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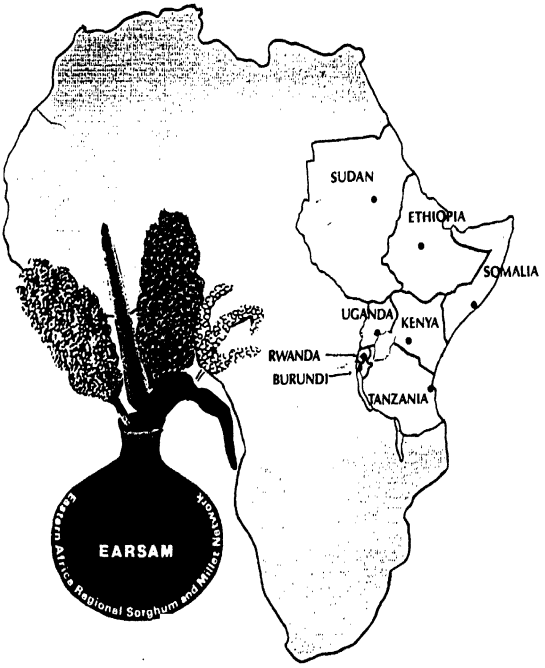

GENETIC DIVERSITY OF SORGHUM AND MILLETS IN EASTERN AFRICA*

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Introduction

The various germplasm collection and evaluation programs carried out by several national, regional, and international organizations have helped us realize and assemble 11,932 diverse germplasm accessions of sorghum and millets from Africa. Germplasm originating from the highlands of eastern Africa could be good source for cold tolerance, those coming from low elevation often show desirable grain quality, early maturity and some drought tolerance. Local germplasm is often valued for its adaptation and as source of resistance to prevailing biotic and abiotic stress factors. The Zerazera, Kurgi, Hegari, Feterita, and Milo types of sorghum have offered several desirable characters and are extensively used in sorghum improvement.

Some landraces of sorghum such as E-35-1 from Ethiopia was found to be promising in Burkina Faso. Dobbs from Nyanza area of Kenya, and Wiru from western Tanzania were well adapted elsewhere. Some of the converted Zerazera lines with reduced plant height and early maturity offer better scope for utilization.

Pearl millet from Dodoma, Tanzania is a good source for large spike character. Material developed from Serere is popular throughout millet growing areas. Eastern Africa is an important area for wild relatives of millets whose potential is yet to be fully realized.

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Eastern Africa is a region of contrasts, where Afri lowest and highest elevations are found. Differences altitude, rainfall and temperature over short geographic tances provide varying environments suitable for diversificat early domestication and subsequent cultivation of landraces.

Sorghum (Sorghum bicolor (L.) Moench), pearl mil (Pennisetum glaucum(L.) R.Br.), and finger millet (Eleus coracana (L.) Gaertn.) are important cereal crops in almost the countries of eastern Africa (Table 1). Finger millet is tensively grown in the uplands of the Rift Valley. It is hig priced and valued for its nutrition. Landraces of sorghum pearl millet are fairly well collected from the more accessi areas of eastern Africa. However, more collections must be m in remote areas not only for cultivated landraces but more their wild relatives.

Collection of cereals germplasm

Diverse forms of sorghum and millets are gradually getting lost due to frequent drought, replacement by high yielding cultivars, population growth, overgrazing and urbanization. The landraces possess several desirable characters including local adaptation. With a view to utilize the germplasm for crop improvement and to conserve them for posterity, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Board for Plant Genetic Resources (IBPGR), and several other international, regional and national organizations have launched several collecting missions in Africa and have collected a wealth of material (Table 1). Sorghum germplasm from eastern Africa is extensively used throughout the world for sorghum improvement (Brhane 1982, Mengesha and Prasada Rao 1982). Diversity of cereals germplasm in eastern Africa and their use is summarized in the following countrywise statements.

Burundi

Sorghum, locally known as "Yamasaka", is the second most important cereal crop. It is grown mainly as a sole crop, but is occasionally mixed with cassava (Manihot escelenta (L.) Crantz). Though traditional landraces are common, improved cultivars like 5Dx160, and SVR8 (IS 25487), an introduction from Rwanda, are grown sporadically. Sorghum is primarily cultivated in Burundi for making beer (Pombe) and thick porridge called "Ugali" (Prasada Rao and Mengesha 1988).

