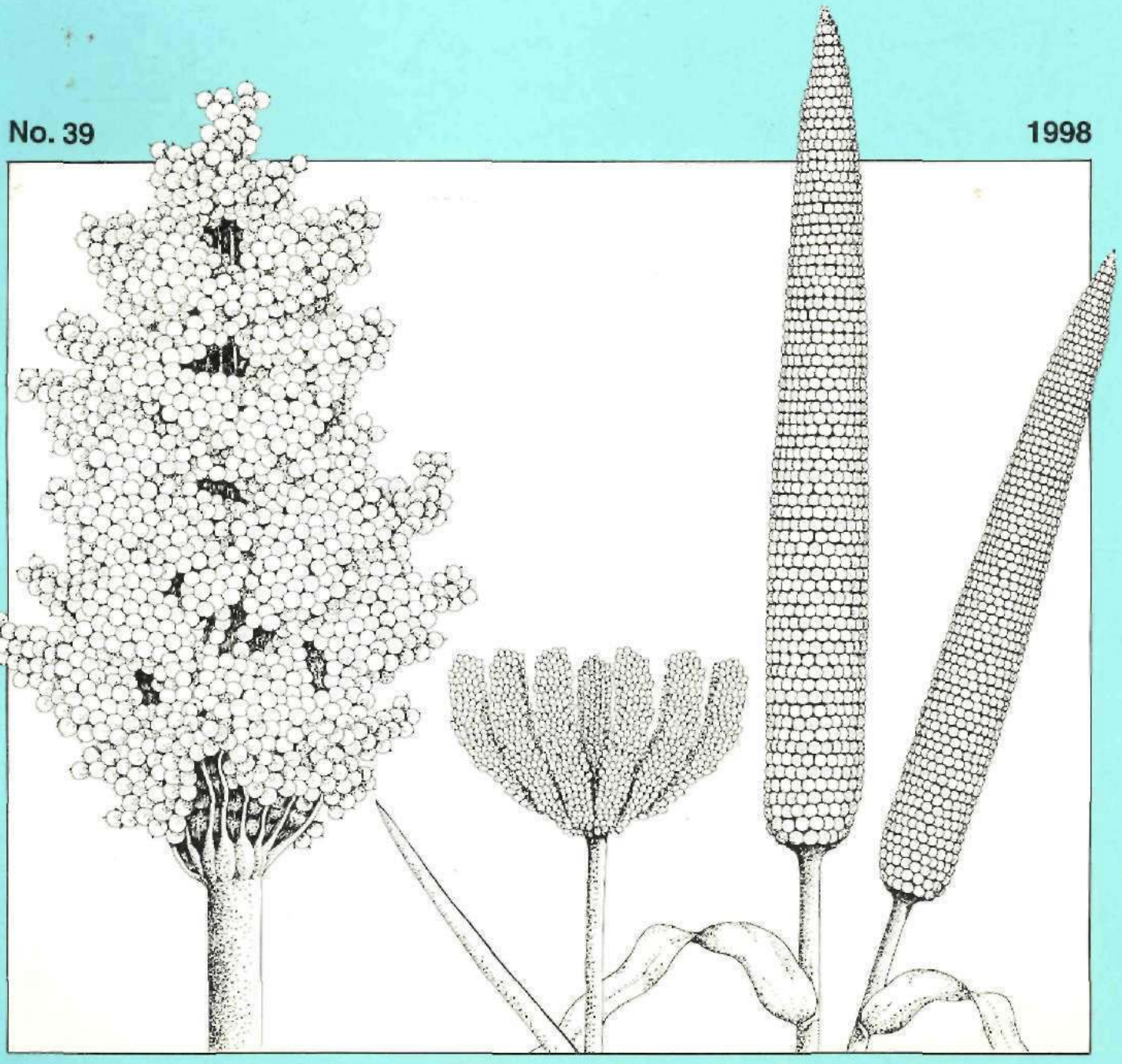
SICNA

International Sorghum and Millets Newsletter

No. 39 1998



International Sorghum and Millets Newsletter

Co-publishers

SICNA
Sorghum Improvement Conference of North America

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics

About SICNA

In 1947, sorghum breeders formed an informal working group to meet and review items of interest in sorghum breeding and genetics. This organization was named 'Sorghum Research Committee'. In the 1960s, with the advent of a number of severe disease and insect problems, special half-day sessions, particularly on diseases. became a part of the Sorghum Research Committee. In 1973, a concept was put forward that all sorghum workers, irrespective of discipline and employer, should meet twice a year to discuss mutual concerns with sorghum research and development. The Sorghum Improvement Conference of North America was that new organization. It is composed of eight disciplinary committees, dealing with genetics and breeding, pathology, entomology, chemistry and nutrition, physiology and agronomy, biotechnology, utilization and marketing, and agribusiness and commerce. SICNA meets formally once a year in conjuction with the National Grain Sorghum Producers Board. A general program of research, education, and developmental activities is prepared by the disciplinary committees. Funding is through membership participation and contributions from commercial donors. Essentially. SICNA represents the United States sorghum activities but accepts reports and encourages memberships from sorghum and millet researchers worldwide.

