PN-ABB-457

OVERVIEW OF THE REGIONAL

SORGHUM AND MILLETS IMPROVEMENT PROGRAM

1988 - 89

L R House

SADCC/ICRISAT

SORGHUM AND MILLET IMPROVEMENT PROGRAM

P O BOX 776

BULAWAYO, ZIMBABWE

Overview Of The Regional

Sorghum and Millets Improvement Program

1988 - 1989[1]

L R House[2]

Introduction

The staff of the Regional Sorghum and Millets Improvement Program (SMIP) are on board and facilities complete or nearing completion. The establishment phase is nearing its end. The input into sorghum and millets is expanding as demonstrated by our Sixth Annual Workshop which was extended from 3 to 5 days to include areas of food technology, economics, livestock feed, and station development and operations. Our interactions with National Programs is being critically evaluated both to keep it relevant and to establish a monitoring capability. Our objective remains the strengthening of National Research capability to improve sorghum and millets and our approach continues to be research, education and training, and station development and management.

Current Staff Position

Staff of the Regional Program is as follows:

L R House	-	Executive Director
S P Ambrose	-	Administrative Officer
A T Obilana	-	Sorghum Breeder
S C Gupta	-	Forage/Millet Breeder
W A J De Milliano	-	Pathologist
K Leuschner	-	Entomologist
M Osmanzai	-	Agronomist
D Rohrbach	-	Economist
M I Gomez	-	Food Technologist
C M Matanyaire	-	Station Development and Operations Officer
N Katuli	-	Regional Station Development and Operations Officer
L Tendengu	-	Regional Training Officer

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1) Paper presented to the SACCAR Board. Gaborone, November 6 - 10, 1989.

2) Executive Director, SADCC/ICRISAT, P O Box 776, Bulawayo, Zimbabwe.

H Ssali, Soil Scientist working in our team is seconded by the International Fertilizer Development Center (IFDC). Emmanuel Monyo is in the second year of his Post Doctoral Fellowship focussing on pearl millet breeding. We have advertised for a Regional Pearl Millet Breeder.

Consultants

For much of the year Dr Gillian Hennessy worked to relate climatic parameters to the occurrence and severity of downy mildew and leaf blight. Correlation of severity with minimum temperature was particularly good. Dr Garry Odvody, pathologist from Texas A & M spent several weeks in Zambia and Zimbabwe where we were particularly interested in sooty stripe.

Mr D S Bisht and Dr Das Gupta, from the ICRISAT Center, again contributed to the training program on Station Development and Management. Several times during the year staff from the ICRISAT Center administration assisted us to improve our operations.

Dr Wayne Hanna, from the Georgia, USA, Coastal Plains Experiment Station, participated in a forage travelling workshop. Again D. Fredericksen from the Imperial College, London, contributed to research on sorghum ergot; and Dr L Faux, from Wye College worked on the ergot and smut of pearl millet.

Earlier, Dr S Appa Rao, from the ICRISAT Germplasm Resources Unit organized a review of sorghum and millets in the SADCC countries. This book is now with the printers and should be available soon.

Interaction With National Programs

A conscientious effort is made to interact with National Programs to ensure relevance in crop improvement efforts. There are a number of aspects to the interaction.

An important opportunity is the annual regional workshop which is a reporting and planning meeting. It has grown in several ways: input into food technology, market economics, feed uses, and station development and management have resulted in the 3 day meeting being extended to 5 and participation from 40 to almost 80. The meeting has truly become an interactive one of reporting and particularly planning. This year we were able to divide the group discipline wise for the planning component. Increasingly, National Programs are contributing materials to Regional Activities. We feel that our annual work plans are developed and finalized at this workshop.

There are one or two monitoring tours each year to several of the SADCC countries. This year the sorghum monitoring tour began in Zimbabwe but focussed on Tanzania. The tour, from 6 to 19 May, included 17 national scientists from 7 SADCC countries. The sorghum breeder from the ICRISAT East African Program and five scientists from the SADCC/ICRISAT program participated.

A forage travelling workshop took place from 23 January to 7 February. The group visited forage research in Zimbabwe, Botswana, Lesotho, Mozambique and Swaziland.

The organization of the monitoring tour(s) is established at the annual workshop. It provides an opportunity for sorghum and millet scientists in the Region to visit each others stations and see their work.

The scientists of the Regional Program spend approximately 30% of their time visiting National Programs. These visits provide good opportunity to interact, to observe problems on the spot, and when relevant, develop research strategy.

The Director of SACCAR is Chairman of the Regional Programs Technical Advisory Committee. This meeting occurs annually while the crop is in the field. Several days are spent discussing in depth the activities of the Regional Program.

