* The figures between parentheses represent the proportions in % of the total for every period

During this period an investigation was performed on the impact of the planting dates on attacks The objective was to determine the dates around which it is advisable to sow to avoid severe attacks The results have shown that by sowing around the 30th of March for the first campaign and the 30th of August for the second, the maize was able to escape severe attacks due to the borers (Table 2)

Table 2 Comparison of development of attacks of stem borers on the varieties of maize TZESR and Bafia planted on different dates in first and second seasons in Yaounde

Planting Date	Rate of attack (%)						Holes * (Number/stem)		Yield (t/ha)	
	3WAP**		6WAP		12WAP					
	TZESR	Bafia	TZESR	Bafia	TZESR	Bafia	TZESR	Bafia	TZESR	Bafia
					first season					
15 March	16***	7 75	36 5	35 9	46 3	44	2 6	3 0	5 3	3 4
30 March	0	1 3	3 9	6 3	14	1 58	3	3 1	7 5	4 7
15 April	0	0	5 2	7 5	35 4	42 5	4 5	4 8	6 9	3 9
30 April	3 5	2 8	27 2	29	52 9	63	8 7	6 5	5 2	2 9
					second season					
15 August	10	9	31	27	68	61	5 2	7 5	3 0	3 6
30 August	12 5	10	35	31	58	63	3 2	5 0	5 4	5 1
15 Sept	5	6	27	20	51	48	4 2	4 7	2 3	2 5
30 Sept	12 5	17 5	59	42 3	41	47 5	4 1	7 7	4 4	2 3

* WAP weeks after planting
** A hole is defined as 2 5cm of stem damaged
*** The data in this table represent the averages of 4 replications

Research is in progress on the rates and method of use of furadan (cabofuran) which are profitable and recommendable for farmers Preliminary results have shown that the application of the granules in the whorls results in better foliar control of borers, especially Busseola fusca

8.2.7 PRIORITIES FOR THE FUTURE

- The establishment, in collaboration with the Maize breeding unit, of a program of selection of varieties resistant to the species of stem borers present in Cameroon
- The establishment of a program of breeding large number of stem borers
- The study of the impact of certain cultural techniques on the development of stem borer attacks, especially in the case of associated crops, dates of planting and harvest, types of soil preparation, fertilization, etc
- Test the impact of certain chemical products (herbicides, insecticides, etc) on the development of attacks of stem borers
- The establishment of a program of integrated pest control

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Evaluation of different cropping patterns in rice-based cropping systems in Western Cameroon Paper presented at the 1990 ASA Ann meeting at San Antonio, TX Oct 21-26

Refereed Publications

Roy, A C et al 1989
Varietal differences in milled quality of rice harvested at different maturities IRRN 14 4 (August, 1989)

Roy, A C et al 1990
Yield response of irrigated lowland rice to different sources of applied nitrogen in Cameroon IRRN (in press)

CEREALS AGRONOMY

Conference Papers and Presentations

"Strategies for maximizing maize yields in the sudano-sahelian zones of Cameroon" (presented at the ASA meeting at Atlanta USA, 1987)

"Research activities and findings on maize agronomy of the NCRE Cereals Agronomy in the lowland savanna of North Cameroon (1982 - 1989)"- (57 pages) - presented at the regional seminar "Cereals of the semi-arid tropics" 1989 at Garoua by the International Foundation for Science (IFS) and published by IFS in 1990

"Research activities and findings on sorghum agronomy of the NCRE Cereals Agronomy Unit in the sudano - sahelian savanna of North Cameroon" (1983 - 1988) - paper presented at the 1988 regional workshop on Sorghum in West and Central Africa (1988 - IRA Maroua/SAFGRAD - ICRISAT - MESIRES) and to be published in the proceedings of this workshop (20 pages)

"Response of improved maize and sorghum varieties to different seed treatments in the lowland savanna of North Cameroon" (paper presented at ASA meeting in Las Vegas in 1988 and at the Cameroon Bioscience workshop 1989) and to be published by CBS

"Effect of Graded Steps of Improved Agronomic Technologies on maize and sorghum performance in the lowland savanna of North Cameroon" (paper to be presented at ASA meeting, Texas 1990)

Reports

"Fiche technique pour la production intensive du mais dans la region de basse altitude du Nord Cameroon" (a maize production guide prepared in 1987 and revised in 1990) mimeo n° 1 (15 pages)

"Fiche technique preliminaire pour la production intensive du mais dans la region du hauts plateaux de l'Adamaoua" (1987)
mimeo n° 2

"Dix suggestions pratiques pour un bon semis et une bonne levee du mais dans les zones maisicoles du Nord Cameroon" (1988)

"Scientific research on maize agronomy and breeding conducted by IRA/Nord" (1987)