About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the SAT. ICRISAT's mission is to conduct research that can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks. training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the World Bank, the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP).

ISMN Scientific Editors 1998

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Technology Exchange in Phase HI of SMIP

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Abstract

The first two phases of SMIP led to the development of a range of improved technologies. During Phase III (1993-98), the priority was therefore to promote the transfer of these technologies (primarily improved sorghum and pearl millet varieties) to smallholder farmers. The three key components of technology exchange activities were: verification of technology under farmers' conditions; backstop support for national seed production and distribution; and review and revision of extension recommendations. These activities were implemented largely by the national research and extension programs. SMIP acted as catalyst and facilitator, focusing on areas where the regional program could be of greatest assistance to national initiatives.

On-farm variety trials involving national research and extension staff, NGOs, SMIP, and farmers were conducted in nine SADC countries to evaluate varieties developed during the previous two phases of SMIP. In five countries (Botswana, Namibia, Malawi, Mozambique, and Tanzania), the trials led directly to national recommendations for release of sorghum and/ or pearl millet varieties. In Swaziland, Zambia, and Zimbabwe the trials served to verify performance and farmer acceptance of varieties that had been released but not widely tested on farmers' fields.

SMIP provided training in seed production techniques to research, extension, and/or NGO staff in five countries (Botswana, Malawi, Mozambique, Namibia, and Zimbabwe), and financial support for national seed production efforts in Tanzania, Zambia, and Lesotho. Seed availability, though still a major constraint to variety adoption, has improved considerably. Regional seed stocks (excluding seed retained by farmers) at the end of the 1997/98 season were over 4400 t for improved sorghum varieties and 965 t for improved pearl millet varieties.

Another key area was the review of extension recommendations. SMIP cosponsored a major regional workshop that examined current management recommendations in each country, and reviewed available information on farmers' production systems, adoption levels, and constraints to the adoption of crop management

recommendations. Adoption rates for management recommendations were low throughout the region. The workshop consensus was that poor adoption was due to a lack of farmer input into technology development, leading to inappropriate or impractical recommendations, and poor understanding among researchers of farmers' production systems and constraints. The consensus was that there is an urgent need to redirect research to focus more directly on 'real' problems, and involve fanners more closely in technology development. Correspondingly, SMIP has supported workshops specifically aimed at promoting the use of farmer-participatory research in both crop management and crop improvement research.

Another crucial SMIP contribution was in developing and strengthening linkages among various stakeholders. Benefits from linkage development are likely to persist well beyond SMIP. In several countries, partnerships developed for on-farm testing were later extended to address the issue of seed systems.

Introduction

The Sorghum and Millet Improvement Program (SMIP) has been implemented in three 5-year phases, beginning in 1984. The third phase of SMIP covered the years 1993-1998. The primary goal of Phase III of SMIP was "to improve food security through increasing productivity of sorghum (*Sorghum bicolor* (L.) Moench) and pearl millet (*Pennisetum glaucum* (L.) R. Br.) grown by resource-poor farmers in drought-prone regions" (ICRISAT 1993, p. 15).

The first two Phases of SMIP focused on developing research infrastructure, human resources, and technology. For Phase III, the SMIP Steering Committee, composed of representatives from each of the SADC national agricultural research programs participating in SMIP, ranked regional research priorities as (1) technology transfer, (2) development of improved varieties, germplasm collection, and exchange, (3) management of diseases, pests, and the parasitic weed *Striga,* (4) human resource development, and (5) evaluation of grain quality. Technology transfer was listed as the first priority, and the specific purpose was to promote the transfer of technologies to smallholder farmers. The strategy proposed for the transfer of technologies (ICRISAT 1993) included:

- Verification of technology under farmers conditions;
- Backstop support for national seed production and distribution;
- The review and revision of extension recommendations;
- The review and evaluation of constraints to technology adoption; and
- The evaluation of research and technology impact.

All aspects of the proposed strategy were followed, with good results, particularly in regard to the release and adoption of improved varieties. This paper describes the approaches, activities, and achievements in technology transfer, in relation to the verification of technology, support to national seed production and distribution efforts, and the review and revision of extension recommendations. Activities and outputs related to the review and evaluation of adoption constraints and the evaluation of impacts are discussed in a separate paper.

Principles and approaches in technology exchange

Since its inception, SMIP has endeavored to work with partners in achieving program goals. Partnerships have been particularly important in the technology exchange activities, since these require input and support from numerous stakeholders. Thus, the most important principles and approaches that have been used in the technology exchange program in Phase III of SMIP relate to interactions among partners, and include the following.

Technology exchange vs **technology transfer**

The successful development and adoption of technology is dependent on a two-way flow of information. Feedback from farmers, extensionists, and other stakeholders to commodity and systems researchers is as crucial to success as is testing, demonstration, and adaptation of improved technologies by research. In developing and disseminating improved technology, SMIP and its partners have strongly encouraged the two-way flow of information. To better reflect this two-way interaction, the term technology exchange was adopted in place of 'technology transfer'.

