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Agricultural biodiversity in Northwest Somalia – an assessment among selected Somali sorghum (*Sorghum bicolor* (L.) Moench) germplasm

MARCO MANZELLI*, STEFANO BENEDETTELLI and VINCENZO VECCHIO
*Department of Agronomy and Land Management, Faculty of Agriculture, University of Florence; *Author for correspondence: P.le delle Cascine 18, 50144 Florence Italy (e-mail: marco.manzelli@unifi.it; phone: +39-055-3288245; fax: +39-055-332472)*

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Abstract. The seed sector situation in Northwest Somalia is critical. The availability of food has decreased and many people are at risk of hunger. Food security can be restored by enhancing the local genetic resources and creating an efficient seed sector. Sorghum is important as a food and fodder crop in this region. It is close to Ethiopia, which is considered as the probable origin and domestication of Sorghum. Twelve morphological and productive characteristics were chosen to assess the phenotypic variability of 16 accessions of sorghum from Northwest Somalia. Univariate (analysis of variance and *G* test) and multivariate (discriminant and cluster analysis) methods were used to assess the morphological variation within the accession and to group the 16 accessions into clusters based upon quantitative and qualitative characters. Elmi Jama Cas, Masego Cas, Masego Cad and Carabi clearly represent distinct landraces with specific features suitable for different purpose, such as grain and/or forage production. Each landrace tested is able to grow under harsh environmental conditions, thus ensuring a low, but stable production for small poor resources farmers. Knowledge and conservation of local landraces will provide a broad base of genetic variability from which improved sorghum varieties can be developed, thus aiding in the stabilisation of a secure and sustainable food supply for farmers of Northwest Somalia.

Introduction

The greatest genetic diversity of cultivated and wild sorghums is present in Africa (Doggett 1988). According to what is reported in the literature, the species *Sorghum bicolor* (L.) Moench was domesticated in the region of the Horn of Africa. In particular, Ethiopia is considered a centre of probable origin of sorghum (Doggett and Prasada Rao 1995).

In the last several years some Researchers within the scientific community have focused their activities on the conservation and characterisation of sorghum biodiversity. Scientific studied have been conducted on sorghum germplasm coming from Ethiopia, Eritrea, India, Burkina Faso, Tanzania, Zimbabwe, etc. (Teshome et al. 1997; Ayana and Bekele 1999 and 2000; Zongo et al. 1993; Appa Rao et al. 1996 and 1998; Chivasa et al. 2000; Friis Hansen

2000). These works have highlighted the existence of a wide phenotypic and genetic variation in terms of morphological, phenological and productive variation, climatic adaptation. The main conclusions of these efforts is that most of the collected accessions are landraces with a high adaptation to specific environmental conditions. These traditional landraces play an important role in local agriculture, contributing to food security, production, environmental sustainability and rural development.

The region of the Horn of Africa including Somalia was affected by civil strife and recurrent droughts. As result, many people are at risk because of a crop production decrease in both rainfed and irrigated areas. Farmers have lost many important inputs, including local selected seed. The indigenous landraces of food crops, which were adaptive to local environmental conditions, are in danger of disappearing in this region. The consequences of these losses are a high risk of genetic erosion and a collapse of the resource-poor farmer seed sector. Consequently the farmer's inability to preserve seed for the next growing season diminishes and implies chronic insecure seed resources.

Rainfed sorghum and maize are the main staple food crops grown as a mono-crop in the Northwest of Somalia, Somaliland (Table 1). Although 60% of the income in the North of Somalia comes from the animal sector, sorghum is important as a food and fodder crop, especially in this environment. For example during the dry season (*Jiilal* in Somali language), the stems of sorghum are the only fodder source and an important family income, while the grains are used to obtain flour from which, after fermentation, a traditional bred is made (*Injera*).

Having seen the importance of this crop as food and fodder and the probable genetic richness present in this area, an attempt was made to assess the indigenous sorghum diversity found within this region. Sorghum represents an important local resource, typically sold in the market and it is well known and accepted by farmers, who have access to the grain.

The objective of the present study was to determine the phenotypic variation in 16 accessions collected in the Northwest of Somalia using univariate and multivariate statistical methods. The aim was to identify accessions for use in sorghum improvement in order to develop cultivars compatible with farmers'

Table 1. North-west Somalia (Somaliland) staple grain crop production.

