INTEGRATED AGRICULTURAL RESEARCH

PROCEEDINGS OF THE SACCAR/WINROCK WORKSHOP, HELD IN LILONGWE, MALAWI, 26 NOVEMBER – 1 DECEMBER 1989

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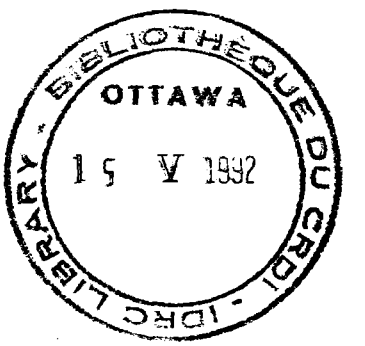
Integrated agricultural research



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Integrated agricultural research

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CONTENTS

SADCC/ICRISAT

SORGHUM AND MILLETS IMPROVEMENT PROGRAM

S.C. Gupta

Introduction

The establishment of the Sorghum and Millets Improvement Program (SMIP) is almost complete. Input into sorghum and millets is expanding. The sixth annual workshop for example, was extended from 3 to 5 days to include food technology, economics, livestock feed, and station development and operations. We are evaluating our relations with national programs to keep it relevant and to establish a monitoring capability. Our objectives remain the strengthening of the role of national research in improving sorghum and millets. Our activities continue to be research, education and training, station development, and management.

Current staff position

SMIP staff consists of an Executive Director, Administrative Officer, a Sorghum Breeder, Forage/Millet Breeder, Cereals Pathologist, Cereals Entomologist, Cereals Agronomist, an Economist, a Food Technologist, Station Development and Operations Officer, Regional Station Development and Operations Officer, and a Regional Training Officer.

One Soil Scientist is seconded to SMIP by International Fertilizer Development Centre (IFDC). There is also a student in the second year of his post doctoral fellowship focusing on pearl millet breeding. The program is also supported by a number of consultants as and when necessary.

Collaboration with national programs

SMIP collaborates with national programs to ensure relevance in crop improvement efforts. National programs are represented in the annual regional workshop, which is a reporting and planning meeting. This meeting covers food technology, market economics, feed uses, station development, and management. The meeting is a forum for reporting and particularly planning. National programs are increasingly contributing materials to regional activities. The annual work plans are developed and finalized at this workshop.

SMIP holds one or two monitoring tours each year to several of the SADCC countries. In 1989 the sorghum monitoring tour began in Zimbabwe but focused on Tanzania. The tour, from 6 to 19 May, included 17 national scientists from 7 SADCC countries. A 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 1989. The group visited forage research in Zimbabwe, Botswana, Lesotho, Mozambique, and Swaziland.

Monitoring tour(s) are decided at the annual workshop. These tours provide an opportunity for sorghum and millet scientists in the region to visit each other's stations and see their work.

Scientists of the regional program spend about 30% of their time visiting national programs. These visits provide good opportunity for exchanging ideas, observing problems on the spot, and when relevant, developing research strategy.

The Director of SACCAR is Chairman of the SMIP technical advisory panel, an annual meeting held while the crop is in the field. Several days are spent discussing in depth activities of the regional program and its relationship with national programs. The next meeting was to be held in Malawi in March 1990. The Project Manager of the regional program reports annually to the SACCAR Board.

While developing 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. These plans did not, materialize, however, although there is in-country demand for returning students. We want to develop joint research projects ideally approved at national working meetings. These projects outline objectives, participating scientists, strategy, and support. We feel that these projects will document the contribution of both national and regional programs.

Staff of the regional program are developing a method to quantify input by the program, joint research, and input by national programs. 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. Eventually, 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 establish the useful duration of the direct ICRISAT contribution to the regional program. Several meetings have been organized by the regional program focusing on different areas.