Key role of national programs in impact generation

It was recognized that for genuine impact to occur at the farm level, direct implementation could only be done by the national agricultural research and extension systems (NARES), considered here in the broadest sense to include research, extension, nongovernmental organizations (NGOs), and other stakeholders in the process of

technology development and dissemination. In fact, for technology exchange in general, implementation can only effectively be carried out by national systems, and the role of the international agricultural research centers (IARCs) is as a partner, to encourage, assist, and facilitate this activity. Thus SMIP held discussions with each national program to identify where the regional program could be of most assistance to the national program, and then contributed within those areas.

Joint planning

The key to effective collaborative action is joint planning. All participants in the process must be included in the identification of mutually agreed objectives, and in the development of implementation plans for all collaborative activities to achieve those objectives.

This approach has worked well. At the regional leyel, SMIP and NARES scientists met annually to discuss program priorities for the region as a whole, and for activities at the national level for each country. This process clarified the regional priorities according to the SMIP program mandate (ICRISAT 1993). Regional meetings were followed by work planning meetings with each of the participating national programs. At the national level, priorities of the national programs were put forward by national scientists. Areas of overlap with the regional priorities for SMIP were then identified. These areas of overlap became the focus for regional collaborative activities, and joint planning with all relevant parties was initiated. There was usually considerable commonality between national and regional priorities because the overall objective at both levels was to benefit farmers, and thus regional priorities followed national interests.

Linkage development. SMIP has always encouraged and catalyzed national efforts in linkage development. For example, SMIP funded national level meetings in all participating Southern African Development Conference (SADC) countries in 1993, where many different departments and organizations were able to come together to consider ways of strengthening collaboration. Provision was always made to include as many of potential stakeholders as possible in national meetings, so that collaborative approaches could be developed from the start. The national level linkages that have developed through these collaborative activities may be one of the most important and lasting contributions of SMIP.

The concept of 'stewardship'. To generate on-farm impact, technologies and information must move from the 'problem definition' stage through the design, testing and dissemination stages, without interruption. It is important to monitor and facilitate this process, or in other words, provide *stewardship* for the progress of the technology through the system to the end user. The most appropriate source of this stewardship is the national research program, which is most familiar with the application and uses of the technology, and will have the greatest vested interest in making it available to end users.

SMIP has promoted this concept of stewardship in Phase III. Stewardship of their own technologies is strongly in the interest of national research programs. An important contribution of SMIP has been to ensure that technical assistance and limited funding were available to support key national initiatives at critical junctures, such as supporting national level meetings for planning and coordination of activities among all the relevant partners.

Activities and outputs—improved sorghum and pearl millet varieties

During Phases I and II of SMIP, regional and national plant breeders were very successful in developing early-maturing, high-yielding sorghum and pearl millet varieties for food use. One of the main objectives of the technology exchange program of SMIP Phase III was to make these materials widely available to farmers, and facilitate adoption. The approach involved three main activities:

- On-farm testing of the varieties;
- Formal variety release at the national level; and
- Seed production and dissemination.

On-farm testing of improved varieties was necessary because prior to Phase III, most participating countries were testing sorghum and/or pearl millet varieties on-station. Before investing resources in promoting the new varieties, it was necessary to detenuine whether they would perform well under the typically more stressful conditions in farmers' fields, and identify which varieties were acceptable to, and/or preferred by, farmers.

Formal variety release at the national level was necessary in most participating countries before seed of a variety could be legally produced and sold to farmers.

Seed production and distribution systems are obvious prerequisites for making new varieties of sorghum and pearl millet widely available. In the medium to long term, these need to be sustainable rather than the present ad hoc efforts initiated in response to disasters.

The activities and outcomes related to on-farm testing, variety release, and seed production/dissemination in SMIP Phase 111 are discussed below.

On-farm variety testing

Systematic on-farm testing was initiated in the 1992/93 season in three countries. By 1994/95, on-farm variety trials with these crops had been expanded to cover ail of the original nine participating SADC countries (Table 1). In all countries, the on-farm trials were conducted by the national research programs in collaboration with national extension services (except Mozambique, where the trials were conducted by World Vision International, with support from the national research and extension programs) and SMIP. In five of the nine countries, NGOs also participated in the on-farm trials programs. Farmers were directly involved with implementing and assessing the trials. On-farm trials peaked in 1994/95, and subsequently declined as adapted varieties were identified in most countries, and SMIP's emphasis shifted to seed production and dissemination (Table 1).

In all countries the trials were jointly designed and implemented by national research and extension personnel, and participating NGOs. Farmers were not always involved in the planning, but were always involved with implementation. In some cases, changes in trial designs were initiated to accommodate farmers requirements (e.g., Tanzania). In many, but not all, cases SMIP provided technical support at planning meetings and/or provided partial funding to support national efforts. SMIP scientists monitored on-farm trials jointly with national scientists. The trials followed the same general format, but each national program designed and

Table 1. SMIP-NARS collaborative on-farm sorghum and pearl millet variety trials in SADC/ICRISAT SMIP.