In July 1982, ICRISAT in collaboration with the L'Institut des Sciences Agronomiques du Burundi (ISABU) collected 105 samples of sorghum of which 61 were Caudatum and 44 Durra-caudatum. A duplicate set of the collected material was delivered to ISABU. However, only 28 samples are viable in Burundi (Toll 1986) and the rest could be transferred from ICRISAT. Subsequently, 158 samples of sorghum were collected by IBPGR (Toll 1986). Though there is limited taxonomic variation, the grain color varied from light brown to reddish brown and panicle shape varied from compact oval to semi-loose with drooping primary branches. Around Bujumbura, it was interesting to find rare twin-seeded sorghums belonging to the race Caudatum and broom corn as the majority of twin-seeded stocks present in the world collection belong to the race Durra.

Though no pearl millet was found during the 1982 ICRISAT exploration in Burundi, several wild relatives such as dwarf forms of Pennisetum purpureum and Pennisetum polystachyon were collected. Pennisetum thunbergii and Pennisetum trachyphyllum were also reported from Burundi.

Finger millet is the most important cereal after maize and sorghum. It is mainly used for making beer. In-curved panicle types are commonly grown in Burundi.

Ethiopia

Ethiopia is an important country in eastern Africa as source of diverse genetic resources of sorghum and finger millet. Several collection missions have been carried out in the country by various international and national organizations. About 5000 sorghum accessions were collected by the Ethiopian Sorghum Improvement Project (ESIP) in the seventies. This collection includes some of the elite landraces such as "Muyera", "Wagereh", "Worge", "Dogonogof", "Zenga", and "Zengheda" as described by Damon (1962). "Tinkish" a sweet culm type and "Fendisha" a pop sorghum were among them. This collection was conspicuously deficient in Zerazera landraces. In realization of the danger of germplasm erosion and also in view of the immediate utility of Zerazeras, a pointed collection mission was organized in 1982 in the Gembella area of Ethiopia in collaboration with the Ethiopian Sorghum Improvement project (ESIP), the Plant Genetic Resources Center (PGRC), Ethiopia, and the IBPGR (Prasada Rao and Mengesha 1981a, 1982). The term "Zerazera" is from the Sudanese local name for sorghums, which belong to the races Caudatum and Caudatum-guinea. They are highly prized for yield, grain quality and resistance to diseases and drought, and are used extensively in several sorghum improvement programs.

The highly variable Zerazera sorghums, locally called 'Ganga', 'Juwalum' and 'Utedit' are extensively grown in the Gambella area by the 'Agnwak' farmers on the banks of 'Baro' river after the receding of floods. These agronomically superior plants are tan, with attractive heads and good grain quality. They are practically free from diseases in spite of the high temperature and humidity prevailing during seed setting. This suggests their possible utilization as source material for yield, grain quality, and resistances for grain molds and leaf diseases. Since most of the samples collected are from crops grown after the receding of floods with the residual moisture under relatively high temperatures, it is likely that some of the lines may also be heat-tolerant. As with other tropical germplasm, the only restriction for the easy flow of Zerazeras into improvement programs may be their photoperiod sensitivity. To circumvent this, some of the Zerazeras have been converted to day-neutral, short background by inclusion in ICRISAT's Conversion Project. Converted lines in different height and maturity backgrounds are available for utilization.

Though Linneaus considers Ethiopia as the center of origin of pearl millet, area under pearl millet is small except in regions bordering Sudan. However, wild species of Pennisetum are abundant in the highlands and need to be collected. Finger millet is the most important millet crop which was collected jointely by ESIP and ICRISAT. The collected material is yet to be transferred to the ICRISAT gene bank for long-term conservation and international exchange.

Kenya

Parts of Kenya were explored by IBPGR to collect sorghum and millets. The remaining areas need to be explored to complete the collection works. IBPGR had collected 418 landraces of sorghum, 47 pearl millet, and 253 finger millets. When evaluated at ICRISAT Center, many of them were found to be photoperiod sensitive. Pearl millet from Kenya is a good source for tillering. In addition, scientists from International Center for Insect Physiology and Ecology (ICIPE) also collected sorghum and pearl millet which were transferred to ICRISAT. Finger millet germplasm collected by IBPGR in Kenya offers a good source for compact and large size panicles.