The Project Manager of the Regional Program gives an annual update to the SACCAR Board. Several times during the year there are opportunities to interact with the Director of SACCAR.

While developing the Phase II program it was projected that the Regional Program would offer Post Doctoral and Research Associate opportunities and provide a short term orientation of the Regional Program to returning students. There is in country demand for returning students and these functions have not materialized. We are now moving to develop joint research projects ideally approved at National working meetings. These projects outline objective, participating scientists, strategy, and support. We feel that these projects well document contribution of both National and Regional Programs.

The staff of the Regional Program are currently developing a method to quantify input by the Regional Program, joint research, and input by the National Program. This is being done for each country. Once a suitable format has evolved, we would like our colleagues in National Programs to make their assessment. Over time, we expect the input from the Regional Program to decline. By quantifying these inputs it will be possible for SACCAR, Donors, and ICRISAT to see what the relative contribution of the Regional Program is. This will be relevant to the useful duration of the direct ICRISAT contribution to the Regional Program.

Several meetings have been organized by the Regional Program focussing in different topic areas.

In February 1988, there was an international meeting on crop utilization, followed by a Regional meeting to focus results of the international meeting to Regional interests. Later this month there will be a small meeting focussing on grain standards particularly as related to the milling and brewing industries.

In March of 1988, the Regional Program participated with the ICRISAT Center and INTSORMIL to organize an international symposium on diseases of sorghum and pearl millet.

Next January we are planning a meeting of Directors and Chief Agric Research Officers, with outside consultants, to focus on the Experiment Station conceptually and organizationally.

National - Regional Research Interaction

We define two important components to the crop improvement process - the generation of variability, and the exploitation of variability. Generation of variability includes activities of germplasm acquisition and evaluation, crossing and early generation evaluation, screening for resistance and quality traits. Exploitation of variability leads, via a logical sequence of nursery selection and yield trial evaluation, to new varieties and hybrids for various end uses. The generation of variability is viewed primarily as a function of SMIP and the exploitation of variability as primarily a function of National Programs. By this definition, there should be a flow of useful breeding stocks from Regional Sorghum and Millet Improvement Program (SMIP) to National Programs. This flow is working reasonably well, but requires communication between interested parties to avoid problems. The SADCC Country Programs differ in their capabilities ranging from generation of variability through the sequence of selection and testing of new varieties and hybrids to a substantial input by the Regional Program in selection and evaluation.

Countries also differ in their requirements; long season types are required in Tanzania, several leaf diseases are severe in some areas of the region, Striga hermonthica is important around Lake Victoria in Tanzania while S. forbesii is found around Ilonga in Tanzania and Kwekwe in Zimbabwe. As a consequence of these differences the Regional Program interacts with each SADCC country based on its strength and needs. It is for this reason that some view the program as an array of bilateral interactions rather than a network.

SMIP scientists assist the returning scientists from study leave to establish their research programs by providing the appropriate breeding materials and our off-season facilities to generate the crosses/genetic variability. Joint projects with National Programs have been developed such as in Tanzania on the improvement of photo-sensitive varieties in pearl millet. For Zimbabwe, discussions have been initiated to cross the best local accessions from Zimbabwe with selected introduced material. The resulting variable populations can be exploited by both programs. Assistance has been committed for 2 years to the Zimbabwe National Program to conduct communal trials, some entries are from the Regional Program.

The Regional Program has responded to a number of activities that are felt to be Regionally efficient. It was recommended at the first workshop that the Regional Program identify a limited number of national stations representing different environmental situations. These locations would be used to evaluate introductions and early generation breeding stocks. It was recognized that entry numbers are frequently high and discarded rates also high.

For the Regional Program to do this at a defined number of stations is cost effective and reduces burden on National Programs.

These locations have also been useful to screen for yield limiting traits. In the case of pathology, the prioritization of diseases and identification of useful "hot spots" for screening was a problem of greater magnitude than originally anticipated. Screening for stemborer resistance is undertaken at Matopos using artificially reared insects and studies on the variability of sorghum seeds of different varieties to insect grain feeding is conducted in a laboratory with controlled climate. Evaluation for response to moisture stress can be done at Sebele, Botswana; Lusitu, Zambia; and Matopos, Zimbabwe. The development and adaptation of procedures for evaluation of quality traits and their utilization for both grain and feed can be focussed at the new facility nearing completion at Matopos. Recently, the Regional Pathologist presented an illustrative situation of useful Regional evaluation. Swaziland, at present, does not have a severe problem with sorghum downy mildew and the local varieties are susceptible. The country is vulnerable to downy mildew but the present levels of infection are not adequate for screening. Screening is good at Matopos, Henderson, or Golden Valley so screening of promising entries in Swaziland for response to downy mildew in Matopos and Henderson will reduce the chance of distributing a highly susceptible line in Swaziland that could encourage the disease. The Regional Program is beginning to identify problems and ecological situations in the Region that are unique and it can be cost efficient to develop crop improvement activities for the SADCC countries capitalizing on these unique opportunities.