Year	Country	Crops	Trial types[1]	Collaborators[2]	Farm evaluations?[3]
1992/93	Malawi	Sorghum/pearl millet	RM,FM	Res/Extn	Yes
	Namibia	Sorghum/pearl millet	RM, FM	Res/Extn/CCN	Yes
	Zimbabwe	Sorghum/pearl millet	RM, FM	Res/Extn	
1993/94	Botswana	Sorghum	FM	Res/Extn	Yes
	Malawi	Sorghum/pearl millet	RM,FM	Res/Extn	Yes
	Namibia	Sorghum/pearl millet	RM, FM	Res/Extn/CCN	Yes
	Tanzania	Sorghum/pearl millet	FM	Res/Extn	Yes
	Zimbabwe	Sorghum/pearl millet	RM, FM, MDN	Res/Extn	Yes
	Swaziland	Sorghum	RM	Res/Extn	Yes
1994/95	Botswana	Pearl millet	FM	Res/Extn	Yes
	Lesotho	Sorghum	RM, FM	Res/Extn	Proposed
	Malawi	Sorghum	RM, FM	Res/Extn/WVI/CSC	No
	Mozambique	Sorghum/pearl millet	FM	Res/Extn/WVI	Yes
	Namibia	Sorghum/pearl millet	RM,FM	Res/Extn	
	Swaziland	Sorghum	RM	Res/Extn	Yes
	Tanzania	Sorghum/pearl millet	FM	Res/Extn/Mvumi RTC	Proposed
	Zambia	Sorghum	FM	Res/Extn/GTZ Project/Fosud	Proposed
1995/96	Lesotho	Sorghum	RM,FM	Res/Extn	Proposed
	Mozambique	Sorghum/pearl millet	FM	Res/Extn/WVI	Yes
1996/97	Lesotho	Sorghum	RM,FM	Res/Extn	Proposed
	Tanzania	Sorghum	FM	Res/Extn/Mvumi/SG2000/CCT	Yes

1. RM = researcher managed; FM = farmer managed; MDN = nurseries.
2. Res = national research program; Extn = national extension service; CCN = Council of Churches, Namibia; CCT = Christian Council, Tanzania; CSC = Christian Service Committee; Fosud = Forum for sustainable development; SG2000 - Sasakawa Global 2000; Mvumi RTC= Mvumi Rural Training Centre; WVI = World Vision International; GTZ - Deutsche Gesellschaft fur Technische Zusammcnarbeit.
3. Yes = farmer evaluations of varieties were conducted; Proposed = systems for obtaining farmer evaluations of varieties were proposed; but SMIP does not have information on whether these were actually conducted.

implemented them according to their own needs and conditions. SMIP collaboration with specific national programs in on-farm trials implementation, the types of trials conducted, and implementing organizations are given by year in Table 1.

In most countries,the on-farm variety trials were of two types, Researcher Managed (RM) trials and Farmer Managed (FM) trials. In both cases, the trials were implemented by farmers and included farmers' local varieties as controls. The RM trials were designed to evaluate the *potential of* the new varieties on farmers' fields, and typically included more varieties than the FM trials (an average of 10 varieties versus an average of 5-6 for the FM trials), had two replications per location, and received higher levels of crop management (timely sowing, thinning, clean weeding). In some countries, they also received standard inorganic fertilizer applications. The FM trials were designed to evaluate the *actual* performance of the new varieties, and to obtain *farmer assessments* of the varieties (primarily preference or

Table 2. Sorghum and pearl millet cultivars released (and varieties pending review by Release Committees) in SADC following the collaborative on-farm variety trials program of SMIP Phase III.

Crop	Country	Year of release	Source of genetic material	Cultivar name
Sorghum	Malawi	1993	ICRISAT	Pilira 1
			ICRISAT	Pilira 2
	Botswana	1994	ICRISAT	Pofu
			ICRISAT	Mahube
			ICRISAT	Mmabaitse
			ICRISAT	BSHI
	Tanzania	1995	ICRISAT	Pato
	Zimbabwe	1996	ICRISAT	Maria[1]
			ICRISAT	SDS 2690-2[1]
		1998	NARS/ICR1SAT	SV-3
			NARS/ICRISAT	SV-4
	Namibia	1998	ICRISAT	Macia
Pearl millet	Tanzania	1994	ICRISAT	Okoa
			NARS/ICRISAT	Shibe
	Malawi	1996	ICRISAT	Tupatupa
			ICRISAT	Nyankhombo
	Zimbabwe	1996	ICRISAT	SDMV 93032[1]
		1998	ICRISAT	PMV-3
	Namibia	1998	ICRISAT	Kangara
			ICRISAT	Okashana 2
	Zambia	1998	NARS	Sepo
Pearl millet[2]	Botswana		ICRISAT	SDMV 89004
			ICRISAT	ICMV 88908
	Mozambique		ICRISAT	SDMV 89005
			ICRISAT	SDMV 90031
			ICRISAT	SDMV 91018

1. Varieties were 'released' by commercial seed companies, who made the decision to produce and sell seed after evaluating the material; however, the seed companies did not go through the formal National Release Committees
2. Varieties pending review by Release Committees.

palatability data). Farmers were expected to apply their normal levels of nonexperimental variables (time of sowing, frequency of weeding, normal fertility management practices, etc.). Hence the term ' farmer-managed'. These trials were composed of fewer varieties, were replicated across farms but not within farms, and typically had lower grain yields than RM trials.

