# Development of a National Pearl Millet Breeding Program for Namibia

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## Introduction

Pearl millet accounts for 24% of total calorie intake as compared with 23% for maize and 13% for wheat (SADC Food Security Bulletin 1991). It plays an important role in the diet of Namibians and is widely grown in 7 of Namibia's 13 political regions which cover an estimated 355 200 ha of land (pers. comm. Namibia Ministry of Agriculture 1994). Except for the diminishing rainfall as one moves from the eastern part of Namibia (Caprivi) to western Omusati, most of the country's pearl millet belt lies in the same belt as the millet-growing areas of Zimbabwe, where improved SADC pearl millet materials have been developed and tested.

With support from the Namibian government and extra financial support from CIDA, SMIP assisted in the establishment of a pearl millet breeding program, concentrating initially on exploiting local germplasm and a few introduced cultivars that are adapted to Namibia's conditions.

## Namibian pearl millet germplasm collection

Most of the pearl millet-growing areas were thoroughly covered during a germplasm collection mission jointly organized by the Ministry of Agriculture and SADC/ICRISAT from 18 Apr to 12 Jun 1991. A total of 1000 pearl millet accessions were collected. One batch was left in Namibia, a second was taken to Muzarabani in Zimbabwe for multiplication, and a third for long-term storage at ICRISAT.

## Evaluation of the germplasm

The 750 accessions of the pearl millet germplasm collected in Namibia were evaluated during the 1991/92 cropping season at three different locations (Omahenene

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and Mashare in Namibia and Muzarabani in Zimbabwe). Very useful variations were observed. Some of the collection grew to a height of 2–3 m and produced two to five stout basal tillers with thick stems. The heads were 30–40 cm long with conical to cylindrical panicles. They matured between 105 and 120 days.

The grains were gray, white, or a mixture of colors with partly corneous endosperm. Most of the accessions had medium to large grains. Selection of superior accessions was made from two locations in Namibia for the initiation of a breeding program.

## Gene pool from the germplasm

Variability in the germplasm limited our choice of phenotypes on which gene pools were based, as follows.

**Early-maturing gene pool** (< 65 days to 50% flowering). This consisted of accessions that are commonly of short stature, have thin stems, and small- to medium-sized panicles and tillers (with some exceptions in which plants in this group have long panicles and thick stems, and are low tillering).

**Medium-maturing gene pool** (65–70 days to 50% flowering). Accessions are of medium duration, medium to tall plant height, medium stem diameter, medium to high tillering, medium to long panicle, and medium to large grains.

**Late-maturing gene pool** (70 days to 50% flowering). Accessions are of late maturity, tall height, thick stem, medium to low tillering, long panicle, medium to broad panicle diameter, medium to large seed size.

**Large panicle gene pool.** Accessions are of medium to late maturity, variable height, medium to thick stems, variable tillering, medium to long panicle, broad to very broad (including club head type) panicle, medium to large seed size.

**Bristled gene pool.** This includes all types of bristled panicles.

**Reduced plant height gene pool.** Accessions are of short height, but not dwarf, with variable stem thickness, tillering ability, panicle length and diameter, and seed size.

## Main features of the breeding program adopted

From these gene pools we embarked on a breeding program that specifically defines two main areas of focus.

**Short-term variety releases.** These varieties are high-yielding, resistant to pests and diseases, and generally adapted to a wide range of Namibian ecological conditions. This work was achieved by growing a large population consisting of 5000 plants and making approximately 2000–2500 selfs. These self-pollinated plants were harvested after reliable data had been collected and evaluated on their yield performance, plant height, plant type, and days to 50% flowering. Composite populations were then formed:

- Namibia Drought-Tolerant Composite (NDTC), developed from the accessions that survived the 1992 drought at Muzarabani in Zimbabwe.
- Namibia Composite 90 (NC 90), developed in 1990 by random-mating eight varieties and two populations selected from the introductory nursery of SADC/ICRISAT SMIP breeding materials grown at Okashana, plus a bulk of 14 Namibian germplasm lines.
- Namibia White Grain Composite (NWGC), formed by random-mating 46 white-grain accessions from the Namibian pearl millet germplasm and an equal number from SADC White-Grained Composite. This is being formed to provide a source of agronomically elite lines with medium to large, hard, round, white grain, for the selection of varieties that can be commercially milled to produce a white meal or flour.
- Maria Kaherero Composite (MKC), based on a set of half-sib progenies taken from a farmer's field in Ruacana during the 1991/92 rainy season. The farmer had obtained seeds of Okashana 1 (ICTP 8203) during 1989/90 which he intersowed with his local landrace variety (LLV). Individual plant selection was carried out based on the Okashana 1 phenotype, but with emphasis on greater vigor and tillering ability than the original Okashana 1.

