The role of introduced sorghum and millets in Ethiopian agriculture

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Introduction

Sorghum (*Sorghum bicolor*) is one of the most widely grown cereal crops in Ethiopia. It is a staple food crop on which the lives of millions of poor Ethiopians depend. It has tremendous uses for the Ethiopian farmer and no part of this plant is ignored. Sorghum grows in a wide range of agroecologies most importantly in the moisture stressed parts where other crops can least survive and food insecurity is rampant.

Being an indigenous crop, tremendous amount of variability exists in the country. As a result, a large number of accessions have been collected by the joint efforts of the Ethiopian Sorghum Improvement Project (ESIP) and the Institute of Biodiversity Conservation (IBC). Many of these accessions have been evaluated in the country and some were released as commercial cultivars for the highlands. Still others have been used in supplementing the germplasm base of the international and national agricultural systems around the globe. Gebrekidan (1973) elucidated the importance of the Ethiopian sorghum germplasm in the world collection. However, in recent years, the variability is becoming less in the lowlands where vulnerability due to recurrent drought and incidence of pests mainly spotted stem borer (*Chilo partellus*) is very high. The local cultivars in these areas are late-maturing resulting in failure of the crop as the rain ends early in the season before or at the time of flowering. For these areas, it is indispensable to introduce early-maturing germplasm that can mature within the range of the rainy season. Over the years, a large number of early-maturing sorghum and millet varieties and hybrid parents and populations with various desirable traits have been introduced and evaluated. This article intends to give a short account of the role of introduced sorghum and millets in the Ethiopian agriculture.

Sources of introductions

The primary and most important source of sorghum germplasm introduction for Ethiopia has been the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). From the very beginning of sorghum research in Ethiopia, a significant number of sorghum germplasm lines have been introduced from ICRISAT and evaluated annually for various desirable traits. The second most important source has been the International Sorghum and Millets (INTSORMIL) collaborative research support program. The East African Regional Sorghum & Millets Network (EARSAM), now East and Central African Sorghum & Millets Network (ECARSAM), Southern African Food Grain Research (SAFGRAD), Texas A&M and Oklahoma Universities, and Centro Internacional de Mejoramiento del Maïz y del Trigo (CIMMYT) were also the sources in different times. The introduced materials include varieties/lines in the form of regional and international trials and nurseries, hybrids for evaluation, hybrid parents (A-, B- and R-lines) and populations. A large number of lines/varieties were introduced in the form of international trials and nurseries for various traits such as earliness and disease and insect resistance [eg, The All Disease and Insect Nurseries (ADIN) of ICRISAT].

Introduced materials

Early-maturing sorghum varieties/lines. The main interest of introducing sorghum germplasm in Ethiopia is to evaluate and release high-yielding and early-maturing sorghum varieties that can escape drought occurring late in the season in the dry lowlands. Over the years, a large number of early-maturing sorghum varieties and lines have been introduced and evaluated for yield and yield related attributes. All the sorghum varieties that have been released so far by the national sorghum research program for commercial production in drought stressed areas were from exotic sources except Gambella 1107.

With focus on market oriented research in Ethiopia, the sorghum project intended to help the few broom exporters, who produce broomcorn in the rift valley of Ethiopia. To this end, four broomcorn varieties were introduced from Amex International, USA in 2004. However, all these entries were found to be segregating for height and panicle shape and size except one variety that showed better uniformity and performance and was adaptable to Melkassa and Mieso areas. Unfortunately, due to the paucity of interest from the exporters' side the adaptation study of broomcorn was terminated prematurely.

In 2004, 34 early-maturing malt sorghum varieties and lines were introduced from ICRISAT, Bulawayo, Zimbabwe. Of those, five were released varieties in many African countries. As three of them did not have the required level of uniformity, only two (Red Swazi and Macia) were included in the adaptation study. Since they performed better in the study areas, in 2006 they were planted in on-farm verification plots and proposed for registration. The National Variety Release Technical Committee evaluated the verification plots in October 2006 and the varieties were officially approved by the standing committee for registration in March 2007. Moreover, two varieties, WSV 387 and SDSL 2690-2 were planted for on-farm verification in the main season of 2007 for release.

***Striga* resistant sorghum varieties/lines.** *Striga* is becoming a major concern threatening sorghum production in many parts of the country. Since it is difficult to control the parasitic weed, sorghum farmers are shifting their cropping system to other crops. The introduction of varieties/lines that combine high yield and *Striga* resistance has been a high priority thematic area of research. Such germplasm have been introduced from ICRISAT and INTSORMIL and evaluations have been made in *Striga* prone areas. Over the years the apparently available *Striga* resistant varieties and lines have been introduced and tested in hot spot areas. Recently, two *Striga* resistant sorghum varieties, Gubiye (P9401) and Abshir (P9403), initially introduced from Purdue University, USA, were released for commercial production in *Striga* infested areas of the country. Furthermore, a new backcrossing program has been started in collaboration with the Purdue University to introgress the *Striga* resistance gene(s) from the introduced resistance sources (SRN 39 and Framida) into the otherwise better yielding locally adapted sorghum cultivars.