In five out of nine participating countries (Botswana, Namibia, Malawi, Mozambique, and Tanzania), on-farm trials led directly to national recommendations for release of sorghum and/or pearl millet varieties (Table 2). Of the remaining four countries, three (Swaziland, Zambia, and Zimbabwe) had previously released improved, early-maturing varieties, and the trials served to verify performance and farmer acceptance of the new varieties. In these cases, the trials also served to increase farmers' awareness of the new varieties. In the fourth country (Lesotho) droughts and other difficulties with trials implementation prevented clear identification of varieties suitable for release.

Thus, in virtually all the original nine participating countries, the on-farm trials served to identify varieties that performed well on farmers' fields and were acceptable to farmers in terms of their plant and grain characteristics. These varieties were therefore clearly suitable for wide-scale dissemination and adoption. In five cases these were new varieties, and in three cases they were varieties that had been previously released but not extensively tested on-farm. In general, farmer evaluations of the new varieties (both sorghum and/or pearl millet) indicated that the selected varieties were popular due to early maturity and preferred panicle and grain quality

Table 3. Sorghum and pearl millet cultivar releases in SADC prior to the collaborative on-farm variety trials program of SMIP Phase III.

Crop	Country	Year of release	Source of genetic material	Cultivar name
Sorghum	Swaziland	1992	ICRISAT	MRS 12
		1989	ICRISAT	MRS 13
		1989	ICRISAT	MRS94
	Tanzania	1988	NARS/ICRISAT	Tegemeo
	Mozambique[1]	1993	ICRISAT	Chokwe
		1989	NARS	Mamonhe
		1989	ICRISAT	Macia
	Zimbabwe	1992	NARS	ZWSH1
		1987	ICRISAT	SV-1
		1987	ICRISAT	SV-2
	Zambia	1995	NARS	ZSV 12
		1990	NARS	MMSH 375
		1990	NARS/ICRISAT	MMSH 413
		1989	NARS/ICRISAT	Sima
		1989	NARS	Kuyuma
		1987	ICRISAT	WSH 287
Pearl millet	Namibia[1]	1989/90	ICRISAT	Okashana 1
	Zambia	1991	NARS/ICRISAT	Lubasi
		1989	ICRISAT	Kaufela
		1987	ICRISAT	WC-C75(ZPM-871)
	Zimbabwe	1992	ICRISAT	PMV-2
		1987	NARS	PMV-1

1. At the time of 'release' there were no formal release procedures in these countries. The varieties mentioned were simply recommended for use by farmers by the NARS.

characteristics. Good grain yield was also sometimes mentioned as a contributing factor, but this was usually a lower priority.

The increase in on-farm trials in the region represented a significant increase in linkage development between research, extension, NGOs, and farmers at the national level. The benefits of the linkage development are likely to persist well beyond SMIP. Once people and organizations have developed successful methods for working together, it is relatively easy to continue these relationships. For example in Zimbabwe, though SMIP ceased supporting on-farm variety trials in 1994, research and extension personnel continued to conduct collaborative on-farm variety trials.

The on-farm trials had a significant effect on variety releases as well. In many countries, breeding programs had never previously taken improved sorghum and/or pearl millet varieties on-farm for testing, so there was naturally some concern over what farmers' reactions might be. However, in the vast majority of cases, the trials did contain some were varieties that proved very popular with farmers. Farmers then began requesting extension personnel and the researchers involved with the trials to provide them with seed of these varieties.

While trials should never be confused with demonstrations, the trials program nonetheless created a demand for specific improved varieties at the farm level. This demand had two very positive effects. First, it generated confidence and enthusiasm within the breeding programs and helped strengthen interaction between research, extension and farmers. With good data from the field as well as strong support from both farmers and extension, breeders could be confident that national release committees would approve release proposals. At the same time, the demand-pull from the farmers exerted pressure to formally release the materials. These two factors together have greatly increased the rate at which new varieties were moved through the system.

Interaction with farmers has led to a greater acceptance of the importance of, and potential benefits from, greater farmer participation in the technology development process. Today, most sorghum and millet research programs in SADC accept that farmers are the ultimate clients and that they should be partners in technology development.