In February 1988, there was an international meeting on crop use, followed by a regional meeting which focused on results of the international meeting to regional interests. In late November 1989, a small meeting focussing on grain standards particularly as related to the milling and brewing industries was held. In March 1988, the regional program participated with ICRISAT Centre and International Sorghum and Millet Collaboration Research Support Program (INTSORMIL) to organize an international symposium and diseases of sorghum and pearl millet. A meeting of directors and chief agricultural research officers, with outside consultants, to focus on the concept and organizations of the experiment station is planned for January 1990.

National - Regional research collaboration

National and regional research have a common interest in improving crops through the generating and exploiting of variability. Generating of variability includes acquiring and generating germplasm, crossing and early generating evaluation, screening for resistance and quality traits. Exploiting of variability leads, via a logical sequence of nursery selection and yield trial evaluation, to new varieties and hybrids for various uses. The

generating of variability is primarily a function of SMIP and the exploiting of variability is primarily a function of national programs. There should, therefore, be a flow of useful breeding stocks from SMIP to national programs. This flow is working well, but requires close communication between interested parties. SADCC country programs differ in their capabilities ranging from generating of variability through the sequence of selecting and testing of new varieties and hybrids to a substantial input by the regional program in evaluation.

Regional countries differ in their requirements and problems. Long season types are required in Tanzania, since several leaf diseases are severe in some parts of that region, *Striga hermontheca* 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 scientists returning from study leave to establish their research programs. They provide appropriate breeding materials and our off-season facilities to generate the crosses/genetic variability. Joint projects with national programs have been developed in Tanzania and Zimbabwe. In Tanzania a project on the photosensitive varieties in pearl millet has been developed; in 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 to the Zimbabwe national program for two years 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 relevant. 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 discard rates are also high. For regional program to do this at a defined number of stations is cost effective and reduces the burden on national programs.

These locations have also been useful to screen for yield-limiting traits. In the case of pathology, the priority of diseases and identification of useful "hot spots" for screening were a bigger problems than originally anticipated. Screening for stemborer resistance is undertaken at Matopos using artificially reared insects. Studies on the vulnerability of different varieties of sorghum seeds to insect grain feeding is conducted in a laboratory with controlled climate. Evaluating for response to moisture stress can be done at Sebele, Botswana; Lusitu, Zambia; and Matopos, Zimbabwe. Developing and adapting procedures for evaluating of quality traits and their use for both grain and feed can be done at Matopos. In late 1989, the regional pathologist evaluated the position in the region. Swaziland was reported to have a problem with sorghum downy mildew and the local varieties were found to be susceptible. The country was found to be vulnerable to downy mildew but the levels of infection were not adequate for screening. Screening is good at Matopos, Henderson, or Golden Valley. 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.

Regional program is beginning to identify problems and ecological situations in the region that are unique. It could be cost efficient to develop crop improvement activities for 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 ten year period, was to have in position a relevant team of sorghum and millet scientists in each SADCC country. The educational program was subcontracted to INTSORMIL. Forty scientists participated in the degree training program in the first five year phase of the program. Although this level of training is encouraging, it is less than 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 educational program for Phase II.

We budgeted for sixty students, however, sixty-two nominations have been approved and there are fifteen additional students awaiting approval.

So far, the regional program has conducted six training programs (Table I).

Table 1: Conducted Regional Training Programs

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
Total	83	

Training programs of 1986, 87, and 88 were conducted by staff from ICRISAT Centre. They also teamed up with regional staff to conduct 1989 Station Management course. Additional nursery/trial management courses could not be held because staff had to be at their homes during the cropping season. We want to strengthen this training by holding it during the off season (winter) at Mzarabani.

In the first five years of the regional program twenty-two individuals were supported for training at the ICRISAT Centre. Recently, a scientist from Mozambique went to the Coastal Plains Research Station at Tifton, Georgia, to learn forage quality evaluating techniques. Two scientists from Lesotho attended a two week training program at Matopos on quality testing procedures, including grain quality testing, product formulation, and

sensory evaluation methods. One BSc technology student from the Bulawayo Polytechnic is spending eight months in an in-service type training program in food technology. The sorghum breeder and entomologist, Department 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 years we have had ten and twelve third year University of Zimbabwe students spend the December-February holidays working with us. We feel that this internship program has been mutually beneficial. We look forward to repeating this program in December.

