Etnobiología 3: 29-41, 2003

FOLK CLASSIFICATION OF SORGHUM (*Sorghum bicolor* (L.) Moench) LAND RACES AND ITS ETHNOBOTANICAL IMPLICATION: A CASE STUDY IN NORTHEASTERN ETHIOPIA

Solomon Benor[1] and Lemlem Sisay[2]

[1]Plant physiology and Microbiology, Department of Biology, University of Tromsø N-9037 Tromsø, Norway. solomonbenor@yahoo.com
[2]Institute of Biodiversity Conservation and Research, Collection and Exploration Division. P.O.Box 30726, Addis Ababa, Ethiopia

ABSTRACT

Ethiopia is one of the centers of origin and diversity for a number of crop species, among which sorghum has a wide range of distribution in the country. Farmers' knowledge about sorghum crop such as types, names, uses, cropping systems, cultivation methods, and so on has been handed down inter-generationally, primarily through oral tradition. During the 1998 and 1999 cropping seasons, sorghum landrace collection was conducted in Ethiopia to document farmers' indigenous knowledge, take conservation measures, and incorporate potential landraces into future breeding programs. The collection strategy was non-random accession collection, incorporating farmers and their rich indigenous knowledge and experience into the collection team. The wealth of genetic diversity in the explored area consisted of drought-tolerant, striga-tolerant, and bird-resistant species. Farmers refer to discrete sorghum types by different names, which vary for several characters. For instance, the name *wotet-begunche* designates a matured sorghum seed with milky taste; *ahyo* and *wof-aybelash* mean bird-resistant, in the case where not a single grain was damaged by birds. Farmers' indigenous knowledge also designates striga-tolerant landraces such as *mera, mogn-ayfere, minchiro,* and *ckerekit.* Pot and field experiments were conducted later to corroborate the indigenous knowledge of bird-resistant and striga-tolerant sorghum landraces. We recommend that the pest-tolerant landraces confirmed by these experiments be incorporated into breeding programs.
Key words: *Sorghum bicolor* (L). Moench, collection, land races, local name, genetic diversity

RESUMEN

Etiopía es uno de los centros de origen y diversidad de diferentes especies de interés agrícola, entre los que se encuentra el sorgo, ampliamente distribuido en el país. Los conocimientos de los agricultores acerca de nombres, variedades, usos, métodos de cultivo y cosecha de dicha planta han sido transmitidos de generación en generación de manera oral. En los periodos de cosecha de 1998 y 1999, se colectaron variedades agrícolas del sorgo en el noreste del país, teniendo como objetivos principales la documentación del conocimiento de los agricultores, tomar medidas de conservación e incorporar variedades potenciales a futuros programas de mejora. Para la catalogación de las variedades se siguió una jerarquización por acrecencia no realizada al azar y los agricultores tomaron parte en el equipo de catalogación aportando su conocimiento y experiencia. La abundancia de diversidad genética en el área estudiada abarca resistencia a la sequía, y tolerancia a *striga* y a la avifauna. Los agricultores llaman a las diferentes variedades por nombres diferentes que varían en caracteres. Por ejemplo, el nombre *Wotet-Begunche* es utilizado para denominar a las semillas maduras del sorgo con sabor lácteo, *Ahyo* y *Wof-Aybelash* para referirse a variedades resistentes a los pájaros, de los que ninguna semilla es dañada por las aves. Según el conocimiento de los agricultores nativos, hay también variedades resistentes a la *striga*, como por ejemplo, *Mera*, *Mogn-Ayfere*, *Minchiro* y *Cherekit*. Para confirmar tales resistencias a aves y a la *striga*, posteriormente, han sido realizados experimentos en macetas y en campo. El resultado de tales experimentos ha demostrado que dichas variedades son resistentes a plagas, y por lo tanto podrían incorporarse a programas de mejora.
Palabras clave: *Sorghum bicolor* (L). Moench, colección, variedad local del agricultor, nombre local, diversidad genética.