Crop	Gù* 1997		Gù 1998		Gù 1999	
	Harvested area (ha)	Production (tons)	Harvested area (ha)	Production (tons)	Harvested area (ha)	Production (tons)
Sorghum	17,610	15,741	14,200	9640	19,105	14,845
Maize	11,398	7979	6300	5040	8720	6976

Source: Food Security Assessment Unit (FSAU) – 1999.
**Gù* is the main rainy season in north-west of Somalia from April to June.

needs and thus maintain a sustainable production level in local farming systems.

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Materials and methods

Plant material

Sorghum samples were collected during the month of February 2000 in the villages and respective satellites of Togwajaale, Boodlay and Kalabayd in the District of Gabiley, the main area dedicated to rainfed cereal cultivation. This collection consists of 48 accessions of local sorghums, maintained at Arabsiyo's Seed Centre. Passport data and descriptors were recorded following guidelines outlined by IPGRI-ICRISAT (1993) "Descriptors for Sorghum [*Sorghum bicolor* (L.) Moench]". Midrib and seed colour, panicle shape and compactness, are the main morphological characters used by local farmers in naming sorghum landraces, and information was also gathered on growth habits, especially days to harvest.

The majority of this collection includes landraces belonging to the race *Durra*, characterised by a compact panicle on a recurved peduncle, a plant height ranging from 1.80 to 3.0 m, waxy stems and juicy sweet stalks typically chewed like sugarcane. The grain colour was white, yellow, or red. In general these landraces produce a high biomass making them suitable for dual purpose (grain and forage usage).

Seed availability and collection site were the main criteria used to select 16 accessions for morphological and agronomical evaluation (Table 2). These accessions were sown in a experimental field close to the village of Togwajaale on vertisols during the rainy season, adopting a randomised block design with four replications and distinguishing between the accessions with a growth cycle of 3–5 months (group A) and those with a growth cycle of 5–6 months (group B). Each plot was 10 m $\times$ 8 m, with a plant density of 10 p/m^2 . The plots were rainfed with no supplementary irrigation. For each accession and each plot at least 20 plants were sampled for qualitative and quantitative variables.

Observations on sugar content and wax presence on the stalks were recorded at flowering and harvest time. Stalk juiciness is associated with midrib colour (Appa Rao et al. 1996), with a low level associated with a white midrib, a high sugar content with a green or yellowish midrib. It was noted that farmers also made this distinction.

At harvest time the following quantitative parameters were measured: Days to Maturity (DM), Plant Height (PH), Internode Number (IN), Plant Dry

Table 2. Collected and evaluated sorghum accessions.

Accession	Local name	Translated name	Collecting area
Group A: supposed growth cycle of 3–5 months			
2	Elmi Jama Cas	White Sorghum	Kalabayd
5	Masego Cas	Red Masego	Boodlay
9	Abaadiro	–	Togwajaale
10	Abaadiro	–	Togwajaale
11	Abaadiro	–	Togwajaale
13	Carabi	–	Boodlay
14	Masego Cad	White Masego	Togwajaale
Group B: supposed growth cycle of 5–6 months			
1	Elmi Jama Cad	Red Sorghum	Kalabayd
3	Elmi Jama Kuuso Normal	Compact Sorghum	Kalabayd
4	Elmi Jama Feruur Geely	Camel mouth Sorghum	Boodlay
6	Elmi Jama Kuuso Feruur Geely	Compact camel mouth Sorghum	Boodlay
7	Elmi Jama Kuuso Feruur Geely	Compact camel mouth Sorghum	Boodlay
8	Elmi Jama Feruur Geely	Camel mouth Sorghum	Boodlay
12	Elmi Jama Feruur Geely	Camel mouth Sorghum	Togwajaale
15	Elmi Jama Kuuso Feruur Geely Aalle	Compact camel mouth sweet Sorghum	Togwajaale
16	Elmi Jama Kuuso Feruur Geely	Compact camel mouth Sorghum	Togwajaale

Weight (PDW), Harvest Index (HI), 1000-Seed Weight (SW1000), Panicle Weight (PW), Total Seed Weight per panicle (TSW), Panicle Length (PL), Panicle Width (PWi).