Variety release

The decision of whether to release new cultivars, and which cultivars to release, is solely the responsibility of NARS. Most countries in the region have legally constituted bodies responsible for formal release of new cultivars, though there is a trend toward relaxing these restrictions.

ICRISAT and SMIP have assisted NARS scientists move new varieties through the fonnal release process, for example by generating data (such as grain quality data obtained in the Food Technology Laboratory at Matopos), assisting with data analysis, and contributing to the final editing of papers. However, these inputs have only been made at the request of, and in response to initiatives by, NARS scientists.

Variety development, testing, and release is a lengthy process, and could take 6-10 years. Given that there have been more than 40 releases in eight SADC countries during the 15 years of SMIP (Tables 2 and 3), this represents a tremendous amount of successful work by national program breeders and collaborating SMIP scientists.

As evidenced in Tables 2 and 3, and Figure 1, the successful process of variety release that was initiated in Phases I and II was continued and enhanced during Phase III. It is interesting to note that at the beginning of Phase III variety release procedures were perceived as a potential constraint to the dissemination of improved varieties (ICRISAT 1993, pp. 17-18). In the event, they were not a major constraint. It is likely that the process of on-farm testing, and the fact that NARS scientists took responsibility for promoting the new varieties, contributed considerably to mitigating this potential constraint.

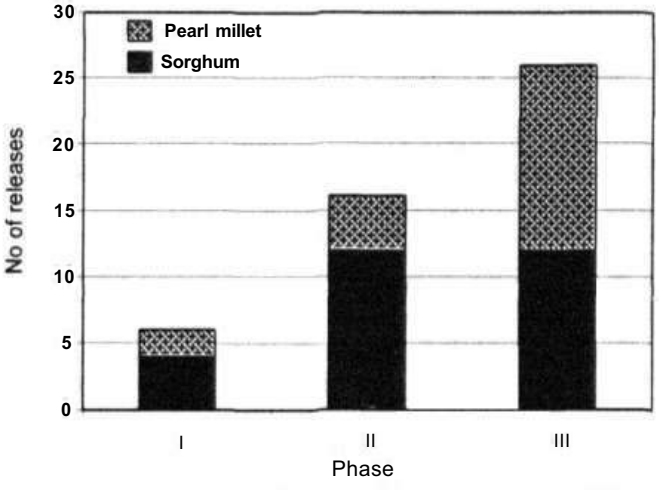

Figure 1. Sorghum and pearl millet releases (and pending releases) by NARES in Phases I, II and III.

Seed production and dissemination

Seed availability is a prerequisite for the adoption of new, improved varieties. In the planning for Phase III of SMIP, there was only one milestone related to seed production per se: "Development of NARS capacities to produce breeder seed (three countries by 1995, seven countries by 1998)" (ICRISAT 1993, p. 30). The issue of breeder seed production has been addressed elsewhere (see papers by Obilana and Monyo, this issue). However, SMIP and NARES activities in regard to seed production have gone well beyond this level during Phase III of the program. This has happened for several reasons given below.

- **Successful variety development and release.** Midway through Phase III it became clear that the process of variety development and release was going to be extremely successful. Therefore, SMIP and NARS scientists agreed that activities aimed at further variety development should be de-emphasized in favor of efforts to facilitate adoption of the new varieties.
- **Constraint to adoption.** Seed availability has been a constraint to the adoption of new varieties in the majority of countries participating in SMIP. Overcoming this constraint was seen as vital to the adoption and widespread use of the new varieties.
- **The concept of 'stewardship'.** From the outset of Phase III, SMIP and some NARS promoted the idea that scientists need to take responsibility not only for technology development, but also for facilitating the movement of that technology onto farmers' fields. This concept became widely accepted, and hence there has been strong support among NARS for enhancing seed availability.

Some of the collaborative activities that have been undertaken to further the process of seed production and distribution include the following:

- **Linkage development.** At the beginning of Phase III, SMIP supported national level meetings in all countries to bring together a wide range of stakeholders involved with sorghum and pearl millet production. These included research, extension, NGO, and private sector representatives. Partnerships and collaboration among stakeholders were seen as vital, both to identifying appropriate varieties and to deliver these to farmers. Initially, partnerships were developed for on-farm variety testing. Later, some of the same partnerships were extended to address the issue of seed systems.
- **Technical assistance and training in seed production.** SMIP breeders provided short-term and in-service training in seed production techniques to research, extension, and/or NGO staff in five countries (Botswana, Malawi, Mozambique, Namibia, and Zimbabwe). The program also provided financial support for national efforts in Tanzania, Zambia, and Lesotho.
- **National seed production/dissemination strategy meetings.** SMIP supported NARS-led meetings to develop national strategies for sorghum and pearl millet seed production and dissemination in Tanzania and Zimbabwe. In both countries, partners in the public and private sectors are now beginning to implement strategies for farmer-based seed production systems and commercial sale of seed.
- **Interaction with private seed companies.** SMIP plant breeders have maintained linkages with private-sector seed companies (with the knowledge and approval of relevant NARES), and have provided breeder seed to them. Private sector seed companies, particularly in Zimbabwe, have been producing seed of improved sorghum and pearl millet varieties, primarily for NGOs involved in humanitarian relief and/or resettlement projects. In addition, commercial seed companies in Zimbabwe have identified (from regional trials data and their own tests) two varieties of sorghum and one variety of pearl millet that they are now producing on their own (they have signed agreements with ICRISAT that the varieties are still available for production by other stakeholders).
- **Dissemination of successful seed production/dissemination models.** Because of the widespread and increasing interest in farmer-based seed production and dissemination systems in the region, SMIP promoted sharing of information on successful models. In 1998, SMIP facilitated a regional workshop to showcase the successful farmer-based pearl millet seed system developed by the Namibian NARES. There were 31 participants from 11 SADC countries.