Rwanda

Sorghum, locally known as 'Amasaka', is the major cereal crop in Rwanda. It is cultivated on hill slopes at altitudes ranging from 1000 m to 2300 m with a bimodal rainfall pattern ranging from 855 to 1575 mm per annum. The high altitude of Rwanda moderates the equatorial temperatures resulting in low temperatures with cool nights except in the southeast. Because of its unique agroclimatic condition, Rwanda presents a wide range of sorghum germplasm. Most of the landraces are sown in January and harvested in July, maturing in about 180 days. Sorghum is primarily grown for making beer. Some is also consumed as 'Ubugali'. 'Igikoma' is another kind of preparation in which sorghum flour is added to hot water, and the mixture is boiled, then some sugar is added. It is stated to be a special food for lactating women and children.

In July 1982, ICRISAT organized a sorghum germplasm collection mission in collaboration with the Institut des Sciences Agronomiques du Rwanda (ISAR). The major sorghum growing areas of Kigali, Butare, Gikongoro, Cyangugu, Kibuye, Gitarama, Ruhengeri, Buyumba and Kibungo districts were explored, and 170 sorghum sampels were collected (Prasada Rao and Mengesha 1982a, 1983). Of these, 123 were head samples collected from the farmers' fields, which were classified based on their spikelet morphology, into the two taxonomic races: Durra-caudatum and Caudatum.

Most of the samples collected belong to the intermediate race Durra-caudatum which has a wide range of variation in panicle compactness and shape. Sorghum cultivars locally called 'Mugabo', 'Kigufi', 'Igihove', 'Amabanda' and 'Kirenge' are most popular. SVR 127, a pure line derived from the cultivar 'Kebo', has high yield potential.

The Caudatum race is not so widely distributed as the Durra-caudatum. 'Bumperaho' which has a semi-loose panicle with light brown grain, is specially preferred for 'Ubugali'. 'Nyiragikoli' is a popular landrace with a semi-loose panicle and stiff primary branches; its grain is chalky-white and is also preferred for 'Ubugali'. The cultivar 'Nyiragikoli' is grown mainly in drier regions of Rwanda.

In general, the landraces of sorghum collected in Rwanda were relatively free from pests and diseases. Not even a single instance of grain mold was noticed even though the months of June and July are not totally free from rain and humidity. Because of high altitudes and low temperatues prevailing in Rwanda, the germplasm from this country may contribute source material for cold tolerance (Prasad Rao and Mengesha 1983).

Somalia

During August-September 1979, IBPGR and ICRISAT organized a sorghum and millet collection mission in Somalia. The mission was carried out in close collaboration with the Ministry of Agriculture of Somalia Government. In this mission, the main sorghum belt of the Bay, Gedo, Bakol, Middle Shebelle and Hiran regions of South Somalia, were covered and 110 samples consisting of 96 sorghum, 3 pearl millet, and other crops (Ramanatha Rao 1979) were collected.

In 1987, ICRISAT launched a second mission in collaboration with the Ministry of Agriculture, Government of Somalia and collected 227 samples of sorghum (Prasada Rao 1987). These included Sorghum virgatum and S. purpureosericeum wild relatives and their natural hybrids. Majority of sorghums collected are Durra types that were early-maturing (around 100 days), and forage types with broad leaves. Zerazera, Dabar and Hegari sorghums, also under cultivation in areas bordering Ethiopia, are longer in duration (110 days) with larger panicles and bold grain. Local sorghums show tremendous variation in pericarp color. The white, flinty endosperm types are claimed to be relatively weevil resistant. The main season for growing sorghum in southern Somalia is 'Gu' (April to June) with a total rainfall of 250-300 mm. There is a practice of ratooning sorghum in 'Dery' (September - November) season. Dark red grain types known as 'Shamuri' are bitter and are claimed to be unpalatable to birds. Farmers consider that goose necked panicles of local sorghums are relatively more resistant to Quelea. The Ministry of Agriculture of Government of Somalia is currently evaluating at Baidoa the entire Somalian germplasm collection for possible selection and exploitation of indigenous germplasm. In general, the southern Somalian collection is of importance to sorghum scientists as it may provide source material for earliness, grain and forage quality, resistance to stem borer, terminal moisture stress, and resistance to storage pests. This observation confirms the concept that environment has much to do with the adaptation and culture of different genotypes in different environm

Sudan

Sudan is an important country for the genetic resources of cereals. The most popular sorghum varieties of the USA, 'Feterita' and 'Hegari', were first obtained from Sudan in 1906 and 1908 (Martin 1970). 'Zerazeras' from Sudan are being extensively utilized in the current breeding programs. Furthermore, Sudan is the place for the collection of wild sorghums, a likely region for early sorghum domestication.