Education and Training

The original strategy for education was developed by two consultants in 1985; the strategy was subsequently modified and approved by the CTC. The objective, over a 10 year period, was to have in position a relevant team of sorghum and millet scientists in each SADCC country. The educational program was sub-contracted to INTSORMIL. Forty scientists participated in the degree training program in the first 5 year phase of the program. While this is a good number, it falls below the initial estimate. At the March, 1989, SACCAR Board Meeting it was suggested that the base be expanded to include more disciplines. Tim Schilling (INTSORMIL) and Lovegot Tendengu (SADCC/ICRISAT) have now visited most SADCC countries to activate the educational program for Phase II. We budgeted for 60 students but to date there are 62 approved nominations and indication of 15 more seeking approval - additional prioritization will be necessary. The present strategy for education is appended for your information. (Appendix 1)

Thus far, the Regional Program has conducted six training programs as indicated below:

Year	No of Trainees	Course
1986	9	Breeding Nursery Management
1987	7	Breeding Nursery Management
1987	16	Station Management
1988	14	Station Management
1989	15	Station Management
1989	22	Pest Identification and Scoring
	82	

The training programs of 1986, 87 and 88 were conducted by staff from the ICRISAT Center and Center staff participated with Regional Staff for the 1989 Station Management Course. We have not had more nursery/trial management courses because of demand for staff at their home location at the end of the cropping season when it is also ideal to conduct the training program. We want to strengthen this training activity using our off season (winter) location at Nzarabani.

During the first 5 years of the Regional Program 22 individuals were supported for training at the ICRISAT Center. Recently, a scientist from Mozambique went to the Coastal Plains Research Station at Tifton, Georgia, to learn techniques to evaluate forage quality.

Two scientists from Lesotho attended a 2 week training program at Matopos on quality testing procedures, including grain quality testing, product formulation, and sensory evaluation methodologies. One BSc technology student from the Bulawayo Polytechnic is spending 8 months in an in-service type training program in Food Technology.

The sorghum breeder and entomologist, Dept of Research and Specialist Services, Zimbabwe, and the sorghum breeder and entomologist from Botswana are undertaking PhD thesis research with Regional Scientists at Matopos.

For the past two year we have had 10 and 12 3rd year University of Zimbabwe students spend the Dec-Jan-Feb holiday working with us. We feel that this has been a mutually beneficial program to them and to us. We look forward to repeating this program again beginning next month.

Two scientists from the region have participated every year in Sorghum/Millet field days at ICRISAT Center, India. These field days provide the opportunity to interact with the scientists Internationally.

An addition to the types of training mentioned above, in 1990, we will add training on Sensory Evaluation Methods and Pollination Techniques.

Station Development

An input into Experiment Station Development has been made at Matopos to establish facilities for the Regional Program; and, at several National Stations. These inputs include land shaping for a more uniform soil surface, irrigation, and drainage, assisting with seed stores, housing, and transport, and farm machinery. Assistance has also included computers and recently laboratory equipment to evaluate forage quality. An effort is being made to respond not only to equipment needs but to better conceptualize the roll of station management and the interactions between station operations personnel and the user scientists. The magnitude of this task is large both in terms of manpower and financial resources; hence, it is not possible to interact equally with all stations at the same time.

A Project For Station Development And Management

When the input was made to strengthen station development and management as a function of the Regional Sorghum and Millet Improvement Program, it was considered that this would fore-run a separate program for this purpose in the SADCC Region. Prospects for donor support seem reasonably good. In fact donor money is already being spent to strengthen some National stations. We are beginning to move in the direction of organizing a project proposal. In January 1990, we plan to host a 3 day seminar for Chief Agricultural Research Officers and Directors on the Experiment Station. We will have a number of people from outside of the Region, who are professional in this area, participate. At this meeting we will present preliminary ideas on this project with the idea of receiving suggestions and direction for project development. Relevant components to such a project will be land use planning including irrigation and drainage, farm structures, machinery and maintenance, station development and records. If this idea is supported, I would hope that a project document could be available by early 1990. Mr Matanyaire and Mr Katuli, station operations officers with the Regional Program, will take prime responsibility for development of a project.