"Approximate cost of production for one hectare of maize in the Benoue area, North Cameroon" (1989)
"Rapport de Stage sur le mais au CIMMYT (Mexique) du 01/12/85 au 17/05/86" (26 pages) by A EBETE MBENG

"Fiche technique preliminaire pour la production intensive du sorgho ameliore dans la province du Nord" 1987 (a sorghum production guide for the extension agents) mimeo n° 3

"Dix suggestions pratiques pour un bon semis et une bonne levee du sorgho ameliore dans les zones de savane de basse altitude du Nord Cameroon" mimeo n° 5
"Agronomic research on sorghum in the traditional cropping systems of the semi-arid of North Cameroon" (mimeo 7), 1988 (RAO and TALLEYRAND)

"Rapport de Stage sur la pathologies du petit mil (01/02 - 04/03 88 a l'ICRISAT (Inde)" 12 page)

"Annual reports on maize and sorghum agronomy Research in the lowland savanna and highland plateaux of Adamaoua" 1986, 1987, 1988, 1989, NCRE/IITA -IRA

Dissertations

"Plant densities for late planted sorghum" - a M S thesis University of Arkansas USA (1988) by NGOUMOU 63 pages

SORGHUM BREEDING

Conference Papers and Presentations

DANGI, O P , 1986
Screening of Advanced Sorghum Lines for resistance to Striga hermonthica in Cameroon Paper presented in the workshop entitled "All African Governmental Consultation on Striga Control in Africa held at Maroua from 20-24 Oct , 1986 organized by OAU/FAO

DANGI, O P , and DJONNEWA Andre, 1988
Present Status of Rainy Season Sorghum Breeding in Cameroon Paper presented in the Regional Workshop on Sorghum Improvement in West and Central Africa held at Maroua, Cameroon during Sept , 20-24, 1988 organized by SAFGRAD/ICRISAT

DJONNEWA A , and DANGI, O P , 1988
Improvement of Transplanted Sorghum in Cameroon Paper presented in Regional Workshop on Sorghum Improvement in West and Central Africa held at Maroua, Cameroon during 20-24 Sept , 1988 organized by SAFGRAD/ICRISAT

DANGI, O P , BEYO Jacques and DJONNEWA Andre, 1989
Present Status of Pearl Millet Improvement Program in Cameroon Paper presented in the IFS Regional Workshop on Cereals of Semi-Arid Tropics held at Garoua, Cameroon from 12-16 Sept , 1989 organized by International Foundation for Science, Sweden

DANGI, O P , and KENGA R , 1989
A Review of Sorghumm Breeding Program in North-Cameroon Paper presented in the IFS Regional Workshop on Cereals of Semi-Arid Tropics held at Garoua, Cameroon, from 12-16 September, 1989 organized by IFS, Sweden

BOULAMA, T , YACOUBOU A , et DANGI, O P , 1989
Etude sur les Techniques de Production du Sorgho sous conditions Pluviales dans la Valles de la Benoue Paper presented in the IFS Regional Workshop on Cereals of Semi-Arid Tropics held at Garoua, Cameroon, during 12-16 September, 1989 organized by IFS, Sweden

RICHARD K , MILLER, F R , ROSENOW, D T , AND DANGI, O P , 1989
Fertility Restoration in Two Cytoplasmic Sterility Systems in Grain Sorghum Paper presented in the IFS Regional Workshop on Cereals in the Semi-Arid Tropics held at Garoua, Cameroon, during 12-16 Sept , 1989

DANGI, O P , Andre D , RICHARD K , and BEYO J , 1990
Pearl Millet Breeding Program in Cameroon Paper presented in the West and Central Africa Regional Pearl Millet Workshop held at Niamey 18-21 Sept , 1990 organized by ICRISAT

Reports

DANGI, O P , DJONNEWA Andre and NDIKAWA R , 1986
Sorghum and Millet Research Improvement Program National Cereals Research and Extension Project Annual Report pp 78-131

DANGI, O P , and DJONNEWA Andre, 1987
Sorghum and Millet Improvement Program National Cereals Research and Extension Project, USAID/IITA/IRA, Annual Report pp 192-231

DANGI, O P , and DJONNEWA Andre, 1988
Sorghum and Millet Improvement Program National Cereals Resarch and Extension Project, USAID/IITA/IRA Annual Report pp 131-155

DANGI, O P , RICHARD K , and BEYO Jacques , 1989
Sorghum and Millet Improvement Program Annual Report of NCRE/USAID/IITA/IRA pp 1-54

Refereed Publications

DANGI, O P , KENGA R , and DJONNEWA Andre 1986
Screening of Advanced Sorghum Lines for resistance to *Striga hermonthica* in Cameroon Crop Sci , Abs 60