Two scientists from the region have participated every year in sorghum millet field days at ICRISAT Centre, India. These field days facilitate exchange of ideas among scientists in the world. In 1990, the Centre will also start courses on sensory evaluation methods and pollination techniques.

Station development

Facilities for regional program experiment station development have been established at Matopos, Mzarabani, and at several national stations. These include land shaping for more uniform soil surface, irrigation, and drainage. Assistance has also included computers, transport, farm machinery, and laboratory equipment to evaluate forage quality. An effort is being made to respond to equipment needs as well as to improve the roles of station management and the relationship between station operations personnel and the user scientists. This task is formidable in both manpower and financial resources terms. It is, therefore, difficult to collaborate equally with all stations at the same time.

Seed production

Seed shortage, particularly of hybrids for advanced testing, farmers' field trials, and extension became apparent at our recent workshop. It was, therefore, agreed that seed producing activity be introduced in our stations operations unit to meet the identified needs.

As our forage program expands we have had an increasing number of Zimbabwe farmers asking for starter stocks of pearl millet and napier grass cuttings. We provided small amounts of these from material growing at the Matopos station.

We are interested in the study made by Denargro on seed producing in SADCC countries and would be willing to train and provide consultancy services.

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) and 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/prereleased:** Two selections - SDS 1513 (Red) and SDS 1954-1 (Red) have been released in Swaziland. Mozambique is releasing two varieties which they named MACIA (selected from SDS 3220) and MOMONHE (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 2338=7, 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 11 new crossbred (SDSL) varieties including SDSL 87013, 87015, 87018, 87021, 87029, 87032, 87035, 87040, 87046, 88048, were made. These are promising for yield and drought resistance across several locations in the region and 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 to be the 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:** In assisting national programs to improve their breeding program capabilities in sorghum, we have generated several hundred breeding lines (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/prereleased: ICTP 8203 has been released in Namibia as Okashana 1. Two varieties: WCC75, and ICMV 82132 (Kaufela) have been released in Zambia.

- **Varieties in national testing:** Five varieties: SDMV 89004, SDMV 89005, SDMV 89007, ICMV 8701, and ICMV 82132 in Botswana; six varieties in Zimbabwe: SDMV 89003, SDMV 89004, SDMV 89005, SDMV 87002, and ICMV 8701 one variety, SDMV 89003 in Malawi is 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 where pearl millet is an important crop: Zimbabwe, Tanzania, Zambia, Malawi, and Botswana. Two hybrids, SDMH 88002 and 88003 have produced 50% more yields in the last two years in Zimbabwe compared to the released variety PMV 1. 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 Centre IE 2929 is released as Lima in Zambia.

- **Varieties in National Testing:** A variety SDEM 113 is in agronomy trials in Zimbabwe. Thirty early maturing varieties have been selected by Tanzanian scientists over the last two years for evaluation in their national trials. Several selections are under test in Zambia from introductions of over 1000 accessions from 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 SDEM 113, 723, 937, 1079, 1059, and 1072 (early maturing), and SDEM 217, 396, 224, and 227 (late maturing).

  Germplasm accessions: There are 2596 accessions representing all the finger millet growing areas of the World. Accessions from Zimbabwe, Zambia, and Malawi have been evaluated in their respective countries. The accessions from Zimbabwe mature early in comparison to accessions from Zambia and Malawi.

- **Hybrid:** Over 500 crosses have been sown to identify hybrid plants. Selected plants will be advanced by pedigree method to produce new varieties. Early generation material will be provided to interested scientists to make their own selections.

Forage Breeding

- **Varieties in national testing:** Six forage pearl millet varieties (SDMV 89104, 89106, and 86-10242) in Swaziland and eleven pearl millet varieties (SDMV 89101 - 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 trials in Botswana.