A SADCC Academy For Agricultural Sciences

The past 3 annual workshops for sorghum and millets have fulfilled the idea of a reporting and planning meeting. This year, inspite of extending the meeting from 3 to 5 days, we were pressed for time. We felt that scientists were anxious for a forum to present their work, and the workshop was one such forum. While organizing the workshop, the idea of a SADCC Academy of Agricultural Sciences evolved. The academy could organize an annual meeting and print a proceedings. This idea is mentioned here for your consideration.

Seed Production

The problem of adequate quantities of seed, particularly of hybrids, for advanced testing, farmers field trials, and extension became apparent at our recent workshop. We are discussing the possibility of adding a small seed production activity to our stations operations unit. Its activities would be limited to the production of seeds for the above mentioned purposes.

As our forage program expands we have had an increasing number of Zimbabwe farmers come to us for starter stocks of the pearl millet x napier grass cuttings. Thus far, we have been able to provide these small amounts from material growing at the Matopos Station.

We are interested in the study made by Denagro on seed production in the SADCC countries. If we can contribute, particularly to project 1 on training and consulting, we would be interested.

Construction

Construction of the dormitory-cum-recreational facility and six apartments at Matopos are complete. The apartments are occupied and the dormitory is in use. The construction of the crop processing lab and header house are well underway and the 4 greenhouses are up. The field service building is also finished. Construction on two houses for senior staff is underway. We are currently concerned about the water resource at Matopos and a search has been made indicating the possibility of securing more water via new boreholes.

Approximately 2.5 hectares of land, away from the existing research fields have been developed to accommodate the pathology and entomology programs. This field is isolated from other crops research activities. We continue to use Lucydale and the Aisleby Farm (Bulawayo Sewage Farm) for which we are grateful.

Mzarabani

Research Highlights

Sorghum Breeding

Significant progress has been made in the region in identifying best performing selections from introduced sorghum accessions (SDS and IC numbers); in developing and selecting new crossbred lines (SDSL numbers) with superior grain yield, grain quality, and better resistance to Downy Mildew, Virus and important leaf diseases in the region.

Varieties released/pre-released. Two selections from our introductions - SDS 1513 (Red) and SDS 1594-1 (Red) have been released in Swaziland. Mozambique is releasing two varieties which they named MACIA (selected from SDS 3220) and MAHONHE (selected from IS 8571). Malawi has identified two cultivars : ICSV 1 and ICSV 112 for pre-release.

Promising varieties. Eight white and seven red/brown selections from SDS introductions, including SDS 3472, SDS 2337, SDS 170, SDS 1770-6, SDS 2656, MP 3487, SDS 1948-3, SDS 1710-1 and ZAM 1518 (all reds/browns); and eleven new crossbred (SDSL) varieties including SDSL 87012, 87013, 87015, 87018, 87021, 87029, 87032, 87035, 87040, 87046, 87048, which are all very promising for yield and drought resistance across several locations in the region, were selected and promoted to three collaborative variety trials with National Programs in fifteen locations for each trial in the region.

Three SADCC/ICRISAT crossbred lines SDSL 8703, 87019 and 87020 have been found best for food quality in preliminary screening.

Promising hybrids. Fifty-three white and four red advanced hybrids have also been selected and promoted to five collaborative hybrid trials with National Programs in ten to twelve locations each in the region.

Breeding material. Towards assisting the National Programs to improve on their breeding program capabilities in Sorghum, we have generated several hundred breeding lines (in F2, F3 and F4) and developed four new breeding (random-mating) populations for the region. These breeding stocks have been made available to national scientists in six of the nine SADCC countries that can use them for selecting improved genotypes and lines.

The thirty hectares of land leased from the Mzarabani Rural Council has been fenced, surveyed and 10 hectares developed for use in the coming season. A tractor and necessary equipment has been stationed there from Matopos.

Highlights Of Progress Made In Sorghum Improvement For the SADCC Region November 1989

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Sorghum Releases

Two selections from our introductions - SDS 1513 (Red) and SDS 1594-1 (Red) have been released for production by Swaziland. Mozambique is releasing two varieties which they names MACIA (selected from SDS 3220) and MANONHE (selected from IS 8571).

Sorghum Pre-Releases

Malawi has identified two cultivars introduced from ICRISAT for pre-release. These are ICSV 1 and ICSV 112.