Statistical analysis

Homogeneity of the error variance among the 16 accessions was assessed by Bartlett's test for each of the quantitative characters. The Bartlett's test was conducted within group A and group B and among the two groups, using a p value of 0.05.

For the quantitative variables with continuos distribution (DM, PH, IN, PDW, HI, SW1000, PW, TSW, PL, PWi) the analysis of variance was carried out using a mix model, considering the *within population* as a fixed source of variation and the *within block* as a random factor. Bonferroni multiple pairwise comparison test was performed for each source of variation.

Sugar content and wax presence were studied using the G test applied to the analysis of three-way tables as suggested by Sokal and Rohlf (1981). The tables were classified according to three factors: time of observation, sugar high/low content or wax presence/absence and accession. The analysis was carried out by applying the following hierarchical model: test for complete interaction ($\alpha\beta\gamma = 0$), test for conditional independence ($\alpha\beta = 0$, $\alpha\gamma = 0$, $\beta\gamma = 0$), test for independence ($\alpha\gamma = \beta\gamma = 0$, $\alpha\beta = \beta\gamma = 0$, $\alpha\beta = \alpha\gamma = 0$), test for complete independence ($\alpha\beta = \alpha\gamma = \beta\gamma = 0$).

Discriminant analysis was used to assess the differences between morphological variation of the 16 accessions for 9 quantitative characters (DM, PH, IN, HI, SW1000, PW, TSW, PL, PWi). The measure of dissimilarity of canonical scores of group means was Euclidean distance. The resulted distance matrix was utilised for the cluster analysis by the Unweighted Pair-Group Method Using Arithmetic Average (UPGMA) algorithm (Sheath and Sokal 1973). The relationship between accessions was visualised by a dendrogram.

Results

Univariate analysis

The Bartlett's test showed homogeneity of the error of variance for each quantitative variable within the two groups. The comparison among group A and B showed homogeneity for the variables KN and HI, and heterogeneity ($p < 0.05$) for all the other quantitative variables. The presence of these differences confirms the initial distinction founded on local germplasm knowledge.

Tables 3 and 4 summarise the means of the quantitative variables used in this study and are grouped by accession and groups A and B. No block effects were observed. All accessions had long growing cycles, varying from 160 to 164 days for group A and from 176 to 181 days for group B. Besides the late

Table 3. ANOVA results and means of quantitative variables by accessions for group A.

Group A						
Accession		DM, d	PH, cm	KN, n °	PDW, g	HI, %
2	Elmi Jama Cas	160 c	163.6 b	11.2 d	184.1 d	24.1 ab
5	Masego Cas	160 c	212.2 a	12.7 bd	238.2 c	19.7 b
9	Abaadiro	164 ab	208.5 a	14.2 ab	398.4 a	18.9 b
10	Abaadiro	164 ac	187.2 ab	13.5 ac	289.8 b	18.1 b
11	Abaadiro	167 a	199.1 ab	13.5 ac	362.9 a	20.5 b
13	Carabi	161 bc	170.1 b	11.8 cd	186.1 d	31.3 a
14	Masego Cad	160 c	208.2 a	15.0 a	309.7 b	23.9 ab
F-test significativity		**	**	**	**	**
		1000-SW, g	PW, g	TSW, g	PL, cm	PWi, cm
2	Elmi Jama Cas	32.9 b	103.8 bc	67.9 bc	11.1 ab	6.8 ac
5	Masego Cas	31.8 b	89.3 c	63.1 bc	10.8 ab	6.6 bc
9	Abaadiro	33.5 b	144.4 ab	95.0 ab	12.1 a	7.2 ab
10	Abaadiro	32.6 b	91.9 c	60.5 c	10.1 b	5.9 c
11	Abaadiro	33.2 b	148.7 ab	94.0 ab	12.0 a	7.4 ab
13	Carabi	50.0 a	153.7 ab	106.2 ab	12.3 a	8.2 a
14	Masego Cad	34.3 b	183.7 a	113.9 a	12.5 a	8.3 a
F-test significativity		**	**	**	**	**

For each column means followed by a common letter are not significantly different at the 0.05 level.
** = *F* test significant at 0.01 level, **F* = test significant at 0.05 level, ns = *F* test not significant.