APPA RAO, M H MENGESHA, O P DANGI, and J P ECKEBIL, 1989
Pearl Millet Germplasm in Northern Cameroon GRNU, ICRISAT, Patancheru, INDIA Bul No 53 1-30

PRASADA RAO, K E , M H MENGESHA and O P DANGI , 1990
Muskwari Germplasm in Cameroon GRU/ICRISAT Patancheru, INDIA In Press

SORGHUM AGRONOMY

Conference Papers and Presentations

M R Rao, R Ndikawa and L Singh, 1988
Progress of Sorghum Agronomic Research in Far-North Province of Cameroon Paper presented at "First West and Central Africa Sorghum Workshop" held at IRA, Maroua, Cameroon from 20-24 September, 1988

L Singh, 1989
Soil and Water Conservation Research in Northern Cameroon Paper presented at Farming Systems Research Workshop on "Appropriate Technologies for Developing Sustainable Food Production Systems in Semi-Arid Regions of Sub-Sahara Africa" held from 11-14 April, 1989 in Ouagadougou, Burkina Faso (West Africa)

L Singh and R Ndikawa, 1990
Suggested Agronomic Practices for Sorghum Production in Semi-Arid regions of North Cameroon IFS (International Foundation for Science) Proceedings of a Regional Seminar on "Cereals of the Semi-Arid Tropics" September 12-16, 1989, Garoua, Cameroon pp 78-85

R Ndikawa and I Singh, 1990
Le Point de la Recherche sur les techniques culturales du sorgho et mil au Nord Cameroun IFS (International Foundation for Science), Proceedings of a Regional Seminar on "Cereals of the Semi-Arid Tropics" September 12-16, 1989, Garoua, Cameroon pp 104-109

L Singh, R Ndikawa and M R Rao, 1990
Agronomic Research on a Unique Transplanted Post Rainy Season Sorghum (Muskwari) in the Semi-Arid northern Cameroon Presentation in ASA-CSSA-SSSA, 1990 Annual Meeting, 21-26 October, San Antonio, TX USA

BAMBUI TLU

Conference Papers and Presentations

McHugh, D 1987
Maize-based cropping systems in the Ndop Plain of the North West Province of Cameroon - A farm labor utilization survey Paper presented at the SAFGRAD On-Farm Trials Workshop at Maroua 21-24 September 1987 11 page

McHugh, D 1988
The value of farm family labor in maize-based cropping systems in the Ndop Plain in the North West Province of Cameroon Contributions of FSR/E towards sustainable agricultural systems - Proceedings of Farming Systems Research/Extension Symposium 1988 University of Arkansas and Winrock International Institute for Agricultural Development pp 35 - 45

McHugh, D 1989
The maize and groundnuts stepwise trial in the Ndop Plain, Cameroon (1987) Paper presented at the Workshop on Design and Analysis of On-farm Trials IITA, 27 February - 3 March 1989 13 pages

Samatana, M and D McHugh 1989
Use of minikits to supplement on-farm variety verification trials in Cameroon Paper presented at the West African Farming Systems Research Network (WAFSRN) Symposium, Accra, Ghana, 28 August - 1 September 1989 17 pages

McHugh, D 1989
A comparison of labor use and income generation for maize-based cropping systems in the mid and high altitude zones of the western highlands in Cameroon Paper presented at the 1989 FSR/E Symposium at the University of Arkanasas at Fayetteville, 8-11 October 13 pages

McHugh, D 1990
The effect of storage loss rates on the valuation of maize stored in farmers' traditional stores and removed periodically for food, feed or sale in Cameroon Paper submitted and accepted for presentation at the 1990 FSR/E Symposium at Michigan State University, East Lansing, 14-17 October 11 pages

Samatana, M and D McHugh
Seeking a cost effective way of getting feedback from farmers Minikits experience in Cameroon Paper submitted and accepted for presentation at the 1990 FSR/E Symposium at Michigan State University, East Lansing, 14-17 October

Meppe, F and D McHugh
Maize-rice cropping systems trial 1990 FSR/E Symposium at Michigan State University, East Lansing, 14-17 October

Reports

McHugh, D , J Tame and E Tambi 1987
Maize-based farming systems in the North West Province - rapid appraisal survey Report No 1 A joint IRA, IRZ and MIDENO survey of farmers in the Ndop Plain, NWP 32 pages

McHugh, D 1988
Maize-based cropping systems in the Ndop Plain of the North West Province Cameroon Study of maize-based cropping systems, with detailed labor data 45 pages plus extensive appendices

Tame, J , D McHugh and E Tambi, editors 1989
Farming systems in the Bui Highlands of the North West Province - a rapid rural appraisal survey Report No 2 A joint IRA-IRZ-MIDENO-CAMCCUL-PAFSAT-CIP-JVS survey of farmers in the Bui highlands 47 pages