Promising Varieties

Eight white and seven red/brown selections from SDS introductions, including SDS 3472, SDS 2337, SDS 170, SDS 1770-6, SDS 2656, MP 531, SDS 2293-1, SDS 2293-6, (all whites), LARSVYT 19, SDS 1503, SDS 1599, SDS 3487, SDS 1948-3, SDS 1710-1 and ZAM 1518 (all reds/browns); and eleven new crossbred (SDSL) varieties including SDSL 87012, 87013, 87015, 87018, 87021, 87029, 87032, 87035, 87040, 87046, 87048, which are all very promising for yield and drought resistance across several locations in the region, were selected and promoted to three collaborative variety trials with national programs in fifteen locations for each trial in the region.

Three SADCC/ICRISAT crossbred lines SDSL 8703, 87019 and 87020 were presently found best for food quality in a preliminary screening.

Promising Hybrids

Fifty-three white and four red advanced hybrids have also been selected and promoted to five collaborative hybrid trials with national programs in ten to twelve locations each in the region.

Towards assisting the national programs to improve on their breeding program capabilities in Sorghum, we have generated several hundred breeding lines (in F2, F3 and F4) and developed four new breeding (random-mating) populations for the region. These breeding stocks have been made available to national scientists in six of the nine SADCC countries that can use them for selecting improved genotypes and lines.

Pearl Millet Breeding

Varieties released/pre-released. ICTP 8203 has been released in Namibia as Okashana 1. Two varieties : WC-C75, and ICMV 82132 (Kaufela) have been released in Zambia.

Varieties in National Testing. Five varieties: SDMV 89004, SDMV 89005, SDMV 89007, ICMV 87901 and ICMV 82132 in Botswana; six varieties in Zimbabwe; SDMV 89003, SDMV 89004, SDMV 89005, SDMV 87001, SDMV 87002 and ICMV 87901; and SDMV 89003 in Malawi are in National Testing.

Promising varieties/hybrids in Collaborative Trials. Twenty seven varieties of different maturity types are in advanced collaborative trials in five SADCC countries: Zimbabwe, Tanzania, Zambia, Malawi and Botswana where pearl millet is an important crop. Two hybrids: SDMH 88002 and 88003 have produced 50% more yield as compared to the released variety PMV 1 in last two years in Zimbabwe. Eighteen promising hybrids have been sown in collaborative trials.

Population breeding. Eight breeding populations have been generated to meet the requirement of different agro-ecological zones. These are being improved for wider adaptation by the Regional Program and for specific adaptation by National Programs.

Finger Millet Breeding

Varieties released. A finger millet accession from ICRISAT Center IE 2929 is released as Lima in Zambia.

Varieties in National Testing. A variety SDFM 113 is in agronomy trials in Zimbabwe. Thirty early maturing varieties have been selected by Tanzanian scientists over last two years to evaluate them in their National Trials. Several selections are under test in Zambia from introductions of over 1000 accessions from the SADCC/ICRISAT program.

Promising varieties. Twenty four promising varieties tested over the last two years have been identified for large scale testing in collaborative trials. The most promising varieties are SDFM 113, 723, 937, 1079, 1059, 1072 (early maturing), and SDFM 217, 396, 224 and 227 (late maturing).

Germplasm accessions. We have a total of 2569 accessions representing all the finger millet growing areas of the World. Accessions from Zimbabwe, Zambia, and Malawi have been evaluated in the country of their origin. The accessions from Zimbabwe are earlier in maturity as compared to accessions from Zambia and Malawi.

Hybridization. Over 500 crosses have been sown for identification of hybrid plants. The selected plants will be advanced by the pedigree method to produce new varieties. Early generation material will be provided to interested scientists who like to make their own selections.

Forage Breeding

Varieties in National Testing. Six forage pearl millet varieties (SDMV 89101 to 89104, 89106 and 86-10242) in Swaziland and 11 pearl millet varieties (SDMV 89101 TO 89105, ps 198, ps 212, ICMS 7704, 435 x 51 and 435 x 51-3 in Mozambique are under advanced testing. Forty one forage varieties are in preliminary trial in Botswana.

Promising varieties. Crosses are made between high yielding grain varieties with brown midrib lines to improve the dry matter digestibility of crop residue while maintaining the grain yield production. New sources of brown mid-rib genes have been identified in local germplasm of sorghum and pearl millet and are being evaluated to determine if there is an improvement in dry matter digestibility. An experiment is planned to estimate the genetic variability of crop residue quality traits in high yielding grain varieties of sorghum and pearl millet.

Interspecific hybrids. Twenty interspecific hybrids between pearl millet and napiergrass generated last year are under test with and without irrigation. One hundred and three new interspecific hybrids have been generated which will be evaluated during this season. The popular method at present is to establish a crop from cuttings. We realize that it will be easier for communal farmers to establish a crop from seed, and therefore are looking for ways to produce seed commercially.