Table 4. ANOVA results and means of quantitative variables by accessions for group B.

Group B						
Accession		DM, d	PH, cm	KN, n°	PDW, g	HI, %
1	Elmi Jama Cad	178 ac	183.7	13.0	190.6 d	23.9 a
3	Elmi Jama Kuuso Normal	176 c	193.2	12.9	406.6 a	16.8 b
4	Elmi Jama Feruur Geely	182 a	187.2	12.6	269.8 c	23.5 ab
6	Elmi Jama Kuuso Feruur Geely	180 ac	188.9	13.1	318.7 b	21.1 ab
7	Elmi Jama Kuuso Feruur Geely	181 ab	186.5	13.5	286.6 c	21.6 ab
8	Elmi Jama Feruur Geely	179 ac	194.1	13.1	308.8 bc	21.6 ab
12	Elmi Jama Feruur Geely	182 ab	190.3	12.8	261.4 c	20.6 ab
15	Elmi Jama Kuuso Feruur Geely Aalle	177 bc	204.5	13.3	337.1 b	21.3 ab
16	Elmi Jama Kuuso Feruur Geely	180 ac	190.7	12.8	286.3 c	17.6 ab
F-test significativity		**	ns	ns	*	**
		1000-SW, g	PW, g	TSW, g	PL, cm	PWi, cm
1	Elmi Jama Cad	32.5 b	92.3 b	65.9 b	10.6 b	6.1 b
3	Elmi Jama Kuuso Normal	34.8 ab	127.4 ab	84.4 ab	11.6 ab	6.6 ab
4	Elmi Jama Feruur Geely	37.9 ab	125.9 ab	87.2 ab	12.4 ab	6.9 ab
6	Elmi Jama Kuuso Feruur Geely	37.6 ab	134.2 ab	93.9 ab	11.8 ab	7.0 ab
7	Elmi Jama Kuuso Feruur Geely	39.1 a	129.7 ab	86.6 ab	11.9 ab	6.9 ab
8	Elmi Jama Feruur Geely	38.7 a	130.2 ab	89.5 ab	12.3 ab	7.1 ab
12	Elmi Jama Feruur Geely	35.6 ab	118.9 ab	76.4 ab	11.8 ab	6.5 ab
15	Elmi Jama Kuuso Feruur Geely Aalle	32.6 b	156.9 a	97.9 a	13.7 a	7.7 a
16	Elmi Jama Kuuso Feruur Geely	32.2 b	103.3 b	67.2 b	11.6 ab	6.4 b
F-test significativity		**	**	*	*	**

For each column means followed by a common letter are not significantly different at the 0.05 level.
** = *F* test significant at 0.01 level, **F* = test significant at 0.05 level, ns = *F* test not significant.

maturing nature of these landraces, a delay in phenological cycle can be due to strong drought stress typical of the area.

Significant differences in plant weight and internode number were found in group A, while homogeneity was detected in group B. Only the accessions Masego Cas (5), Masego Cad (14), Abaadiro (9) and Elmi Jama Kuuso Feruur Geely Aalle (15) exceeded the average limit of 200 cm, showing high number of internodes as well. Carabi (13) and Elmi Jama Cas (2) had the lowest values in both variables. All of the accessions are tall in comparison to improved varieties currently available in the region.

Both groups A and B varied for plant dry weight, with values ranging from 184 to 406 g. In group A the accessions Carabi (13) and Elmi Jama Cas (2) had the lowest value, while the accession Elmi Jama Cad (1) in group B had the lowest plant dry weight. The two accessions Abaadiro (9 and 11) of group A and the accession Elmi Jama Kuuso Normal (3) of group B had the highest values, while the other accessions ranged in values from 240 to 340 g.

Low harvest index characterised all he accessions, indicating greater vegetative growth. In such agro-pastoral environment this landrace characteristic has a strategic importance as the whole plant represents a good forage resource, especially during the dry season. Carabi was the only accession exceeding a harvest index of 30%.

Table 5. Results of analysis of three-way frequency distribution for groups A and B referred to sugar content.