Introduction

A number of crops have originated, or have been domesticated, in Africa, including sorghum, pearl and finger millets, coffee, cow pea, African rice, *Digitaria* spp., sesame, castor, oil palm, yam, and others (Simmonds 1979, Anishetly *et al*. 1981, Mooney 1983, Paroda *et al*. 1991). The continent also is a center of crop diversity, including durum wheat and barley. Ethiopia is

the diversity center for 11 crops (Zohary 1970), and some 38 species are connected with Ethiopia as a primary or secondary gene center (Vavilov 1951). Vavilov and other scientists identify Ethiopia as the established center of origin and diversity for sorghum, coffee, durum wheat, barley, castor, teff, sesame, mustard and chat. The greatest variability of the wild and cultivated sorghum crops occurs in the northeast quadrants of Africa especially in the Ethiopian and Sudanese parts of East Africa (Dogget 1965). Thus, Ethiopia has a wealth of crop genetic diversity in both cultivated and wild forms. This immense wealth is the result of the rugged terrain, wide range of agro-climatic conditions, broad diversity of ecological habitats, and – primarily – a consequence of agricultural populations interacting with the crop plants in those habitats. The wide range of environmental conditions under which sorghum is growing in Ethiopia has given rise to a tremendous range of genetic variability in the country (Berhane 1981).

Ethiopian sorghum germplasms have contributed a great deal to identifying resistant lines in the World Sorghum Improvement Program. For example, SCO 326, derived from IS 3758, is resistant to zonate leaf spot, rust, sooty stripe, and leaf blight. Among the pests, midge has been a major problem, but SCO 175, derived from IS 1266 ex Ethiopia is providing a good source of resistance. In addition, a number of midge-resistant lines exist, primarily those derived from Zera Zeras of the Ethiopia-Sudan region: SC 052, SC 063, SC 239, SC 319, SC 414, and SC 574 (Dogget 1968).

In Wollo Region sorghum (*Sorghum bicolor* (L.) Moench) is the first stable food crop in terms of area coverage and production (Mengesha 1975). According to CSA estimates for the 1997/98 cropping season, using total area cultivated as the reference point, sorghum is the number one crop in Wag-Himra and Oromia, number two in South Wollo, and number three in North Wollo. Sorghum lines IS 11758 and IS 11167 identified from Wollo region are highly prized throughout the world for high lysine content (House 1985). Farmers' knowledge about sorghum crop such as types, names, uses, cropping systems, cultivation methods, and so on has been handed down intergenerationally, primarily through oral tradition (Solomon *et al*. 1999).

A number of general collecting missions have been undertaken throughout Africa, but the fast-changing environment (e.g., due to global warming, habitat destruction, and drought) will necessitate more rescue missions for wild and weedy types as well as domesticated races (House 1985, Moss 1990). The broad range of genetic diversity that exists in Ethiopia, particularly in primitive and wild gene pools, is currently subject to serious genetic erosion and irreversible losses (Worede 1991). Many attempts have been made to characterize threats to plant diversity in wild and cultivated populations, among which Muchiru (1985) identifies habitat loss, overexploitation, introduced species, indirect effects, and – as a discrete factor – agricultural development.

The objectives of this paper are, therefore, to report on farmer's indigenous knowledge on the use and classification of sorghum and to assess the extent of genetic erosion in the study area.