Seed production and availability in SADC. Through the efforts of both public and private sectors, seed production of improved varieties of sorghum and pearl millet in SADC has steadily grown. At the end of the 1995/96 season, rough estimates indicated that there were about

Table 4, Seed stocks of improved varieties of sorghum and pearl millet that include ICRISAT genetic material, anticipated by producers in selected SADC countries, at harvest in 1998. Estimates collected in Feb 1998.

Country	Sorghum (t of seed)	Pearl millet (t of seed)
Angola	—	—
Botswana	234	—
Lesotho	—	—
Mozambique	183	8
Malawi	23	1
Namibia	—	388
Swaziland	—	—
Tanzania	[1]	[1]
Zambia	146[2]	5[2]
Zimbabwe[4]	3842	563
Region	4428	965

1. Farmer-based seed production efforts undertaken. Data not yet available.
2. Varieties developed by NARS.
3. Note: Zimbabwe data includes 720 tons of sorghum variety Macia produced by the private sector but not captured in the above Seed Stocks Inventory (AB Obilana, personal communication).

Source: Rusike and Rohrbach 1998.

2500 t of seed of improved sorghum varieties, and about 125 t of seed of improved pearl millet varieties available for sale in the region (this did not include seed retained by farmers). By 1998, these figures had increased considerably (Table 4.) While much of the increase was accounted for by the private sector (presumably servicing relief and rehabilitation programs), it nonetheless indicates an increasing demand for the varieties, and an increasing potential for developing sustainable, demand-driven seed systems.

Through strong efforts by national programs, with support from SMIP, significant levels of adoption (>20% of area sown) are now occurring in several countries (Botswana, Namibia, Swaziland, Zambia, and Zimbabwe). Further details on the adoption and impact of the new varieties in SADC are given elsewhere in this issue.

Seed availability remains the primary constraint to adoption of improved varieties in many SADC countries, including such major sorghum and millet producers as Tanzania and Mozambique, Continuing efforts to improve seed systems in SADC will be required to ensure that farmers have access to new varieties and that the potential benefits of regional crop improvement efforts are fully realized.

In addition to continuing efforts to improve seed systems, for the future it will also be important to increase user input in the variety development process. Incorporating user needs and interests in developing the next generation of improved varieties will increase the probability that these in turn will be adopted and utilized. One approach is through the application of farmer-participatory breeding techniques, and through consultations with the milling and livestock feed industries.

Technology exchange activities in crop management

There were two milestones related to crop management in Phase III of SMIP: (1) Extension recommendations for sorghum and pearl millet reviewed in all SADC countries (except Angola)—1995; and (2) Extension recommendations revised in at least four SADC countries—1998.

Review of extension recommendations

The workshop to review national extension recommendations and production systems for sorghum and pearl millet in SADC countries was held 19-23 Feb 1996 in Harare. It was sponsored by SADC/ICRISAT SMIP, the FAO/Swedish International Development Agency (SIDA) Farming Systems Programme, SACCAR, and the Southern African Association for Farming Systems Research and Extension (SAAFSRE). The workshop was attended by a multidisciplinary group of 34 participants from 10 SADC countries.

At the workshop, most of the national research programs in SADC presented papers that reviewed their formal crop management recommendations for sorghum and millet. In addition, these papers reviewed available information on farmers' production systems, levels of adoption of recommended practices, and constraints to adoption of recommended practices at the national level. Following the presentations, significant time was allocated to discussion of these reports and issues arising.

It was clear from the presentations and discussions that adoption levels for crop management recommendations, such as for tillage and soil fertility maintenance, are very low across the region. There was general agreement that the lack of farmer input into technology design and development had resulted in recommendations that were

either inappropriate or impractical hence the low adoption rates. Further, there was general agreement that research does not have a good understanding of farmers' production systems and constraints, and that it is important for research to generate such an understanding as soon as possible.

Surveys had been conducted in most countries, and there was at least limited information available on farmer-identified production constraints. However, national reports indicated that in general there were no recommendations available to address these constraints. For example, while the constraint most commonly mentioned by farmers across the region was shortage of labor, there were no recommendations on labor-saving management options. Of eight countries reporting, six did not have recommendations to address the primary production constraints identified by fanners, one did not have information on farmer-identified constraints, and one did not discuss the issue.