- **Promising varieties:** Twenty-two varieties of sorghum and twelve of pearl millet have been selected for evaluating in collaborative trials in SADCC countries.

- **Dual purpose types:** Crosses are made between high yielding grain varieties with brown mid-rib 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 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 napier grass generated in 1988 are under test with and without irrigation. 103 new interspecific hybrids have been generated. At present a crop is established from cuttings. It is for communal farmers to establish a crop from seed, and, therefore, ICRISAT is looking for ways to produce seeds 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 recognised major problems of drought, the need for appropriate technology and producing practices. Research objectives are: to identify and alleviate producing 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 fulfil the above objectives.

- **Production constraints:** An evaluation of agronomic constraints to increased sorghum and millet production has been undertaken. More information is available about improving stand establishment and crop growth uniformity in sandy soils by using nematocides. 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 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 vigour ($R=0.44$, $P=0.01$), plant height ($R=0.41$, $P=0.101$), and crop growth uniformity ($R=0.88$, $P=0.05$). Further experiments are being conducted to determine ways to overcome the problem. Preliminary results indicate that the dosage of nematocide (Furadan and Nemacur) can be reduced and the results of seed dressing are encouraging.

  ICRISAT has also evaluated the performance of four cereal 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 to 10 cm sowing depth have been identified. It seems that newly released cultivars are sensitive to sowing depth, particularly if sown in dry soil. This finding 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 were studied at Matopos during the 1988/89 crop season. WUE improved to 11.4 kg ha^{-1}/mm of rain with the yield 4 891 kg ha^{-1} in a treatment

which received stubble mulch, 50 kg ha^{-1} nitrogen (N) 3 hand weedings, while it remained at 2.4 where there was no stubble mulch, no N and no weeding. 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 sorghums performed better or at par with varieties across all treatments and produced on average 36% more grain yield than 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 waterstress was developed. Comparisons were made between plots on tied ridges with those that were well drained. Supplementary irrigation was given to the nonstressed plot. Drought intensity and drought susceptibility indices were developed. Using these indices, promising hybrids MMSH 375, and MMSH 378 were ranked 1, 2, and 3 respectively (1 being most promising).

Cereals pathology

Identifying diseases: In 1989, disease samples were sent to CAB International Mycological Institute, UK, for confirming and identifying pathogens on sorghum and millets in Angola, Botswana, Lesotho, Malawi, Swaziland, Tanzania, Zambia, and Zimbabwe. Five of the most important diseases for pearl millet in the region were: Ergot (Malawi, Tanzania, Zambia, and Zimbabwe); leaf spots (Botswana, Malawi, Tanzania, Zambia, Zimbabwe); pearl millet, downy mildew (Malawi, Tanzania, Zambia, and Zimbabwe); rust (Tanzania, Zambia, and Zimbabwe); and smut (Malawi, Tanzania, Zambia, and Zimbabwe). The major diseases of finger millet were blast and blight. Seven most important diseases for sorghum in the region were: Ergot, (Botswana, Malawi, Tanzania, Zambia, and Zimbabwe); anthracnose (Botswana, Tanzania, Zambia, and Zimbabwe); leaf blight (Tanzania, Zambia, Zimbabwe, and Botswana); covered kernel smut (Botswana and Tanzania); downy mildew (Botswana, Tanzania, Zambia and Zimbabwe); sooty stripe (Zambia and Zimbabwe).

Identified locations for testing (hot spot locations) against:

- **Pearl millet diseases**

Pearl millet downy mildew	- Mongu, Zambia;
Ergot	- Ngabu, Malawi; Panmure, Zimbabwe
False mildew	- Panmure, Zimbabwe
Other leaf spot diseases	- Mongu, Zambia

- **Sorghum diseases**

Anthracnose	- Mansa, Zambia
Ergot	- Masumba, Zambia; Panmure, Harare, Gwebi, Zimbabwe
Grain molds	- Ifakara, Tanzania;
Sorghum downy mildew	- Golden Valley, Zambia; Matopos, Panmure, Zimbabwe;
Leaf blight	- Golden Valley, Zambia, Henderson, Zimbabwe;
Striga asiatica	- Hombolo, Tanzania; and
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. Research is attempting to develop a capability to screen for sorghum sooty strips.