McHugh, D 1990
Maize-based farming systems in the Bui Highlands of the North West Province of Cameroon Study of maize-based farming systems, with detailed labor data 31 pages plus extensive appendices

EKONA TLU

Conference Papers and Presentations

Almy, S W
"The Shift to Permanent Cultivation in Coastal Cameroon", at the Amer Anthrop Assoc meetings, Phoenix AR, November 1988

Almy, S W et al
"Evaluation of adaptation of improved varieties to diverse environments a low cost minikit method", at the WAFSR Network Symposium, Accra, Ghana, August 1989

Besong M T , and S A N D Chidebelu
"Cassava variety performance in Cameroon An on-farm experiment in Fako Division, South West Province, Cameroon", at the WAFSRN Symposium, Accra, Ghana, August 1989

Woldetatios T , C N Poubom, M A Mboussi et al
"Adaptive research on improved varieties to the diversified agro-ecological zones of South West Province,Cameroon", at the WAFSRN Symposium, Accra, Ghana, August 1989

Woldetatios T , C Poubom, M Messia, M Besong, S W Almy
"The effect of N-P-K time and rate of application on maize" American Soc of Agron Abstract 60 1989

Almy, S W , T Woldetatios, C Ateh, et al
"Farmers' Approaches to Soil Fertility Maintenance Under Reduced Fallows", at the Farming Systems Symposium at Fayetteville AR, October 1989

Besong, M T , and S W Almy
"Farmers' Land Preparation Methods & Weeding Practices in South West Cameroon their effect on farm labour input", at the Assoc for Farming Systems Research and Extension Symposium, East Lansing MI, October 1990

Ngundam, C P , T Woldetatios, S Almy, et al
"Adaptive Research on Cassava in the SWP Results of On-Farm Trials and Farm Consultations", poster at the Assoc for Farming Systems Research and Extension Symposium, East Lansing MI, October 1990

Almy, S W , M Besong, T Woldetatios, et al
"Farming Systems Research and the Extension Service Working Across Ministries in the South West Province of Cameroon", at the Assoc for Farming Systems Research and Extension Symposium, East Lansing MI, October 1990

Woldetatios, T , C Poubom, M Mboussi, et al
"The Influence of N-P-K on the Yield of Cassava x Maize Intercropping South West Province, Cameroon" American Soc of Agron Abstract 1990

TLU-Ekona
"Testing & Liaison Unit, IRA-Ekona 1987-88 Results and 1989-90 Work Plan", at the IRA Biennial Food Crop Meeting, Yaounde, February 1989

Poubom, C N and M A Mboussi
"Presentation of TLU-Ekona Results in Farming Systems and Cereals", at the IRA Programme Meeting for Ekona Centre, Ekona, Oct 1989

Woldetatios, T , M T Besong and S W Almy
"The Testing & Liaison Unit of IRA-Ekona", at the launching of the provincial National Extension and Training Programme, Kumba SWP, July 1990

Reports

Almy, S W , M T Besong, C Poubom N , A Igwacho and P Tambe
Farming Systems Survey of Fako Division, SWP Fiche technique, Ekona IRA, 1987

Mfonfu V
"Agricultural Research Strategies for National Food Self-Sufficiency" Cameroon Tribune Jan 2, 1987

Almy, S W
Farming Systems Survey of Meme Division, South West Province Fiche technique, Ekona IRA, 1988

TLU-Ekona
The Testing and Liaison Unit at the Institute of Agronomic Research Brochure, Ekona IRA, 1988 (rev 1989)

Almy, S W and C T Asanga
"On-farm Maize Storage and Seed Preservation in Fako and Meme Divisions, South West Province Cameroon" Fiche technique, Ekona IRA, 1988

TLU-Ekona
"Consolidated Soils Results for the Meme, Manyu and Ndian Farming Systems Surveys (SWP)" Background document, Ekona TLU/CNS, 1988

Almy, S W , and M T Besong
"Market Prices in South West Province" Fiche technique, Ekona IRA, 1989

Almy, S W , and M T Besong
Farming Systems Survey of Manyu Division, South West Province Fiche technique, Ekona IRA, 1989

Almy, S W , and M T Besong
Farming Systems Survey of Ndian Division, South West Province Fiche technique, Ekona IRA, 1989

Fondong B
"IRA-Ekona More Maize for Hungry Mouths" Cameroon Tribune Nov 7, 1989

Makwein M
"Bridging the Researcher-Farmer Gap" Cameroon Tribune Mar 23, 1990

Asanga, C T , A Ateh, S W Almy, and T Woldetatios
"An evaluation of 3-liter and 11-liter plastic cans (sealed and unsealed) for storage of dried maize as regards to insect population dynamics and grain quality" Fiche technique, Dschang IRA 1990