$S_1$ progeny selection is being carried out on all composite populations to improve productivity and grain quality traits, and to produce varieties of a wide range of phenotypes adapted to Namibian environments.

The SADC Early Bold Grain Composite (SDEBGC) and SADC White Grain Composite (SDWGC) are being utilized in the national program. The performance data of the four composite populations grown at Omahenene Research Station during 1993/94 are shown in Table 1.

**Table 1. Performance data of four composite populations grown at Omahenene Research Station, Namibia, 1993/94.**

| | Days to maturity (50% flowering) | Potential yield (t ha$^{-1}$) | |
|---|---|---|---|
| Population | Mean | Mean | Range |
| NC 90 | 63.38 | 2.03 | 0.3–4.0 |
| MKC | 62.12 | 2.04 | 0.3–3.9 |
| SDWGC | 60.71 | 2.11 | 0.4–4.0 |
| SDEBGC | 63.95 | 1.99 | 0.7–3.2 |

**Long-term breeding of cultivars for quality attributes and a good milling profile.** Though most Namibian pearl millet farmers now use open-pollinated varieties of composite populations, we are nevertheless developing a series of inbred lines that will constitute our pollinator sources for the development of hybrid pearl millet for commercial farmers.

The food-quality laboratory that is to be used in screening the varieties or composites for their quality traits may not always be available due to lack of resources or trained personnel, but consumer demand requires that we devise a way of testing the varieties for their needs. Also, the hybrid program requires that an appropriate service for the production, maintenance, and certification is in place to guarantee the quality of seeds that are delivered to farmers.

In 1994 seed production, distribution, and development is handled by the Ministry through researchers at research stations. But it is envisaged that a National Seed Service Unit will be formed to take over responsibility for seed bulking and distribution.

## National cultivar testing

The system of testing now in operation in Namibia involves (a) advance national variety trials; (b) initial variety trials conducted each season; (c) regional collaborative variety and hybrid trials with SADC/ICRISAT SMIP. All these feed promising materials to the on-farm verification program. Six varieties identified through this system were under farmers' verification trials in 1994.

A total of 119 cultivars were selected for use in the national testing from the collaborative trials. SDMV 90016 and ICMV-F 86415 have yielded 12–16% more than the farmers' LLV in 2 years of testing (Table 2).

Two Okashana 1-based hybrids (SDMH 92012 and SDMH 92018) are among the materials selected for testing. These have shown a yield superiority of 15–23% over Okashana 1 at Omahenene Research Station (Table 3). The advantage of these topcross hybrids is that both Okashana 1 and the hybrids can be used as seed. Other promising hybrids are also indicated in Table 3.

**Table 2. Performance data of elite varieties under Namibian conditions across seasons and locations.**

| | Mean yield[1] ($t\ ha^{-1}$) | |
|---|---|---|
| Variety | 1992/93 | 1993/94 |
| Okashana 1 | 1.89(24)[2] | 1.14(14) |
| SDMV 90016 | 1.77(16) | 1.12(12) |
| ICMV-F 86415 | 1.69(11) | 1.15(15) |
| Farmers' LLV | | 1.00 |

1. Yield averages across the three locations.
2. Numbers in parentheses indicate yield superiority over farmers' LLV.

**Table 3. Performance data of selected hybrids under Namibian conditions across seasons and locations.**

| Variety | Mean yield (t $ha^{-1}$) | |
|---|---|---|
| | 1992/93[1] | 1993/94[2] |
| SDMH 91004 | 2.57(13)[3] | 1.89(38) |
| ICMH 88088 | 2.53(11) | 1.30(-5) |
| SDMH 90005 | 2.36 (4) | 1.56(14) |
| ICMH 87913 | 2.08(-8) | 1.73(26) |
| SDMH 92012 | - | 1.57(15) |
| SDMH 92025 | - | 1.75(28) |
| SDMH 92018 | - | 1.69(23) |
| Okashana 1 | 2.27 | 1.37 |

1. Yield averages across three locations.
2. Yield averages across two locations.
3. Numbers in parentheses indicate yield superiority over the improved local (Okashana 1).

## Conclusion

The potentially high-yielding LLVs identified through evaluation of local germplasm are already being improved for agronomic desirability by recurrent selection and through a process of limited backcrossing involving Okashana 1 and the SADC White Grain Composite. These materials are in their third backcross in 1994 and will form the nucleus of the breeding program.

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# Soil Management for Optimized Productivity Under Rainfed Conditions in the Semi-Arid Tropics[1]

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## Contents



## I. Introduction

The semi-arid tropics (SAT) are defined in the context of Troll's (1965) vegetation zone delineation as the region within the tropics where the mean

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