Hybrids and hybrid parents. A number of male sterile lines (A-lines), their maintainers (B-lines) and restorer lines (R-lines) have been introduced and screened for their adaptation and hybrids have been developed from them. Early in the program, very good male sterile lines like CK 60A, IS10360A and Tx622A were used to make hybrids. Using these lines, some hybrids were developed in the 1980s. However, the yield advantage they exhibited over the standard open-pollinated varieties was not encouraging. Afterwards, the introduction and hybrid development activities were continued. Currently, two better yielding sorghum hybrids (ICSA 21 × ICSR 50 and ICSA 15 × M5568) than the best open-pollinated standard check variety, Teshale are on the pipeline (Adugna and Tesso 2006).

In 2005, two sorghum hybrids (G-202 and G-204) were introduced from Zuari Seeds Limited, a private company in India and sown at the quarantine field of Melkassa Agricultural Research Center. The performance of both hybrids was found to be excellent. However, due to the limited access of the parental lines, further activities could not be undertaken.

A major problem associated with the development of sorghum hybrids especially of those introduced from Purdue University has been the breakdown of male sterility at Werer in the off-season. On the contrary, some of the ICRISAT-bred male sterile lines have been stable for nearly two decades.

Sorghum populations. Population improvement using recurrent selection is part and parcel of the sorghum improvement program in Ethiopia to concentrate genes that are distributed in the population into a single background by effecting random mating. About three decades ago, two sorghum populations were introduced from Texas A&M, TP 24 white and TP 24 brown. Though both were introduced for dry lowlands, the brown population was specifically intended for bird prone rift valley areas. Among S1 progenies derived from TP 24 white population, the S1 selection improved the grain yield by 27% and the top ranking S1 progenies produced two to three times higher yields than the check varieties Gambella 1107 and 76T1#23. Another early-maturing population was recently introduced from Purdue University. However, it did not perform well in the dry lowlands and was discarded.

Millets. Although the center of origin of finger millets (*Eleusine coracana*) is in the highlands of the central to eastern African region, the diversity for various desirable traits in the Ethiopian landraces has been limited. Due to this reason, despite the continuous efforts to identify better varieties from among the Ethiopian landraces, it has never been successful. In 1993, 57 lines were introduced from EARSAM. Two of the lines (KNE# 1098 & KNE# 409) were identified by the national program to be better yielding across the Ethiopian millet growing intermediate-high altitude areas. These lines were approved as varieties for release for commercial production in 1998 with the names Tadesse and Padet, respectively. From the same set another line, KNE# 411 was identified by the Bako Agricultural Research Center and released for production in the western Ethiopian region in 2002 with the name Boneya. The ICRISAT pearl millet (*Pennisetum glaucum*) variety ICMV 221 was introduced from India and registered in 2007 after adaptation study with the local name Kola-1. The Amharic word 'Kola' stands for lowland.

Contributions of the introduced varieties. New technologies are reluctantly adopted only if there are other alternatives. Ethiopian farmers have been cultivating various sorghum landraces known by different local names. In the lowlands, which are stricken by recurrent drought they fail to give yield as almost all are late-maturing and are not able to cope with the changing environment. At different times the seeds of the improved varieties were available to the farmers. For instance, the famine that persisted in some parts of the country has forced farmers to consume their own seed or sell as a food commodity in order to survive, which often resulted in massive displacement of native seed stock [mostly sorghum, wheat (*Triticum aestivum*) and maize (*Zea mays*)] by exotic seeds provided by relief agencies. Currently, the farmers in many lowland areas are growing them because of their earliness and able to harvest very good yield unless there is harsh drought in the season. Farmers at Konso and Derashe use mixture of the varieties (Gambela 1107 being dominant) and call them all *Jerjertu*, the Oromo word, which means early (fast). Similarly, the improved varieties are being adopted by farmers in the dryland areas of the country but there is no statistical evidence as to how much of the sorghum land is covered by them.

With the INTSORMIL and EIAR collaborative *Striga* pilot project that was being operated in all major sorghum growing regions of the country, the farmers in *Striga* prone areas have tested the resistant varieties (Gubiye and Abshir) in their own farms and understood that these could be better options. Many farmers witnessed that they could harvest some grain in a previously abandoned land due to the parasitic weed. Over 100,000 farmers are presently growing *Striga* resistant sorghum varieties (Tesso et al. 2006).