- **Identifying 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.

  Some 3000 sorghums were tested in all SADCC countries but Angola and Mozambique. For the first time ICRISAT has confirmed resistance in a single entry to as many as three diseases; i.e., against downy mildew, leaf blight, and anthracnose. Promising entries with multiple resistance were SC 326-6, IS 8283, and IS 18688. In addition, 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:** Screening trials were evaluated. The SADCC sorghum shoot pest nursery (4 000 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). Useful results were obtained from Matopos, Panmure, Mzarabani, and Golden Valley only because of drought.

- **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 compared with natural infestation at Panmure. Significant yield loss was found with early infestation. Late infestation showed 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.

Food Technology Crop Use

- **Grain quality:** Several procedures have been standardized and are being used: pearling index, milling yield, endosperm hardness score, floating test, gelatinizing temperature, and size grading fractioning. These tests have been used to grade sixteen traditional varieties of sorghum to 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 Breed 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 evaluating 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 sorghum 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. Brix and dry matter determinations were also 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 Centre:** Two screening methods for 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 simple rapid test (8 min/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 chipboard and paper. These experiments are preliminary, but chipboard made using sorghum and millet is equally as strong as that made from wood.

Economics

- **Lesotho:** A coarse grains market reconnaissance survey was conducted in Lesotho with the assistance of two representatives from the Department of Agricultural Research. This led to the planning and implementing of more formal farm household and marketing agent surveys. These will assess the potential viability of sorghum dehullers and 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 collecting ended in November 1989 and she returned to Purdue University to write a thesis on a grain market performance.

- **Tanzania:** A very brief reconnaissance of major production and marketing issues was conducted early in 1989. This led to the planning of a more formal market system reconnaissance scheduled for November 1989. This will examine factors influencing market flows of small grains and constraints to industrial use. It will be implemented by an economist and food technologist from 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 of sorghum and millet substitution for maize and wheat in the milling, baking, brewing, and stock feed industries of Zambia was conducted by a team comprised of the SADCC/ICRISAT economist and food technologist and several Zambian professionals. The team's report has recently been submitted to the Government of Zambia for consideration. This offers a basis for the establishing 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 use 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 study considers the evolving competitive position of sorghum and millet in the agroeconomy over the next ten years.

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

Two Zimbabwean research associates are examining marketing constraints facing small farmers with diverse resource facilities 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 offer relatively quick results of immediate relevance to regional policy makers. Each set of national results will help determine the likely contribution of sorghum and millet as industrial inputs and as food security crops within SADCC countries over the next 10 - 20 years.

Future Outlook

The contribution of SMIP to different national programs will vary from country to country and from one research activity to another depending on their strength and needs. ICRISAT will assist research programs which are strong by supplying early generating breeding materials, and will continue to produce the finished products for the others until their programs are strengthened. In the next five years, ICRISAT hopes that there will be adequate scientific manpower in sorghum and pearl millet improvement in most of the countries and will develop joint projects with them to improve these crops. This collaboration will strengthen the research capabilities of national programs. SMIP will however continue to produce finished products of finger millet and forage breeding for most of the countries which are not likely to be able to do this by themselves during this period.

As national programs become strong, SMIP may reduce emphasis on developing finished products and contribute more on coordinating research activities and collaborative trials in which most of the varieties/hybrids will be contributed by national programs. The program on crop use including the use of sorghum and millets as grain feed will expand. At present we are collaborating with Matopos research station, Zimbabwe, on comparative nutrition of small grains in beef fattening diets.

We suggest establishing a modest seed production unit in our program to produce seeds for advanced trials, farmers field trials, and some extension activities. Our effects will continue to improve the research stations in the region. There is need to establish something like a SADCC Academy of Sciences where the scientists from the Region can publish their results.