Realizing the importance of sorghum germplasm collection in Sudan, an expedition was organized by the Genetic Resource Unit of ICRISAT in November 1979 in collaboration with the IBPGR and the Ministry of Agriculture, Democratic Republic of the Sudan. A pointed collection was organized in 1983 in Gezira, Kassala, and Blue Nile provinces and collected 155 samples comprising mainly the 'Zerazera' landraces and the wild relatives of sorghums.

A wide range of sorghum landraces belonging to the races Caudatum, Durra, Guinea-caudatum, Durra-caudatum, Durra-bicolor and Bicolor-caudatum were collected (Prasada Rao and Mengesha 1979a, 1981a). Many landraces such as 'Dabar', Zerazera', 'Safra', Mugud", 'Kurgi', Feterita', and 'Mayo' have good agronomic value and would probably prove useful in breeding programs. 'Tetron', cultivated in the Kafai area near the Ethiopian border, is reported to be Striga resistant which needs confirmaton. 'Hegari', once a very popular landrace, is completely out of cultivation, and 'Zerazeras' and 'Kurgis' are on the verge of extinction. Some wild sorghums once reported to be abundant are now found only in isolated patches. These too are being replaced by the more aggressive shattercanes and other weedy types in the Kassala province.

Pearl millet locally called 'Dukhun' is important crop next to sorghum. There are three types of pearl millet with three different grain colors. 'Dukhun Akhder' has grayish pericarp color, 'Dukhun abet' is creamy white and 'Dukhun Ahmer' is with light red pericarp. Heads are mostly medium-long and thick with good grain compactness. Considerable variation was observed for seed color including yellow, brown and purple. ergot is present in isolated areas. Grain size in one of the wild Pennisetums (P. schweinfurthii) is relatively large.

Tanzania

Tanzania offers a wide genetic diversity of cereals. IBPGR and ICRISAT collaborated and collected germplasm from Tanzania (Prasada Rao and Mengesha, 1979a, 1980, Ramanatha Rao and Mwenda 1987, Appa Rao et al. in press). Guinea sorghums belonging to the subraces Roxburghii, Conspicuum, Guineense, and Margaritiferum occur in Tanzania, but the most common belong to conspicuum and guineense types (Prasada Rao and Mengesha 1979a, 1980). Distribution of tall guineas in Morogoro, Dodoma, Iringa, and southern Tanzania suggest their ecological adaptation to the higher rainfall regions by virtue of their lax panicles, open glumes, and vitreous grains. In general, Caudatums look agronomically good and are comparatively early maturing. Some are mainly used in the preparation of beer. Durra ('hemba-hemba') and Durra-caudatum landraces are prevalent in the drier parts of Tanzania. The majority of the samples collected belong to the basic races of Guinea, Caudatum and Durra or their intermediate races. Bicolors and half bicolors are very few and kafirs have not been seen.

Wild and weedy sorghums: Morogoro and Iringa are apparently important regions for the collection of wild sorghums. Sorghastrum sp, a closely related genus to Sorghum, with characterisitc absence of pedicellate spikelets, is abundant along the road sides. Sorghum versicolor and Sorghum purpureosericeum, the two para sorghums with characteristic bearded sheath nodes, are mostly seen along the road sides from Mikumi to Morogoro and Dar-es-Salaam. In addition, races S. arundinaceum and S. verticilliflorum have also been collected on the bunds of small streams. The distribution of wild sorghums is more towards the high rainfall regions of southern Tanzania rather than the central and northern regions.

Pearl millet, locally called 'Uwele', is mainly distributed in the drier regions of Dodoma, Singida, Shinyanga and Babati. There is wide variation in the landraces in respect of head length, width and shape; grain color, shape and size; and bristling characters (Appa Rao et al. in press). The variation in head types ranges from short, compact, oval to large, long and cylindrical.

Basal branching is noticed in some types. Presence and length of bristles is variable in the types collected. Grain colors are gray, light gray, yellow and white. Grain size varied from very small to extremely large with different characteristic shapes.

Around Dodoma, pearl millet produces very long (>50 cm), thick (>50 mm), loose spikes. basal tillering is poor with no aerial tillers. Around Singida, pearl millet tillers considerably but produces only small spikes. Differences in tillering and spike size between Dodoma and Singida landraces might be because of the evolution of different genotypes adapted to different farming practices. Around Igunga, where the soils are heavy and farming is intensive, pearl millet tillers profusely and produces short (15-20 cm long), thick (>60 mm) spikes.