Sorghum and millets for forage. Several crosses have been generated to improve forage sorghum and pearl millet for forage yield and quality.

Cereals Agronomy

The Agronomy Unit recognizes major problems of drought and the need for appropriate technology and production practices. Research objectives are focussed to identify and alleviate production constraints, to develop information on suitable crop management in order to improve production and Water Use Efficiency (WUE), and to provide information for improving quality of research results. The following activities are undertaken to fulfill the above objectives:

Production constraints. Evaluation of agronomic constraints to sorghum and millet production increase has been undertaken. Information has been gained on improving stand establishment and crop growth uniformity in sandy soils by use of nematocides.

Results of exploratory experiments conducted at the Sandveld, Matopos, Makoholi and Mlezu stations in Zimbabwe and Sebele Research Station in Botswana confirmed our previous findings that presence of nematodes in sandy soils is a factor causing poor seedling establishment and crop growth variability. Treatments receiving nematocides Nemacur or Furadan were uniform in crop growth and plant stand. Grain yield increased by 62 and 77% over the control (1 806 kg ha^{-1}) for the cultivar SV1 and 30 and 23% for the cultivar Red Swazi (1 685 kg ha^{-1}). Correlation analysis indicate that grain yield was significantly associated with seedling vigor ($r = 0.44$, $p = 0.01$) plant height ($r = 0.41$, $p = 0.01$) and crop growth uniformity ($r = 0.28$, $p = 0.05$). Further experiments are being conducted to determine ways to overcome the problem. The preliminary results indicate that the dosage of nematocide (Furadan and Nemacur) can be reduced and the results of seed dressing is encouraging.

We have also evaluated the performance of four cereals species viz sorghum, pearl millet, finger millet and maize with and without Furadan treatment in an exploratory experiment conducted at Sandveld, Makoholi, and Mlezu Research Stations. The results indicate that sorghum is more sensitive to nematodes than the other cereals.

Differences among sorghum cultivars for emergence from 5 and 10 cm sowing depth has been identified. It seems that newly released cultivars are sensitive to sowing depth, particularly if sown in dry soil. This suggests that selection pressure should be applied on this trait.

Crop Management Investigation has been undertaken to determine cultural practices best suited to potential and newly released hybrids/varieties of sorghum and millets over a wide range of environments.

Effects of till, nitrogen side dressing and hand weeding on WUE and performance of a sorghum hybrid DC-75 and a variety SV1 was studied at Matopos during 1988/89 crop season. WUE improved to 11.4 kg ha^{-1} per mm of rain with the yield 4 891 kg ha^{-1} in a treatment which received stubble mulch, 50 kg ha^{-1} nitrogen, 3 hand weedings while it remained at 2.4 where no stubble mulch, no

N and no weeding was used. Yield was increased by 40% to 2 150 by application of N alone and 129% to 3 506 by weeding alone and 182% to 4 314 by a combination of both N application and weeding.

Hybrid sorghum performed better or at par with varieties across all treatments and produced on average 36% more grain yield than the variety (3 319 kg ha^{-1} vs. 2 431 kg ha^{-1}). There was no significant interaction indicating yield increase was achieved across the low, moderate and high production levels.

Sorghum cultivars SV1, DC-75 and Red Swazi were evaluated for their response to date of planting (DOP). There was significant genotype x DOP interaction, indicating that farmers could be provided with the option of selecting cultivars depending on the start of the season.

Studies of drought A drought screening method by inducing/relieving water-stress was developed. Comparisons were made between plots on tied ridges with those that were well drained. Supplementary irrigation was given to the non-stressed plot.

Drought intensity and drought susceptibility indices were developed. Using these indices, promising hybrids MMSH 205, MMSH 375 and MMSH 378 were ranked 1, 2 and 3 respectively (1 being most promising).

Cereals Pathology

Identification of diseases In 1989, disease samples were sent to the CAB International Mycological Institute, UK, for confirmation and identification of pathogens on sorghum and millets in Angola, Botswana, Lesotho, Malawi, Swaziland, Tanzania, Zambia and Zimbabwe.

The five most important diseases for pearl millet in the region were: Ergot (Malawi, Tanzania, Zambia, Zimbabwe); leaf spots (Botswana, Malawi, Tanzania, Zambia, Zimbabwe); pearl millet downy mildew (Malawi, Tanzania, Zambia, Zimbabwe); rust (Tanzania, Zambia, and Zimbabwe) and smut (Malawi, Tanzania, Zambia, Zimbabwe). The major diseases of finger millet were blast and blight.