Materials and Methods

Collections were made and ethnobotanical data were gathered during the 1998 and 1999 cropping seasons in collaboration with Sirinka Agricultural Research Center and the Ethiopian Institute of Bio-Diversity Conservation and Research. While collecting, information about the samples was gathered using the standard collection data format Performa developed by IBPGR and ICRISAT (1993). Each sample has a unique collection form on which are recorded a collection number, first initial of the collector's name, vernacular name, date of collection, description of site and crop sample, and other observations (Table 1). Soils were sampled at each collection site and pH values were determined using a field pH meter. Cloth bags were employed to collect sorghum fruiting heads, to allow free circulation of air. Data on ethnobotany was collected, based mainly on questionnaires and semi-structured interviews with selected farmers. Most of the interviews and discussions were conducted in Amharic, the official language of the country. Information on types of farmers' sorghum varieties, their unique

uses, advantages and utilization aspects were also collected. At the end of the each interview, collected plants were assigned collection codes and were sorted According to their uses and advantages (Table 1). Seed samples of each of the collections were kept both at Sirinka Research Center and in the Ethiopian Institute of Biodiversity Conservation and Research. During the course of the collection, attention was given to the naming of local varieties and it was checked to avoid duplication of naming and to confirm the special advantage of that variety in different places.

Farmers included in the collection teams imparted their own indigenous knowledge. Checklists were prepared to record information on sorghum germplasms and their threat to genetic erosion. The model developed by Goodrich (1987) was used to estimate the threat of genetic erosion that a particular taxon (wild or cultivated) faces in a defined area. The model is based on scoring a variety of factors (biological, environmental and socioeconomic) and summing the factors.

Results and Discussions

The collection covered areas of altitude ranging from 1420m (Oromia zone) to 2400m (Wag-Himra zone) above sea level. Latitude and longitude values ranged from 10°21'09N (Oromia zone) to 12° 30'42N(Wag-Himra zone) and 38°55'73E (North-Wollo) to 40°00'96E (Oromia zone), respectively (Figure 1). The soil pH ranged from 5 to 8.

Farmers who participated as identifiers imparted their own rich local knowledge and experience and in this way assisted the team in discerning one farmer's variety from the others. Furthermore, the farmers identified samples that had different names but were types already collected. The average land race types collected from areas other than Fontenina were three, but in Fontenina (South-Wollo) the team was able to collect more than 65 land races from two farmers' fields (Table 2). In Fontenina, Hara, and surrounding locales farmers grew mixtures of different morphological types of sorghum in the same field. Considerable variations were found for plant height (more than 4m in the case of *Key Rejimu Minchiro*), panicle length

Figure 1. Map of the study area (Amhara national regional state).

(ranging from very small in *Chibte* to very large in *Jamoye* and *Enkoylel-Zengada*), and ear compactness (ranging from very loose in *Kilo* and *Minchiro* to very compact in *Chibte*, *Gorad*, and *Tengele*). The grain color varied from white to brown, red, black, and yellow (Table 1). Surprisingly, one land race, *Shilime*, contained both red and white colors in a single panicle, and in a single seed. Farmers suggested that this was a result of cross between *Gorad* and *Wogere*, which have white and red colors respectively. Further investigation will be important to establish how such seed colors are transmitted from generation to generation.

The result of this collections mission indicated that Fontenina (South-Wollo) and Hara (North-Wollo) and their surrounding areas are the sorghum belts where the most genetic diversity for sorghum is found (Figure 2). Variations for morphological characters were more apparent as well in Fontenina (South Wollo) and Hara (North Wollo). Farmers identify different sorghum types by different names, which vary for several characters (Table 1).

Most of the names for each land race refer to their unique characteristics. For instance, the name *Chibite* designates a sorghum