Pennisetum purpureum Schum. was found growing extensively in relatively high rainfall areas. It was used as a fence and the mature stalks were used to make benches. Pennisetum mezianum Leeke was found in black soils around the roadside and in low-lying areas. Pennisetum polystachyon L. Schult. was found almost everywhere, especially on light soils with two distinct types that varied in spike color.

In 1978 and 1979 expeditions, 18 samples of wild Pennisetums have been collected, out of which P. polystachyon, P. purpureum and P. mezianum could be identified. Shibras are found in the cultivated fields.

Finger millet, locally called as 'Ulezi', is distributed in the Singida, Babati, and Dodoma regions. Arusha and Moshi in the northern Tanzania and Sumbawanga in the south western Tanzania are important finger millet production areas and may be more important areas for the collection of finger millet. Both top-curved head types were collected. Eleusine indica and eleusine multiflora are wild types distributed in Tanzania. In 1987, a total of 587 samples consisting of 299 pearl millet, 261 sorghum and 15 finger millet were collected (Appa Rao et al. in press).

Uganda

Sorghum, pearl millet, and finger millet are important crops of Uganda. Sorghum and millet improvement began at Serere under the aegis of East Africa Agriculture Research and Forest Research organization (EAAFRO) in 1958. Local germplasm was collected and utilized. Red/brown sorghums are grown because of damage by yellow weavers and bishop birds (Doggett 1982). In pearl millet, early-maturing forms with profuse tillering are common. Some of the composites developed have wide adaptation elsewhere in Tanzania, and Botswana. Sorghum and pearl millet germplasm from Uganda were collected by IBPGR.

EVALUATION

To classify and identify useful traits in the germplasm, all the accessions are evaluated and screened at Patancheru in two different seasons; rainy and postrainy. In order to realize the full potential of the accessions, the material is grown under optimum management conditions. Standard descriptors are used to evaluate the material (IBPGR/ICRISAT 1981, 1982). Most of the sorghum and pearl millet from the highlands of eastern Africa flower only in November/December with the onset of short days at Patancheru. The photoperiod sensitive lines become more vegetative during the rainy season while their growth and development is drastically reduced during the postrainy season. Considerable variation was found in all the characters studied (Table 2).

Screening for special traits like resistance to diseases and insects, and grain quality are carried out by various specialists. Lines identified as sources of resistance (Tables 3 & 4) are maintained as genetic stocks collection. Though most of the characters are realized during evaluation at Patancheru, some of the lines do not express fully as a few lines which look promising and attractive in the farmers' fields appear different at Patancheru. However, when evaluated at or near their original habitat, they behave more or less similar to the original farmers' fields. This suggests the need for evaluating the germplasm at or near the place of origin. As a beginning, some 5000 accessions of sorghum germplasm were evaluated at Nazret, Ethiopia in 1981 in collaboration with PGRC and ESIP.

References

Appa Rao, S., Mitawa, G.M., Felix, J., and Mengesha, M.H. (In press). Pearl millet germplasm collection from Tanzania. FAO/IBPGR Plant Genetic Resources Newsletter.

Brhane, G. 1982. Utilization of germplasm in sorghum improvement. Pages 335-345 in Sorghum in the eighties: proceedings of the International Symposium on Sorghum, 2-7 Nov 1981, ICRISAT Center, India. Vol. 1. patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Damon, E.g. 1962. The cultivated sorghums of Ethiopia. Experiment Station Bulletin No. 6, Imperial Ethiopian College of Agriculture and mechanical Arts. 72 pp.

Dogget, H. 1982. Sorghum improvement in east Africa. Pages 60-87 in Crop Improvement in East Africa (Leakey ed.), Farnham Royal, England: CAB.

Martin, J.H. 1970. History and classification of sorghum. Pages 1-27 in Sorghum Production and Utilization, eds. J.S. Wall and W.M. Ross. The Avi publishing Company Inc. West Port Connecticut.

Mengesha and Prasada Rao. 1982. Current situation and future of sorghum germplasm. Pages 322-333 in Sorghum in eighties: proceedings of the International Symposium on Sorghum, 2-7 Nov. 1981, ICRISAT Center, India. Vol. 1. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid tropics.

Prasada Rao, K.E. 1987. Trip report Somalia. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 3pp (limited distribution).

Prasada Rao, K.E., and Mengesha, M.H. 1979. Sorghum and Millets germplasm collection in Tanzania. Genetic Resources Progress Report No. 9. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 29 pp.

Prasada Rao, K.E., and Mengesha, M.H. 1979a. Sorghum and Millet Germplasm Collection in Eastern Sudan. Genetic Resources progress Report No. 16. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 27 pp.