Thus, scientists and extension personnel from across the region clearly identified the need to redirect research to focus more directly on farmers' production constraints as the highest priority for crop management research on sorghum and pearl millet in SADC. This included developing a thorough understanding of farmers' production systems and constraints, and the consensus that more farmer involvement in technology design and development is vital to ensuring that research products are relevant and practical.

To address the issue of increasing fanner participation in the development of practical and appropriate crop management strategies and technology, SADC national programs requested SMIP to conduct a regional workshop to enhance understanding of Farmer-Participatory Research (FPR) approaches. This workshop was held 7-11 Jul 1997, in Harare. Since this workshop, SMIP has assisted in promoting the use of FPR approaches in both crop management and crop improvement research.

Revision of extension recommendations

SMIP has collaborated in the revision of existing sorghum and/or pearl millet extension recommendations in Namibia, Swaziland, and Zimbabwe. Collaborative work with the national research program and the NGO World Vision International has also been undertaken in Mozambique. These efforts have focused primarily on refining plant density and fertilizer recommendations, although in Namibia and Mozambique, where recommendations for smallholder farmers did not previously exist, the work has addressed a broader range of crop management topics as well.

Given the very low rates of adoption of standard extension recommendations in countries across the region, and the concensus from the Recommendations Review Workshop (above) that the standard recommendations do not address farmers' primary constraints, efforts in this area have not, however, received a high priority. Rather, activity has focused on addressing the issue of greater fanner involvement in technology development (through FPR approaches) and in developing new strategies for crop management research as a whole. This process has been initiated in collaboration with the national program in Zimbabwe. Focusing on soil fertility, a new approach involves the use of FPR in understanding farmers' current systems and constraints, and in developing practical options for farmers. It also employs crop growth modeling to assess the sustainability and risk associated with different options. A significant change in crop management research strategy is required if real production increases are to occur at the farm level. Considerable expansion of this work is being proposed for the next phase of SMIP.

Discussion and conclusions

Approaches to technology exchange

While recognizing that technology development and adoption can only be achieved through strong national-level efforts, SMIP has been successful in developing collaboration between national and regional programs to assist and facilitate this process. In addition, the regional program has ensured that national programs have had access to the global knowledge base and germplasm resources, and this has been very important in the development of improved varieties. Within the SADC7 ICRISAT SMIP, the interaction among participating NARES has also led to the development of a strong defacto network of scientists that greatly facilitates the sharing of knowledge and technology across the region. The technology exchange process has been enhanced at both the regional and national levels.

Development and dissemination of improved varieties

Collaboration between the national programs and SMIP has been extremely successful in terms of the development, testing, and release of improved varieties of sorghum and pearl millet. With over 40 national-level variety releases in the last 15 years, the availability of improved varieties is no longer a major constraint.

SMIP has collaborated with the private sector, NARES, and others in the region in the development of seed systems to ensure that seed of the improved varieties is available to farmers. Significant levels of seed production are now occurring, leading to significant adoption. However, the availability of seed of the new varieties is still a major constraint to broader adoption in many countries of the region, and continued efforts to develop sustainable seed systems are required.

Revision of extension recommendations

Research in SMIP indicates that the adoption of a new variety alone may provide farmers with a 10-50% yield increase. Adopting the new variety together with improved crop management practices can provide a 100-300% yield increase. Thus, improved crop management is required both to capitalize on the yield potential of the new varieties, and to achieve the primary goal of increasing incomes and improving food security for smallholder farmers in the semi-arid areas of SADC.

Across the region, there is now consensus among scientists in sorghum and pearl millet research programs that it will not be sufficient to simply refine existing production recommendations. Rather, there is a need to address the issue with entirely new strategies. These new strategies include the need for an improved understanding of farmers' systems and constraints, and more farmer involvement in the development of practical options to address farmers' real constraints and needs.

The future

It is recognized that improved varieties and improved crop management technology alone will not be sufficient to achieve major increases in productivity at the farm level. Input supply systems (for seeds, fertilizers, etc.) will need to be improved, and output markets will need to be enhanced to provide the incentives and rewards for increasing farm production.

Thus, in Phase IV of SMIP it is proposed to continue collaborative research with NARES and other advanced research institutions on the important issues described above. But it is also expected that the existing partnerships will be significantly expanded to include other actors who can simultaneously assist in addressing the issues of input supply and product marketing and utilization. New partners in this process would include NGOs, the private sector, and an expanded range of public sector participants. A strong and effective network for communications, joint planning, and the sharing of information will be required for the effective coordination of activities by such a broad range of partners.

Collaboration among partners tends to increase in difficulty as the number of partners expands. Nonetheless, collaboration and cooperation are key to the process of technology exchange and are vital in effecting change at the farm level. In the next and last phase of SMIP, the objective will be to build on the strong regional partnerships developed to date, and expand these into an effective and sustainable system for the development and delivery of technology for the full range of end users.

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