The finger millet variety, Tadesse (KNE# 1098), has become a pioneer in areas where the crop was previously unknown. It first appeared for farmers nearby Arsi Negelle sub-center of Melkassa Agricultural Research Center in 2001 through demonstration. However, as that area has high rainfall and potential for cultivation of diverse crops including wheat and maize, the finger millet variety did not have a place. As the demonstration was further moved to the prairie dry districts of Siraro and Alaba, it has got its right place there. Due to severe drought that occurred in 2002, almost all crops in these areas failed. Only the finger millet demonstrated its tolerance. In later seasons the demand for seed was high. In 2005, 5270 ha of land in the two districts was covered by the improved finger millet variety, Tadesse (Anchala et al. 2006). This is equivalent to an increase of nearly 2% of the national finger millet area in that year. Farmers in these areas are replacing their maize with finger millet. They sell 100 kg of finger millet to the villagers as seed

Table 1. Introduced exotic sorghum and millets varieties released/registered in Ethiopia.

Crop	Variety name	Original name	Year of release/ registration	Source	Specific character
Sorghum	Dinkmash 86	ICSV 1	1986	ICRISAT	Early
Sorghum	Melkamash 79	Diallel Pop 7-682	1979	ICRISAT	
Sorghum	Kobomash 76	NES-830x705	1976	ICRISAT	
Sorghum	Seredo	Seredo	1986	ICRISAT	
Sorghum	76T1#14	76T1#14	1979	ICRISAT	
Sorghum	76T1#19	76T1#19	1976	ICRISAT	
Sorghum	76T1#23	76T1#23	1976	ICRISAT	Early
Sorghum	76T4#416	76T4#416	1976	ICRISAT	
Sorghum	Meko	M36121	2000	ICRISAT	Good food making quality
Sorghum	Teshale	3443-2-OP	2002	ICRISAT	
Sorghum	Gubiye	P9401	2000	Purdue University	*Striga* resistant
Sorghum	Abshir	P9403	2000	Purdue University	*Striga* resistant
Sorghum	Birhan	PSL5061	2002	Purdue University	*Striga* resistant
Sorghum	IS9302	IS9302	1986	ICRISAT	Adapted to mid altitude areas
Sorghum	IS9323	IS9323	1986	ICRISAT	
Sorghum	Red Swazi	Red Swazi	2007	ICRISAT	Early, malt sorghum variety
Sorghum	Macia	Macia	2007	ICRISAT	Malt sorghum variety
Sorghum	Yeju	ICSV 111Inc	2002	ICRISAT	
Sorghum	Hormat	ICSV 1112BF	2005	ICRISAT	*Striga* resistant
Finger millet	Tadesse	KNE#1098	1998	EARSAM	Good threshing quality and wide adaptation
Finger millet	Padet	KNE#409	1998	EARSAM	
Finger millet	Boneya	KNE#411	2002	EARSAM	
Pearl millet	Kola-1	ICMV 221	2007	ICRISAT	

for 300 Ethiopian Birr, which is twice the price of the same quantity of maize. All of the above indicate that the introduced varieties have contributed to improving the livelihood of some poor farmers in the country.

Problems associated with the introduced sorghum varieties. Despite the worldwide sorghum breeding done to date, less than 10% of Africa's sorghum area is being planted with improved varieties from research stations. Similarly, in Ethiopia the released early-maturing sorghum varieties from introductions are not well assimilated into the production system as expected. It can be viewed from various facets. As explained earlier, the sorghum plant is everything for the local farmer. To this end the introduced early-maturing varieties did not meet some of the requirements of the farmers. First, in good seasons the local cultivars yield better than the improved ones. Second, the varieties are very early-maturing and are liable to bird attack. In the words of the Ethiopian farmer, "A man who speaks the truth first is reviled by the audience and a sorghum plant which matures first is taken by birds." Third, these varieties have reduced biomass and therefore have less feeding value to their animals than their own local cultivars. Fourth, due to the loose research-extension-farmer linkage, farmers in many places do not know the improved varieties. Finally, and probably the most critical setback is the conflict of concern among the technology generators and those who advocate diversity that made farmers to distrust the technology.

Future prospects of sorghum introduction. The current direction of agricultural research in Ethiopia is towards introducing and testing of finished technologies that are market oriented so that they become cheap. To this effect, the national sorghum research project has started introducing and testing the adaptation of sorghum and millets varieties having various end uses for market. Moreover, towards food self sufficiency, the already ongoing research activities of introducing better yielding varieties than the already released varieties and germplasm for making crosses with them will also continue.

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