Refereed Publications

Almy, S W , and M T Besong
"Cassava in the Farming Systems of Cameroon's High-Rainfall Coast" In IITA, Cassava-Based Cropping Systems Research 1 Ibadan IITA, 1988

Besong, M T , and S A N D Chidebelu
"Food Crops Marketing in Cameroon the Case of Cassava, its Derivatives and Related Commodities in Fako Division of South-West Cameroon" Accepted for publication in Revue Science et Techniques, MESIRES IRA/IRZ

MAROUA TLU

Conference Papers and Publications

JOHNSON, J J 1987 The 1985 On-farm Test Results of Sorghum Varieties in Food Grain Production in Semi-Arid Africa, OAU/STRC-SAFGRAD Proceeding of an International Drought Symposium, Nairobi, Kenya May 1986 pp 651-671

JOHNSON, J J 1987 On-Farm Research in the Cameroon OAU/STRC-SAFGRAD, Proceedings of the On-farm Research Workshop held in Maroua, Cameroon 21-23 September 1987 pp 46-52

FOBASSO, M T 1989 On-Farm Maize and Millet Experiments in the Center North Zone of Cameroon, In Cereals of the Semi-Arid Tropics, Internat Foundation of Science, Proceedings of a Regional Seminar on Cereals of the Semi-Arid Tropics, September 12-16, 1989, Garoua, Cameroon, pp 110-114

RUSSEL, J T 1989 On-Farm Research of Sorghum Varieties and Agronomic Practices in Northern Cameroon In Cereals of the Semi-Arid Tropics Int Found of Sci , Proceedings of a Regional Seminar on Cereals of the Semi-Arid Tropics Sept 12-16, 1989 Garoua, Cameroon, pp 62-71

JOHNSON, J J J T RUSSELL and M T FOBASSO 1989
On-Farm Testing on Improved Sorghum, Millet, Maize, Cowpea, peanut and Agronomic practices in the Centre-Nord, North Cameroon Presented at Farming Systems Research Workshop on Appropriate Technologies for Achieving Sustainable Food Production Systems in the Semi-Arid Tropics of Africa 11-14 April, 1989 Ouagadougou Burkina Faso

NKOLBISSON TLU

Conference Papers and Publications

D BAKER August, 1989
Economic Research in FSR Steps in Methodology Presented at WAFSRN symposium, Accra, Ghana

J.A POKU AND D BAKER October, 1988
Effects of 20-10-10 Fertilizer on Maize Yields in the Centre Province of Cameroon Presented at ASA meetings, Las Vegas, USA

J. POKU, E ATAYI, AND D MCHUGH October, 1988
Farming Systems Research - Cameroon Experience Prepared for FSR/E symposium, Fayetteville, Arkansas

J POKU AND D BAKER February, 1989
Maize Response to Fertilizer in the Centre Province, Cameroon (A Methodological Case Study) Presented at the Design and Analysis of On-Farm Trials workshop, IITA, Ibadan, Nigeria

D BAKER January, 1989
Maroua TLU Planning for 1989 Training case study prepared for UCD Farming Systems Research and Extension Concepts and Methods workshop

J POKU June, 1990
On-Farm Research in the Centre Province, Cameroon Presented at Collaborative Group on Maize-Based Systems Research (COMBS) workshop, Kumasi, Ghana

J POKU August, 1988
On-Farm Trials in Southern Cameroon Presented at RCMP in-house review meeting, IITA, Ibadan

D BAKER October, 1990
Reorientation, Not Reversal African Farmer-Based Experimentation Prepared for 1990 AFSRE symposium, Lansing, Michigan

J NDJEUNGA and D BAKER October, 1990
Risk Assessment Methods for Technology Screening Prepared for 1990 AFSRE symposium, Lansing, Michigan

D BAKER AND J POKU January, 1989
The NCRE/TLU Experience Presented at CUDS Farming Systems Research and Extension Concepts and Methods workshop

Reports

Background, Strategy and Activities
Briefing Document for NCRE Project Phase II Evaluation June, 1989

CAMEROON
The Development Setting for IITA Activities Prepared for IITA External Program Review team January, 1990

J POKU September, 1990
Consultancy Report on Weed Management in Cropping Systems Research Conducted by the NCRE Cereals Agronomy Unit in Garoua, North Cameroon

G DIMITHE October, 1990
Cropping Practices and Crop Utilization in TLU Representative Villages, Centre Province

DOYLE BAKER AND JOHN POKU December, 1988
Incoming Review of TLU Activities (Mission Report)

D BAKER November, 1989
ISNAR International Agricultural Management Workshop (Mission Report)