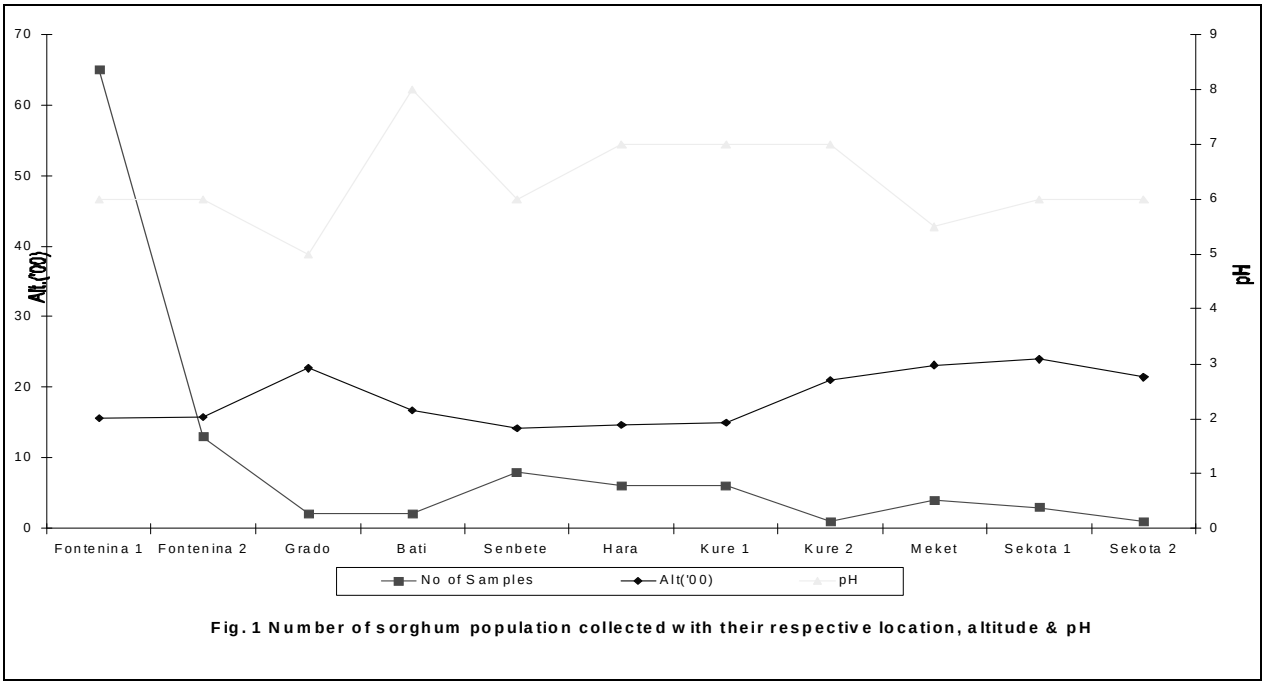

Figure 2. Number of sorghum population collected with their respective location, altitude and pH.

with a compact head; *Wotet-Begunche* indicates seeds with milky taste; *Ahyo* designates tolerance to bird and striga; *Cherekit* indicates white seed color; *Minchiro* designates loose, drooping panicles; *Wof-Aybelash* connotes bird-resistant; *Marchuke* and *Mar-Beshenbeko* mean full of honey; *Ayfere* refers to striga-resistance; *Shilme* connotes a fruiting head that contains seeds of different colors; *Gubete* invokes the softness of the roasted seed.

The observation of reddish brown and dark red accessions of *Ahyo* and *Wof-Aybelash*, in which not a single grain was damaged by birds, is consistent with the view of IBPGR (1987) that reddish-brown and dark red grained sorghums are bird-resistant because of tannins in the sub-coat.

Farmer's varieties that are believed to be striga-tolerant were evaluated through an experimental pot methodology in 1999 (Table 3), and the results indicated the striga-tolerance value of few sorghum landraces is close to that of the standard released varieties (Bayu *et al*. 2001).

In most parts of Fontenina and Hara, sweet-stalk sorghums were grown for chewing, much like sugar cane, and also were marketed near urban areas. More than 23 types of sweet-stalk accessions were collected during this mission. Several striga-tolerant sorghums were collected as well: e.g., *Mera, Mogn-Ayfere, Ahyo, Minchiro, Kindibe-Tikur Cherekit*, and *Kindibe-Nech Cherekit.*

Among the collected farmers' varieties those which are severely threatened by genetic erosion are *Marchuke*, *Wotet-Begunche* (due to roasting at soft & hard dough stages), and many of the sweet-stalk sorghums, such as *Zergataw-Watigela, Amelse-Tinkish, Necho-Tinkish, Tuba-Tinkish*, *Mali-Tinkish*, *Jofa-Tinkish*, *Sererge-Tinkish* (Tables 5-7). Results of the farmers' interviews indicated that these varieties are becoming very scarce in the collection area.