	Hypothesis	*G* value (df)	Result	Independence
Group A				
Test1	$\alpha\beta\gamma = 0$	2.86 (6)	$\alpha\beta\gamma = 0$	No three factor interaction
Test 2	$\alpha\beta = 0$	4.88 (7)	$\alpha\beta = 0$	A and B are independent at each level of factor C
	$\alpha\gamma = 0$	3.34 (12)	$\alpha\gamma = 0$	A and C are independent at each level of factor B
	$\beta\gamma = 0$	77.15** (12)	$\beta\gamma \neq 0$	B and C are not independent at each level of factor A
Test 3	$\alpha\beta = \alpha\gamma = 0$	8.04 (13)	$\alpha\beta = \alpha\gamma = 0$	A is completely independent of factors B and C
Group B				
Test 1	$\alpha\beta\gamma = 0$	5.86 (8)	$\alpha\beta\gamma = 0$	No three factor interaction
Test 2	$\alpha\beta = 0$	5.85 (9)	$\alpha\beta = 0$	A and B are independent at each level of factor C
	$\alpha\gamma = 0$	7.49 (16)	$\alpha\gamma = 0$	A and C are independent at each level of factor B
	$\beta\gamma = 0$	62.26 **(16)	$\beta\gamma \neq 0$	B and C are not independent at each level of factor A
Test 3	$\alpha\beta = \alpha\gamma = 0$	7.49 (17)	$\alpha\beta = \alpha\gamma = 0$	A is completely independent of factors B and C

In the last column letters indicate the following factor: observation time (A), low/high sugar content (B), accession (C).

Table 6. Results of analysis of three-way frequency distribution for groups A and B referred to wax presence.

	Hypothesis	*G* value (df)	Result	Independence
Group A				
Test 1	$\alpha\beta\gamma = 0$	26.73** (6)	$\alpha\beta\gamma \neq 0$	Three factor interaction
Group B				
Test 1	$\alpha\beta\gamma = 0$	14.28 (8)	$\alpha\beta\gamma = 0$	No three factor interaction
Test 2	$\alpha\beta = 0$	105.44** (9)	$\alpha\beta \neq 0$	A and B are not independent at each level of factor C
	$\alpha\gamma = 0$	15.96 (16)	$\alpha\gamma = 0$	A and C are independent at each level of factor B
	$\beta\gamma = 0$	23.16 (16)	$\beta\gamma = 0$	B and C are independent at each level of factor A
Test 3	$\alpha\gamma = \beta\gamma = 0$	24.79 (17)	$\alpha\gamma = \beta\gamma = 0$	C is completely independent of factors A and B

In the last column letters indicate the following factor: observation time (A), wax presence/absence (B), accession (C).

The 1000-seed weight was similar for all accessions except for Carabi (13) which had the highest value (50.0 g). This parameter is of particular interest in relation to drought resistance (Okonkwo and Onoenyi 1998). Large seed size in sorghum is associated with higher germination percentage, better stand establishment and higher grain yield (Ayana and Bekele 2000). This is not the case in the United States. Typically, large seeded sorghums have poor germination and stand establishment and lower total grain yield.

Based on panicle weight and total seed weight, four accessions, Masego Cad (14), Carabi (13) and Abaadiro (9 and 11) in group A, showed good yield potential. Little variation was observed in group B, except for the Elmi Jama Kuuso Feruur Geely Aalle (15) which had value of 156 g.

With regard to panicle dimensions the values ranged from 10.1 to 13.7 cm in length and from 6.1 to 8.3 in width. Group A had a higher variation than group B. Panicle length and width are important components which contribute to yield (Appa Rao et al. 1996). They are stable characters, which are a typical feature of a particular race (Mann et al. 1983; Doggett 1988; Harlan 1992). The accessions of the area, in general, had compact (*kuuso* in Somali language) and oval panicles, typical feature of race *Durra*. The semi-compact elliptic forms, called *farangaago* by local farmers, were less frequent.

Head compactness seems to be associated with humidity at flowering and ripening time. In particular very dense panicles are frequently found in areas of extremely dry conditions (Appa Rao et al. 1996).