ESTHER ROSALIE NGO NLEND April, 1990
L'analyse economique des essais de fertilisation du mais en champs paysans dans la province du Centre Rapport de stage pre-optional, Centre Universitaire de Dschang April 1990

L ENYONG April, 1990
Maize and Groundnut Post-Harvest Practices in the Centre Province of Cameroon

NCRE Project Circumstances and Status
Briefing Document for Phase II Evaluation Team June, 1989

Nkolbisson TLU
Approaches and Activities Presented to IITA External Program Review team January, 1990

Note explicative sur le test varietal de mais August, 1989

Proposal for SODECAO and IRA/TLU Nkolbisson collaboration
Five Year Plan and Budget February, 1989

Quelques conseils pratiques sur la production du mais, du manioc et de l'arachide dans la province du Centre August, 1989

G DIMITHE September, 1987
SAFGRAD Meeting Report on On-Farm Testing Methodology (Mission Report)

D BAKER December, 1989
Testing and Liaison Unit Proposals for NCRE Project Phase III, 1991-95

D BAKER January, 1990
TLU Concept and Approaches Prepared for IITA External Program Review team

TLU Mandate and Coordination
Briefing Document for NCRE Project Phase II Evaluation June, 1989

D BAKER February, 1989
UCD Farming Systems Workshop (Mission Report)

D BAKER, J POKU and D MCHUGH March, 1989
Workshop on the Design and Analysis of On-Farm Trials (Mission Report)

J POKU June, 1989
1988 Farming Systems Research Highlights

J POKU June, 1990
1989 Farming Systems Research Highlights

Dissertations

AMADOU NCHARE June, 1990
Utilization des varietes ameliorees de mais par les paysans apres participation a un essai en milieu reel Memoir, Centre Universitaire de Dschang

NKOLBISSON TESTING AND LIAISON UNIT 1987 and 1988 Results Presented to 1989 IRA Biennial Food Crops Program Planning Meeting, Yaounde February, 1989

MAIZE PATHOLOGY

Conference Papers and Publications

1988 - IRA biennial food crops meeting Yaounde Cameroon 6-10 February

- Seminar on Post Harvest Technology Organized by FAO/UNDP Food Los Reduction Project Bamenda 19 June - 2nd July

- Regional Workshop on Sorghum Improvement in West and Central Africa Maroua, Cameroon 20-23 September

1989 - First Annual Conference of the Cameroonian Biosciences Society Ngaoundere, 5-9 December

1990 - Second Annual Conference of the Cameroonian Biosciences Society Dschang, 28th November to 1st December

Refereed Publications

NANKAM, C , and NGOKO 1986
Sorghum and millets diseases in Cameroon Rev Sci et Tech Sci Agron 2(2) 153-155

NANKAM, C , and D C Foley 1987
Authracnose Kernel rot of maize caused by Colletobrichum graminicola (ces) Wils Mode of entrance into and disease progressian in ears Jour Iowa Acad Sci 95(3) 79 - 81

RICE PATHOLOGY

Reports

TCHATCHOUA J 1986
Incidence et lutte contre la pyriculariose dans l'Ouest Cameroun essai de traitement de semences Agri-Overseas

Refereed Publications

MONTY P JONES, TCHACHOUA J , JEUTONG F 1989
Rice disease situation in irrigated and upland rice Cameroon For Environmental and Experimental Botany

JONES M P , JEUTONG F , AND TCHACHOUA J 1989
Diseases of Rice in Cameroon for Warda Technical Newsletter

HIGHLAND CEREALS ENTOMOLOGY

Conference Papers and Publications

Asanga C T 1988
A Report on Insect Pest Scoring of Sorghum Breeder's Lines at Maroua Presentation at the Regional Workshop on Sorghum Improvement in West and Central Apica 20-23 Sept 1988, Maroua Cameroon

Asanga C T 1987
Maize Pest Problems in Cameroon The Present and Future Role of Host Plant Resistance in CIMMYT 1989 Towards Insect Resistant Maize for the Third World Proceeding of the International Symposium on Methodologies for Developing Plant Resistance to maize Insects Mexico D F CIMMYT

Refereed Publications

Asanga C T , and R B Mills 1986
Hermetic Storage of Pearl Millet Pennisetum americanum (C) Leeke, Laboratory Studies J Stored Brod Res 22(4) 211-216

LOWLAND CEREALS ENTOMOLOGY

Conference Papers and Publications

Aroga, R 1990
The principal species of maize stem borers in Cameroon Sequence of appearance and types of damages Presented to the first Comite Camerounais of Biosciences held to Ngaoundere of the 5 to the 9 December 1989

J Tonye, C THE, R Aroga and R Ambassa Kiki
The Main Pests of Maize Course presented to the refresher seminar of agricultural extension agents organized on 22 February to 4 March 1988 at Yaounde