Of the one hundred eight collected plants, more than 75% of the samples were collected in an altitude less than 1900 masl. In both low, intermediate and high altitude areas, seeds are the most widely used plant parts, accounting for more than 95% of the sorghum uses. Stalks are then the second preferred parts of the plant.

Result of the interviews conducted on different age classes showed that older people are more knowledgeable on ethnobotanical information than the younger ones. In general, the result of this study has made a good

beginning of documenting and putting to use farmers' indigenous knowledge in different research areas.

Summary and Conclusion

The objective of the collection program described here has been to cover the major sorghum growing areas of Wollo and to document farmer's indigenous knwoledge. During the present ethnobotanical survey, one hundred eight sorghum accessions were collected. A wide diversity of sorghum in Wollo has been located to Fontenina (South-Wollo) from 10^0 58'33N latitude to 39^0 46'20E longitude, and from 1420m to 1580m elevation above sea level, at pH value of 6.0.

Sorghums indicated by local farmers' knowledge to be bird-, striga-, and drought-resistant/tolerant will be tested in the breeding program. Farmers' varieties with higher yields and pest-resistance shall also be included in variety trials through a landrace improvement program. It should be emphasized that recollection exercises are necessary for farmers' varieties in Ethiopia where genetic erosion is common, primarily due to natural disasters.
This would prevent loss of such potentially useful stored in gene banks. For the sake of future generations, we must collect and study the wild genetic resources. More targeted collections and re-collection also can help to prevent or disturb the process of evolution, which could be a long-term problem for plant genetic resources and weedy relatives of our cultivated plants as well as the domesticated races.

Acknowledgements

We would like to give a special thanks to farmers living in North-Wollo, South-Wollo, Wag-Himra, and Oromia zones of the Amhara National Regional State for their kind collaboration and useful information imparted during the collection program.

Literature cited

Anishetty, N. M. and Perret P. M. 1981. The IBPGR in relation to African crop genetic resources. FAO/IBPGR Newsletter 46:31-36

Brehane, G. 1981. Salient features of the sorghum breeding strategies used in Ethiopia. Ethiopian Journal of Agricultural Sciences. Vol. III No.2

CSA, Agricultural sampling survey Vol.1 June 1998. Statistical bulletin 189. Addis Ababa, Ethiopia.

Doggett, H. J., 1965. Sorghum breeding research. *In*: annual report for 1964 of the east African Agriculture and forestry research organization. P. 81 Kikuyu, Kenya.

Doggett, H. J., 1968. Sorghum 2nd edn. Tropical agriculture series. Longman group UK limited.

Frankel and Hawakes, Ip2. Cambridge university press, Cambridge, pp.449-453.

Mooney, P. R., 1983. The law of the seed : another development and plant genetic resources. Development dialogue, No. 1-2:173 pp.

Goodrich, W. J. 1987. Monitoring genetic erosion: detection and assessment. IIBPGR, Rome.

House, L. R. 1985. A guide to sorghum breeding. 2nd edn. Patancheru, A.P. 502324, India: ICRISAT.

IBPGR., 1987. A catalogue of passport and characterization data of sorghum, pearl millet and finger millet germplasm from Zimbabwe. IBPGR, Rome.

IBPGR and ICRISAT. 1993. Descriptors for sorghum [*Sorghum bicolor* (L.) Moench]. International Board for Plant Genetic Resources, Rome, Italy: International Crop research Institute for the Semi-Arid Tropics, Patancheru, India.

Mengesha, M. H., 1975. Crop germplasm diversity and resources in Ethiopia. *In*: Crop genetic resource for today and tomorrow.