The seven most important diseases for sorghum in the region were: Ergot, (Botswana, Malawi, Tanzania, Zambia, Zimbabwe); anthracnose (Botswana, Tanzania, Zambia, Zimbabwe); leaf blight (Tanzania, Zambia, Zimbabwe, Botswana); covered kernel smut (Botswana, Tanzania); downy mildew (Botswana, Tanzania, Zambia, Zimbabwe); sooty stripe (Zambia, Zimbabwe) and rust (Tanzania, Zimbabwe). In addition Striga was considered important in most countries and nutgrass at stations in Tanzania, Lesotho, Malawi, Swaziland, Zambia and Zimbabwe.

Identified locations for testing (hot spot locations) against:

Pearl millet diseases:

1	Pearl millet downy mildew	- Mongu, Zambia;
2	Ergot	- Ngabu, Malawi, Panmure, Zimbabwe;
3	False Mildew	- Panmure, Zimbabwe;
4	Other leaf spot diseases	- Mongu, Zambia.

Sorghum diseases:

1	Anthracnose	- Mansa, Zambia;
2	Ergot	- Masumba, Zambia, Panmure, Harare, Gwebi, Zimbabwe;
3	Grain molds	- Ifakara, Tanzania;
4	Sorghum downy mildew	- Golden Valley, Zambia, Matopos, Panmure, Zimbabwe;
5	Leaf blight	- Golden Valley, Zambia, Henderson, Zimbabwe;
6	Striga asiatica	- Hombolo, Tanzania;
7	Striga hermonthica	- Ukiriguru, Tanzania.

Screening techniques Screening techniques have been developed or adapted for ergot and smut of pearl millet and downy mildew and leaf blight of sorghum at locations where the diseases are endemic. Input is being made to develop a capability to screen for sorghum sooty stripe.

Identification of sources of resistance All pearl millets of the regional program and foreign introductions were screened for resistance to locally important diseases. ICMPES 28 had multiple disease resistance to ergot, false mildew and rust.

In total, some 3 000 sorghums were tested in all SADCC countries but Angola and Mozambique. For the first time we have been able to confirm resistance in a single entry to as many as three diseases; ie, against downy mildew, leaf blight and anthracnose. Promising entries with multiple resistance were SC 326-6, IS 8283, IS 18688. Additionally, sources of resistance were found for downy mildew, leaf blight, and anthracnose. Forage varieties were identified with a low incidence of downy mildew and low leaf blight severities. Forage millet varieties with resistance to false mildew and ergot were identified.

Pathotypes It appears that regional pathotypes are present for pearl millet downy mildew and rust, sorghum downy mildew and anthracnose.

Cereals Entomology

Screening Time was spent evaluating screening trials. The SADCC Sorghum Shoot Pest Nursery (400 entries) and the International Sorghum Stem Borer and the International Sorghum Shootfly Nursery were evaluated at Matopos, Panmure and Mzarabani (Zimbabwe), Golden Valley (Zambia), Kasinthula (Malawi) and Hombolo (Tanzania). Because of drought only useful results were obtained from Matopos, Panmure, Mzarabani and Golden Valley.

Stemborer yield loss trial This trial is part of the PhD Thesis research of Mr Sithole, entomologist with the Department of Research and Specialist Services, Zimbabwe. The trial was artificially inoculated at Matopos and natural infestation at Panmure. Significant yield loss was found with early infestation. Late infestation showed only marginal yield loss. (Infestation 20 days after emergence vs 45).

A trial was also conducted to determine the impact of leaf feeding by stemborers. Plant height was reduced more when infestation occurred 22-24 days after emergence compared to 30 days.

Screening of resistance to the sugarcane aphid A new rapid leaf sleeve cage technique was developed and used for screening. A number of entries showed good levels of resistance. In the greenhouse, tests were conducted to identify resistance mechanisms based on detailed behaviour studies.

Armoured cricket A trial was conducted in Lusitu, Zambia, under the supervision of the Zambian entomologist, Mr Musonda. The trial was to study the biology, ecology and some control methods for armoured crickets. The cricket has become a serious pest during the last four (drought) years. The results showed that cricket nymphs depend for their development on immature grass seed. When this seed matures they migrate to the still immature seeds of sorghum and millet. Control methods like surrounding farmers fields with a shallow trench in which insecticide powder is placed and Sevin as a spray hold promise for protection.

Storage insects Out of 400 sorghum lines tested against Sitophilus 8 entries could be selected with very low infestation levels.

Food Technology/Crop Utilization

Grain Quality Several procedures have been standardized and are being used. These procedures are for pearling index, milling yield, endosperm hardness score, floatation test, gelatinization temperature, and size grading fractionation. These tests have been used on 16 traditional varieties; characterization of these sorghums will provide a reference base for quality evaluation of improved sorghums from the breeding program. Traditional varieties have been acquired from Lesotho and Botswana to expand the regional data base on acceptable food quality.