Sugar content varied within accessions, but no significant difference were detected between flowering and harvest periods (Table 5), indicating that midrib colour, reported as a juvenile characteristic (Appa Rao et al. 1996), does not vary during the crop cycle. Elmi Jama Cad (1), Masego Cas (5), Carabi (13), Elmi Jama Kuuso Feruur Geely Aalle (15), Elmi Jama Kuuso Feruur Geely (16) showed few plants with a green-yellowish midrib, with percentage varying from 0 to 30%. All the other accessions had percentages comprised between 60 and 80%.

The presence of wax was significatively higher during flowering time in group B ranging from 70 to 100%, while the percentage values varied from 20 to 50% at harvest time (Table 6). No difference were found between accessions in group B (Table 6). In group A, three factor interaction was highly significant, however, trends observed in group A were similar to those in group B.

Multivariate analysis

Discriminant analysis, using the accessions as a grouping variable, revealed that only 3 accessions – Masego Cas (5), Carabi (13), Masego Cad (14) – reached a relatively high percentage of classification (Table 7). In particular the accession Carabi (13) reached a value of 88.2%, confirming a higher phenotypic homogeneity.

The first three discriminant functions explain 82.4% of the total variation between the 16 sorghum accessions for the 9 quantitative variables studied (Table 8). The variables days to maturity, plant height, 1000-seed weight,

Table 7. Summary of discriminant analysis for 16 sorghum accessions by accession.

	No.	True accession															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	48	**24**							4	8	8		4				
2	56	4	**28**			4	4		4			4			8		
3	80			**36**		4		4	4	12	4	4	4			4	4
4	44	4		4	**16**				8		4					4	4
5	108	4	8	4		**76**				8		4		4			
6	60			4	8		**12**	12	8		8	4	4				
7	44				4			**12**	8				8	4	4		4
8	84			8	28	4	4	12	**20**	4							4
9	116	12		4		16	16		4	**12**	20				20	4	8
10	108	12	16	4					4	12	**36**		4	4			16
11	100		20	8	4		8	4	4	12		**8**			16	8	8
12	80	8		4	8	4		12	8				**16**			12	8
13	68		8											**60**			
14	88	4							4		4	8			**64**		4
15	72	4		4		4			4	4	4	8	4			**36**	
16	64			12	8		4				4		4			8	**24**
% correct		50.0	50.0	45.0	36.4	70.4	20.0	27.3	23.8	10.3	33.3	8.0	20.0	88.2	72.7	50.0	37.5

Table 8. Eigenvalues, total variance and cumulative variance.

	DF1	DF2	DF3	DF4	DF5	DF6	DF7	DF8	DF9
Eigenvalues	0.99	0.747	0.313	0.153	0.135	0.09	0.028	0.02	0.012
% of total variance	39.8	30.0	12.6	6.1	5.4	3.6	1.1	0.8	0.5
% cumulative variance	39.8	69.8	82.4	88.5	94.0	97.6	98.7	99.5	100.0

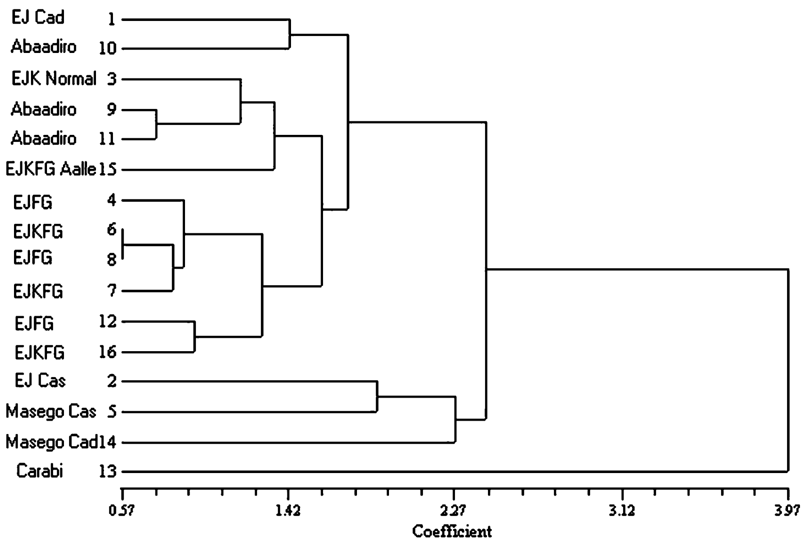

Figure 1. Dendrogram showing the clustering patterns between the 16 Somali sorghum accessions.

panicle weight, length and width were the most important characters contributing to the first three discriminant functions.