Moss, H., 1990. The role and experiences of an IBPGR collector in the SADCC region. *In*: Proc. Conserving plant genetic resources of Zambia, First national workshop on plant genetic resources, Oct., 8-12, 1990, Siavonga, Zambia.

Muchiru, S., 1985. Conservation of species and genetic resources. An NGO action guide. Environment liaison center, Nairobi.

Paroda, R. S. and K.R. Arora, 1991. Plant genetic resources: General perispective. *In*: Plant genetic resources –conservation and management. R.S.Paroda and R.K. Arora (eds.). IBPGR, New Delhi, pp.1-24

Putter, A., (ed), 1994. Safeguarding the genetic basis of Africa's traditional crops. CTA, the Netherlands/IPGRI, Rome.

Simmonds, N. W., 1979. Principles of crop improvement. Longman group Ltd., London.

Benor, S and L. Sisay. Diversity of sorghum germplasms in the northeastern Ethiopia and their implication for conservation and breeding. 9th proceeding of the Crop science society of

Ethiopia, 22-23 June 1999, Addis Ababa, Ethiopia.

Sustainable agriculture and environmental rehabilitation program (SAERP). Household level socio-economic survey of the Amhara region. Vol.1 UNDP SAERP/WARDIS Project No. ETH/94/001/B/01/99. May/June 1996.

Vavilov, N. I., 1951. The origin, variation, immunity and0 breeding of cultivated plants. Chronica Botanica, 13: 1-366.

Wondimu Bayu, S. Benor and L. Admassu. 2001. Tolerance of sorghum landraces and varieties to striga (*striga hermontica)* infestation in Ethiopia. Acta Agronomica. Hungarica, 49(4), pp.343-349(2001). An international multidisciplinary journal in agricultural sciences, Hungary.

Worede, M., 1991. Crop genetic resources conservation and utilization: An Ethiopian perspective. *In* AAAS (ed.) Science in Africa, achievements & prospects. Proc.Symp.Am. Assoc. Adv. Sci. 15 Feb. 1991.

Zohary, D., 1970. Centers of diversity and centers of origin. In genetic resources in plants, their exploration and conservation. (Eds.O.H. Frankel and E. Bennet). pp.33-42. Black well, Oxford.

Table 1. Selected landraces with promising characteristics collected from Wollo Region.

Collection No.	Vernacular name	Ear compactness and shape	Grain color	Special use/Remark
SSGM022*	Kindibe-Tikur Cherekit	Semi-compact	White	Striga-tolerant
SSGM037	Minchiro	Loose	Reddish-brown	Striga-tolerant
SSGM132	Woitezera	-	White	Striga-tolerant
SSGM131	Alaila	-	White	Striga-tolerant
SSGM050	Kindibe-Nech Cherekit	Semi-compact	White	Striga-tolerant
SSGM063	Mera	Semi-compact	White	Striga-tolerant
SSGM033	Mog-Ayfere	Compact	Red	Striga-tolerant
SSGM019	Ahyo	V.compact	Reddish-brown	Striga-tolerant and bird-resistant
SSGM031	Wof-Aybelash	compact	Dark-red	Bird-resistant
SSGM001	Abula-Gorad	V.compact	White	Drought-tolerant/General-purpose
SSGM051	Rejimu Nech-Jamoye	Semi-loose	White	Drought-tolerant/General-purpose
SSGM028	Key-Ganseber	Compact	Reddish brown	Highly preferred for local beer
SSGM046	Shilime	Compact	Red & white	Red and white colors in same panicle
SSGM003	Chibte-Watigela	Compact	Red	Many nodal tillers
SSGM057	Gogobsa-Tinkish	Semi-compact	Red	Many nodal tillers
SSGM107	Enkoylel-Zengada	Semi-compact	Red	Large head size, high land sorghum
SSGM 039	Key-Marchuke	Semi-compact	Red	Subject to genetic erosion
SSGM054	Wotet-Begunche	Semi-compact	White	Milky taste, subject to genetic erosion
SSGM092	Hawaye	Semi-compact	Yellow	Sweet-stalk/in a state of genetic eros.
SSGM078	Yejib-Murt	Semi-compact	Reddish brown	Sweet-stalk/in a state of genetic eros.
SSGM011	Tikur-Kilo	V.loose drooping panicles	Black	Wild type/used as animal feed
SSGM017	Gubete	Semi-compact	Brown	Highly needed for roasting purpose
SSGM053	Key-Jiru	Compact	Yellow	High-yielding
SSGM096	Keyo-Amarica	Compact	Yellow	Early maturing type
SSGM038	Mar-Beshenbeko	Loose	Reddish brown	Sweet-stalk
SSGM036	Necho-Yegenfo-Ehil	Compact	White	Highly needed for porridge purpose
SSGM058	Yikir-Mindaye	V.loose	Red	Roasting purpose
SSGM024	Enat-Gorad	V.compact	White	High yielding