Reports

J Tonye, C THE, R Aroga and R Ambassa Kiki
Practical Guide for the production of Maize in the Forest zone of Cameroon (Fiche Technique N 01 01 of June 1988)

J Tonye, C THF, R Aroga and R Ambassa Kiki
Identification Guide of the principal insects of field maize in the forest zone of Cameroon (Fiche Technique in preparation)

Refereed Publications

Aroga, R 1990
Insect Pests of Maize in the field in the zone of low altitude low and high rainfall a tentative inventory
(Submitted for publication in the Review of Science and Technique)

Aroga, R 1990
Stem borers of Maize in Cameroon behavior of the principal species
(Submitted for publication in Science and Technique)

Aroga, R 1990
Stem borers of Maize in Cameroon Influence of planting dates on development of the attacks
(Submitted for publication in Science and Technique)

Aroga, R 1990
Influence of 9 varieties of maize (Zea mays L) on the population dynamics of Stem borers
(Submitted for publication in Science and Technique)

Ambassa KIKI R, R Aroga and J C Ngongang
Chemical Weed Control of Maize (Zea mays) in the center of Cameroon Implication for the development of populations of stem borers
(Submitted for publication in the Revue Agronomie Tropicale)

LONG-TERM TRAINING

During the 1986-90 period the following persons initiated or completed their higher degree studies under NCRE/USAID funding

1	Mr Julius Takow	PhD	Rice Agronomy Texas A & M University
2	Miss Pauline Zekeng	PhD	Extension Agronomy North Dakota State University
3	Mr Manfred Besong	PhD	Agricultural Economics University of Nsuka
4	Mr Edward Ngong-Nassah	PhD	Extension Agronomy South Dakota State Univ
5	Mrs Laetitia Enyong	PhD	Agric Education/Extension Virginia Polytech
6	Mr Marc Samatana	MSc	Agricultural Economics Michigan State University
7	Mr Titus Ngoumou	MSc	Cereals Agronomy Arkansas State University
8	Mr Francois Meppe	MSc	Extension Agronomy Oklahoma State University
9	Mr Richard Kenga	MSc	Sorghum Breeding Texas A & M University
10	Mr. Jupiter Ndjeunga	MSc	Agricultural Economics University of Illinois
11	Mr Celicard Zonkeng	MSc	Maize Breeding Texas A & M University
12	Mr Jacob Eta-Ndu	MSc	Maize Breeding University of Minnesota
13	Mr Zachee Ngoko	MSc	Maize Pathology Texas A & M University
14.	Mr Pascal Ngninbeyie	MSc	Rice Agronomy Louisiana Rice Research Sta
15	Mr Andre Djonnewa	MSc	Sorghum Breeding Alabama A & M
16	Mr Martin Ngueguim	MSc	Extension Agronomist North Carolina State Univ
17.	Mr Mbassa Ndioro	MSc	Maize Breeding University of Minnesota
18.	Mrs Christine Poubom	MSc	Agricultural Extension University of Missouri
19	Mr. Georges Dimithe	MSc	Agricultural Economics Awaiting Placement
20	Mr. Anatole Mgeng Ebete	MSc	Cereals Agronomy Awaiting Placement
21	Mr. Ranava Ndikawa	MSc	Sorghum Agronomy Awaiting Placement

TECHNICAL CONSULTANTS

1	Dr D Mikkelsen	Rice Production and Research
2	Dr I Buddenhagen	Maize Pathology Review
3	Dr M Bosque-Perez	Maize Entomology Review
4	Mr P Walker	Workshop on Statistics
5	Dr B T Kang	Alley Cropping and Fallow Design
6	Dr G Baird	NCRE III Contract preparation
7	Dr J Poku	Weed Management in Cereals
8	Dr K F Nwanze	Sorghum Insect Training
9	Dr N Hulugalle	Soil Erosion Experiment Design
10	Dr R A Boxall	On-Farm Grain Storage
11	Dr B T Kang	Soil Erosion Control
12	Dr V T John	Rice Pathology