Prasada Rao, K.E., and Mengesha, M.H. 1980. Sorghum germplasm collection in Tanzania. Sorghum Newsletter 23: 35-36.

Prasada Rao, K.E., and Mengesha, M.H. 1981. Genetic resources of sorghum from eastern Sudan. Sorghum Newsletter 24: 101

Prasada Rao, K.E., and Mengesha, M.H. 1981a. A pointed collection of Zerazera sorghums in the Gambella area of Ethiopia. Genetic Resources Progress Report No. 33. patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 37 pp.

Prasada Rao, K.E. and Mengesha, M.H. 1982a. Zerazera sorghum in Ethiopia. Sorghum Newsletter 25: 87-88.

Prasada Rao, K.E., and Mengesha, M.H. 1982b. Sorghum germplasm collection in Rwanda. Genetic Resources Progress Report No. 46. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 28 pp.

Prasada Rao, K.E., and Mengesha, M.H. 1983. Sorghum germplasm from Rwanda. Sorghum Newsletter 26: 86-87.

Prasada Rao, K.E., and Mengesha, M.H. 1988. Sorghum germplasm in Burundi. Genetic Resources Collect Report No. 1, Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Ramanatha Rao, V. 1979. Germplasm collection mission in Somalia. Genetic Resources progress Report No. 12. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 19 pp.

Ramanatha Rao, V., and Mwenda, F.F. 1987. Groundnut germplasm collection in Tanzania. FAO/IBPGR Plant Genetic Resources Newsletter 70: 35-37.

Snowden, J.D. 1936. The cultivated races of sorghum. Ondon: Adlard and Son. 274 pp.

T lant genetic resources project for , Zaire). Rome, Italy: International sources.

Table 1. Area under sorghum and millets, and number of germplasm samples available at ICRISAT.

	Sorghum		Millets	Pearl millet	Finger millet
Country	Area (000 ha)	No.of samples	Area (000ha)	No.of samples	No. of samples
Burundi	180	115	50	0	11
Ethiopia	910	4464	230	1	27
Kenya	160	872	60	69	317
Rwanda	145	150	3	0	-
Somalia	500	125	-	3	-
Sudan	4896	2385	1485	559	-
Tanzania	800	437	332	449	20
Uganda	200	1245	350	66	617

Table 2. Range of variation in some selected characters of sorghum and pearl millet germplasm samples evaluated at ICRISAT Center, Patancheru.

Character	Sorghum	Pearl millet
Days to 50% flowering	36-199	36-159
Plant height (cm)	55-655	63-475
Peduncle exsertion (cm)	0-55	-21-+30
Head length (cm)	2.5-71	6-165
Head thickness (mm)	10-290	10-64
Number of tillers	1-15	1-26
Stalk sugar content (%)	12-38	1.4-19.7
Grain color	White-dark brown	White-dark purple
100-seed mass (g)	0.58-8.56	0.27-1.93

Table 3. Sorghum genetic stocks collection maintained at Center.

Type	Number of accessions
Promising lines for pest resistance	
Shoot fly (*Atherigona soccata*)	60
Stem borer (*Chilo partellus*)	70
Midge (*Contrarinia sorghicola*)	14
Headbug (*Calocoris angustatus*)	6
Promising lines for disease resistance	
Grain mold	156
Anthracnose (*Colletotrichum graminicola*)	15
Rust (*Puccinea purpurea*)	31
Downy mildew (*Peronosclerospora sorghi*)	155
Striga-low stimulant lines (Lab screening)	645
Striga-resistant lines (Field screening)	24
Other characters	
Glossy lines	501
Pop sorghum lines	36
Sweet-stalk sorghum lines	76
Scented sorghum lines	17
Twin-seeded lines	131
Large-glume lines	71
Bloomless sorghum lines	207
Broomcorn sorghum lines	52
Cytoplasmic male sterile and maintainer	240

Table 4. Pearl millet genetic stocks collection maint. ICRISAT.

Screened for	No. of promising lines
Insect Resistance	
Myrthimna spp.	8
Shoot fly	45
Aphids	14
Shoot bugs	8
Thrips	3
Spider mites	13
Disease Resistance	
Downy mildew	124
Ergot	24
Smut	34
Rust	86
Drought Tolerance	2
Other traits	
High protein content	100
High sugar content	4
Male sterility	25
Glossy leaf	8
Dwarf lines	6
Morphological variants	692
Viable chlorophyll mutants	11