*The first initial letters of collectors Solomon, Samson, Getachew & Mekonnen

Table 2. Sorghum collection undertaken by Sirinka Agricultural Research Center and the Institute of Bio-Diversity Conservation and Research, 1998.

Area explored	**Major landraces**	**Number of samples collected**
South Wollo	*Tengele, Gorad, Cherekit, Jamyo, Ahyo*	78
North Wollo	*Jigurti, Degalit, Jamyo*	12
Wag Himra	*Quancha, Amsale, Aliqua*	8
Oromia	*Cherekit, Ahyo, Kilo, Minchiro, Mera, Jigurti, Mog-Ayfere*	10
	Total germplasms collected	108

Table 3. Comparison of striga-tolerant sorghum collected landraces with improved commercial varieties.

Identification	Plant Ht. (cm)		Striga count [SQRT]	Oven dry sorghum shoot biomass[gm]	
	TD*	UT*		TD	UT
Kindibe-Tikur-Cherekit	86.0	105.0	3.91	62.86	66.76
Mogn-Ayfere	104	140.0	4.06	61.12	92.93
Minchiro	54.6	90.66	4.44	39.28	58.10
Kindibe-Nech-Cherekit	99.6	101.6	4.11	65.76	63.73
Mera	69.4	87.00	4.25	46.42	60.03
Ayfere-Delanta	126	164.0	4.04	70.74	87.93
Ayfere-Asfachew	1.51	108.1	2.74	74.88	70.63
P-9401*1*	71.9	74.33	1.05	48.20	43.36
P-9403[1]	80.6	45.89	2.26	35.28	48.66
SRN-39[1]	73.5	69.00	1.52	40.72	64.13
Wotere	26.8	75.61	2.66	80.54	92.73
Merar	55.3	45.55	5.24	38.10	50.60
Jigurti[2]	47.8	55.37	4.93	56.10	65.00
Degali*t*[2]	65.9	94.35	5.24	51.66	76.30
Key # 8574[3]	50.8	76.00	6.41	22.60	44.90
Mean	67.6	88.8	4.05	52.9	65.72
LSD 5%	41.3	75.1	2.97	30.1	27.1
CV	48.2	50.5	6.43	44.9	24.6

TD*, treated with striga; UT*, untreated with striga; 1, released commercial varieties; 2, local check; 3, susceptible check; others from collection

Table 4. Causes for genetic erosion of sorghum land races in Wollo Region.