NCRE RESEARCHERS 1986-1990

Dr Emmanuel A Atayi	Togolese	Chief of Party	Nkolbisson	1981-1990
Dr Thomas C Stilwell	American	Deputy Chief of Party	Nkolbisson	1989-1990
Mr Scott Welch	American	Administrative Officer	Nkolbisson	1985-1987
Mr Timothy L Romocki	American	Administrative Officer	Nkolbisson	1987-1989
Mr James O Cross	American	Administrative Officer	Nkolbisson	1989-1990
Dr V Balasubramanian	Indian	Maize Agronomist	Nkolbisson	1989-1990
Dr John Poku	Ghanaian	Extension Agronomist	Nkolbisson	1986-1990
Dr Doyle Baker	American	Agricultural Economist	Nkolbisson	1988-1990
Dr Laures Empig	Filipino	Maize Breeder	Nkolbisson	1984-1987
Dr Leslie Everett	American	Maize Breeder	Bambui	1984-1990
Dr Joseph Kikafunda	Ugandan	Maize Agronomist	Bambui	1982-1990
Mr Dermot McHugh	American	Agricultural Economist	Bambui	1982-1990
Dr Monty P Jones	Sierra-Leonian	Rice Breeder	Dschang	1988-1990
Dr Animesh Roy	Bangladeshi	Rice Agronomist	Dschang	1981-1990
Dr D Janakiram	Sri Lankan	Rice Breeder	Dschang	1981-1988
Dr T Woldetatios	Ethiopian	Extension Agronomist	Ekona	1987-1990
Dr S Almy	American	Socio-Economist	Ekona	1987-1990
Dr Om P Dangi	Indian	Sorghum Breeder	Maroua	1981-1990
Dr Lallan Singh	Indian	Sorghum Agronomist	Maroua	1988-1990
Mr John Russell	American	Extension Agronomist	Maroua	1988-1990
Dr Mulumba Kamuanga	Zairois	Agricultural Economist	Maroua	1988-1990
Mr Jerry Johnson	American	Extension Agronomist	Maroua	1983-1987
Dr Meka E Rao	Indian	Sorghum Agronomist	Maroua	1986-1988
Dr Henri Talleyrand	American	Cereals Agronomist	Garoua	1982-1990
Dr S Sinnadourai	Sri Lankan	Extension Agronomist	Ekona	1986-1990

NATIONAL COUNTERPARTS 1986-1990

Dr	Jacob A Ayuk-Takem	Director-IRA Maize Breeder NCRE National Coordinator	Nkolbisson
Dr	Charles The	Maize Breeder	Nkolbisson
Dr	Jean Tonye	Extension Agronomist	Nkolbisson
Mrs	Regine Aroga	Entomologist	Nkolbisson
Mr	Celicard Zonkeng	Maize Breeder	Nkolbisson
Mr	Jean Bosco Zangue	Maize Breeder	Nkolbisson
Mr	Georges Dimithe	Agricultural Economist	Nkolbisson
Mrs	Laetitia Enyong	Socio-Economist	Nkolbisson
Mr	Blaise K Nguimgo	Maize Agronomist	Nkolbisson
Miss	Regine Mankolo	Extension Agronomist	Nkolbisson
Mr	Michel N Ndoumbe	Extension Agronomist	Nkolbisson
Mr	Pierre Boumtje	Agricultural Economist	Nkolbisson
Mr	Roger Nkoa Mewoli	Maize Breeder	Nkolbisson
Mr	Jupiter Ndjeunga	Agricultural Economist	Nkolbisson
Mrs	Rose Ndemah-Ngeh	Extension Entomologist	Nkolbisson
Mr	Zachee Ngoko	Plant Pathologist	Bambui
Mr	Edward Ngong-Nassah	Extension Agronomist	Bambui
Mr	Martin Nguegui m	Extension Agronomist	Bambui
Mr	Ndioro A Mbassa	Maize Breeder	Bambui
Mr	Claude Nankam	Cereals Pathologist	Bambui
Miss	Pauline Zekeng	Extension Agronomist	Bambui
Mr	Jacob T Eta-Ndu	Maize Breeder	Bambui
Mr	Isidore Tabi	Maize Breeding	Bambui
Mr	Christopher Ngong	Maize Agronomist	Bambui
Mr	Jean Enam	Agricultural Economist	Bambui
Mr	Marc Samatana	Agricultural Economist	Bambui
Mr	Francois Meppe	Extension Agronomist	Bambui
Mr	Fabien Jeutong	Rice Breeder	Dschang
Mr	Cletus Asanga	Entomologist	Dschang
Mr	Julius Takow	Rice Agronomist	Dschang
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Continued

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Mr	Mboussi A Messia	Extension Agronomist	Ekona
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Mr	Andre Djonnewa	Sorghum Breeder	Maroua
Mr	Ranava Ndikawa	Sorghum Agronomist	Maroua
Mr	Martin Fobasso	Extension Agronomist	Maroua
Mr	Charles Njomaha	Agricultural Economist	Maroua
Mr	Jacques Beyo	Sorghum Breeder	Maroua
Mr	Richard Kenga	Sorghum Breeder	Maroua
Mr	Anatole Mbeng Ebete	Cereals Agronomist	Garoua
Mr	Blaise Mongmong	Maize Breeder	Garoua
Mr	Titus Ngoumou	Extension Agronomist	Garoua