Cluster analysis, based on Euclidean distance matrix, was used to obtain a dendrogram of the accessions (Figure 1). The dendrogram clearly indicates that the accession Carabi (13) is isolated from the other accessions. Three accessions Masego Cas (5), Masego Cad (14) and Elmi Jama Cas (2) form a distinct second cluster, while the other accessions form a distinct third cluster.

Discussion

Morphological and agronomic studies of sorghum germplasm from Southern Somalia have been done (Damania and Rao 1980; Prasada Rao et al. 1989). However, no information is available on sorghum germplasm from Northwest Somalia. This study represents a preliminary investigation on sorghum germplasm collected in the District of Gabiley. The results showed a wide range of variation within and among accessions for the characteristics studied, confirming the existence of variable populations which can be grouped into distinct clusters (Figure 1). In addition names given by farmers to the accessions are partially consistent and represent morphologically different sorghum landraces, confirming research done in previous studies. This underscores the importance of considering farmers' knowledge of diversity in collection, evaluation and selection of local germplasm.

Elmi Jama Cas (2), Masego Cas (5), Carabi (13) and Masego Cad (14) clearly represent distinct landraces, each with unique characteristics. In particular, Carabi (13) showed characteristics different from all the other accessions: reduced height, white and vitreous grain, high 1000-seed weight and a high morphological and productive stability. Furthermore, farmers indicate that this accession was best for the *injera* production. Masego Cas (5), Masego Cad (14) and Elmi Jama Kuuso Feruur Geely Aalle (15) showed high yield potential in terms of biomass and grain production suggesting a dual-purpose application. Several accessions had high sugar content, which can be exploited in new utilisation of the crop.

In general the accessions are characterised by tall and late maturing plants. These landraces are able to grow and produce under very harsh environmental conditions (drought, poor soils, excessive radiation, etc)., showing specific ecological characteristics (e.g. wax presence, high seed weight, compact panicle, tall plants). Local environment conditions have influenced the genotypic constitution of these landraces suggesting a close relationship between agro-ecological conditions and morpho-phenological variation of this germplasm.

The presence of such variation in a narrow collection area indicates that farmers deliberately maintain a wide diversity of sorghum landraces to meet their social, economic, cultural and ecological needs. In fact, farmers' selection for desiderable agronomic traits is the main force in shaping the genetic dynamics of the crop populations. They provide opportunities for hybridisation among interfertile landraces, which may be otherwise geographically or ecologically isolated. This also provides an opportunity for *in situ* conservation of local biotypes and maintenance of agro-ecological environments. The dynamic process of continuous interaction and adaptation shapes the local genepool that is maintained by farmers' manipulation. Thus landraces and farmers are interdependent and both are in need of each other for their survival (Appa Rao et al. 1998).

Today this traditional dependence is at risk with catastrophic consequences for local poor resources farmers and maintenance of genetic diversity within sorghum. Traditional landraces are being relegated to marginal and risk-prone areas as they are replaced by improved varieties. This can lead to the lose of local knowledge of traditional landraces and an erosion of genetic diversity.

The case of Somalia follows the same trend observed in other PVS where the local agriculture, founded on an ancient relationship between ecological characteristics and social needs, is continuously threatened by unpredictable environmental and social changes. Somali farmers report the loss of old traditional landraces, preferred for traditional bread production, such as Abaadiro, Carabi and Masego. Moreover they have reported a decrease in sorghum production and consumption due to importation of wheat flour and rice from Ethiopia. Conservation and improvement of sorghum accessions are, therefore, of practical value. Improvement of the crop will lead to greater stability of a traditionally reliable food source that is known and understood in Northwest Somalia.

This research is the first attempt to characterise some of the genetic diversity found within Somalia. The analytical tools outlined in this manuscript can be a useful tool in detecting genetic variation within local sorghum germplasm and will aid in the conservation and preservation of unique genetic diversity. These results can also be used in improvement programs that can create sorghums that are adapted to and meet local needs. Production stability and global food security are linked to the conservation and exploitation of world-wide genetic resources and this research attempts to add to that body of knowledge.

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