Vernacular name	Zone	Causes for Genetic Erosion	Growing period
Aliqua	Waghimra	Drought, stalk borer	April-December
Shiula	Waghimra	Drought, striga	April-December
Waliya	Waghimra	Drought, stalk borer	May-December
Minaba	Waghimra	Drought, stalk borer	March-December
Awunawuna	Waghimra	Drought, stalk borer	May-December
Kuchbiye	Waghimra	Drought/lack of rain in *belg* season	June-November
Wondaybelash	Waghimra	Stalk borer	June-December
Debala	Waghimra	Drought, stalk borer	June-December
Zengada	In both zones	Drought/lack of rain in *belg* season	March-December
Chirqua	Waghimra	Drought/lack of rain in *belg* season	April-December
Witezera	Waghimra	Drought/lack of rain in *belg* season	May-December
Degalit	In both zones	Drought/lack of rain in *belg* season	April-December
Alaila	Waghimra	Drought/lack of rain in *belg* season	June-December
Yikirdemewoze	Waghimra	Drought/lack of rain in *belg* season	March-December
Fechifecha	Waghimra	Drought/lack of rain in *belg* season	March-December
Key marchuke	South & North Wollo	Man made	May-December
Wotet Begunche	South Wollo	Man made	May-December
Degalit	In both zones	Drought/lack of rain in *belg* season	April-December
Hawaye	North Wollo	Drought/ stalk borer	May-December
Yejibmurt	South Wollo	Man made, stalk borer	May-November
Kolobo	North Wollo(Gobye)	Drought/lack of rain in *belg* season	May-November

Table 5. Assessment of sorghum land races of Wollo Region for genetic erosion using Goodrich model.

No.	Factor	Standard score	Survey score
1	**Taxon distribution****		
	· Rare	10	10
	· Locally common	5	
	· Wide spread/abundant	0	
2	**Drought**		
	· Known to have occurred in 2 or more consecutive years	10	10
	· Occurring on average 1 or more times every 10 years	5	
	· Occurring less than once every 10 years	0	
3	**Flooding**		
	· Area known to be very flood prone	10	10
	· Area not known to be flood prone	0	
4	**Area under the crop**		
	· Decline rapidly	10	10
	· Increasing or static	0	
5	**Modern cultivar of the crop**		
	· Available & used by >70% of the farmers	15	
	· Available and used by 50-70% of the farmers	10	
	· Available & used by < 50% of the farmers	5	
	· Not yet available, but introduction planned	2	
	· Not yet available	0	0
6	**Mechanization**		
	· Tractors used by >30% of the farmers	10	
	· Animal traction used by >50% of the farmer	5	
	· Manual labor used by >50% of the farmer	0	0

Table 5… Continuation.

No.	Factor	Standard score	Survey score
7	**Distance to major road**		
	· <10 km	10	
	· 10-30 km	5	
	· >30 km	0	0
8	**Extent use of the target species**		
	· Industrial exploitation	15	
	· Exploitation by surrounding farmers	10	
	· Local exploitation	5	5
	· Protected or not used	0	
9	**Distance to major population center**		
	· <20 km	10	
	· 10-30 km	5	
	· >30 km	0	0
10	**Extent of wild habitat within the study area**		
	· Very restricted (<5%)	15	15
	· Restricted (5-15%)	10	
	· 15-50%	5	
	· Extensive (>50%)	0	

******for sorghum land races listed in table 4

Table 6. Distribution of households by main causes of crop failures in the Amhara Region-1996.

No.	Causes	Response	
		No. HHS	%
1	Uneven distribution of rainfall/drought	821	**43.7**
2	Locust	62	**3.3**
3	Army worms	86	**4.6**
4	Hail storm	143	**7.6**
5	Heavy rain fall	208	**11.1**
6	Frost	67	**3.6**
7	Weeds	53	**2.8**
8	Decline in soil fertility	206	**11**
9	Others	231	**12.3**
	Total	1877	100

Source: Sustainable agriculture and environmental rehabilitation (SAERP), 1996

Table 7. Distribution of households by major drought/famine occurrence observed-1996.

	Occurrence observed	No. of HHS	%
1	Once	282	16.3
2	Twice	697	40.2
3	More than two times	754	43.5

Source: Sustainable agriculture and environmental rehabilitation (SAERP), 1996