Malting and diastatic power A laboratory micro-malting (20 grams) procedure has been standardized. The laboratory procedure is capable of malting 50 x 20 gram samples in one operation. The technique has been used to micromalt 554 samples in support of the thesis research of J N Mushonga (Head Crop Breeding Institute and Sorghum Breeder, Department of Research And Specialist Services, Zimbabwe). It will be useful in the future to evaluate breeding samples. The procedure for diastatic power has been modified and standardized in our laboratory for evaluation of these malts. The micro malts from the research material of J N Mushonga have been evaluated for diastatic power.

Sweet sorghum quality evaluation trial Sweet stemmed sorghums are being evaluated as a possible source of alcohol for blending with petrol. Seventy-four sweet stemmed sorghums were sown at Aisleby (irrigated) and at Matopos (dryland). Sequential harvests were made at pre-flowering, flowering, early dough and late dough stages of crop development and Brix and dry matter determinations were made at these stages of maturity. At the hard dough stages Brix readings at Aisleby and Matopos ranged 11.1 - 19.1 and 14.2 - 20.5 respectively. A trend of higher mean Brix and dry matter values was observed over all stages of maturity for entries grown in the rainfed as compared to the irrigated location.

Collaboration with Carlsberg Research Center Two screening methods of evaluating sorghum malt modification were tested during a study visit to the Carlsberg Laboratory. These rapid techniques made use of fluorescent dyes and malt friability measurements. The objective is to substitute a simple rapid test (8 minutes/sample) for the laborious diastatic power measurement.

Sorghum/Millet cellulose Leaf and stem material of five varieties of sorghum and one variety of pearl millet were sent to the Carlsberg Laboratory where experiments are underway to make a compressed chip board and paper. These experiments are preliminary, but chip board has been made using sorghum and millet equal in strength to that made from wood.

Economics

Lesotho A coarse grains market reconnaissance survey was conducted in Lesotho with the assistance of two representatives of the Department of Agricultural Research. This led to the planning and implementation of more formal farm household and marketing agent surveys designed to assess the potential viability of sorghum dehullers and to evaluate sorghum marketing problems.

At the suggestion of the Principal Economist, a Master's Degree candidate funded by SADCC/ICRISAT returned to Lesotho to conduct her thesis research. Four months of data collection are now coming to an end and she will return to Purdue University to write a thesis on coarse grain market performance later this month.

Tanzania A very brief reconnaissance of major production and marketing issues was conducted earlier this year. This led to the planning of a more formal market system reconnaissance scheduled for November. This will examine factors influencing market flows of small grains and constraints to industrial utilization. It will be implemented by an economist and food technologist from the Sokoine University of Agriculture. This will lead, if funding becomes available, to a longer term assessment of marketing constraints and opportunities in the Tanzanian small grains economy.

Zambia A study was identified and initially planned of sorghum and millet substitution for maize and wheat in the milling and baking, brewing and stockfeed industries of Zambia. The study was conducted by a team encompassing the SADCC/ICRISAT Economist and Food Technologist and several Zambian professionals. The team report has recently been submitted to the Government of Zambia for consideration. This offers a basis for the establishment of a new sorghum and millet (and cassava) production and market policy for Zambia based on industrial user demand.

A conference paper on the industrial utilization of sorghum and millet was jointly prepared with a Zambian scientist from the University of Zambia. This was presented at the Fifth Annual Conference on Food Security Research in Southern Africa in October.

Zimbabwe A joint assessment of the dynamic comparative advantage of sorghum and millet in Zimbabwe was initiated in collaboration with a Fulbright scholar and a representative of the Zimbabwe Ministry of Agriculture. This considers the evolving competitive position of sorghum and millet in the agro-economy over the next ten years.

A visiting research scholar with the SADCC/ICRISAT Economics Program is completing one year of farm surveys investigating factors influencing farmer decisions to grow and consume alternatives coarse grains (sorghum, millet and maize).

Two Zimbabwean Research Associates are examining marketing constraints facing small farmers with diverse resource endowments and varying access to market infrastructure.

In general, the preliminary emphasis of the Economics unit has been on shorter term studies which identify sorghum and millet marketing constraints and assess the competitive position of these crops in the national agro-economies. These studies aim to offer relatively quick results of immediate relevance to regional policy makers. In combination, each set of national results will help determine the likely contribution of sorghum and millet as industrial inputs and as food security crops within the SADCC region over the next ten to twenty years.